PHONOLOGICAL LEARNING RESULTS IN A GENERALISATION OF ACCENT ADAPTATION TO NOVEL LEXICAL ITEMS

A behavioural study into novel accent learning using a cross-modal priming task

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Abstract

This behavioural study investigated how people adapt to a novel accent and how phonological learning works when words are presented in isolation. A previous study by Bujok (2019) used six vowel shifts to create a novel Dutch accent. Bujok's experiment showed that participants could easily adapt to the artificially created accent, but it remained unclear whether the participants either learned the rules (e.g., the ɪ -> ʏ vowel shift), or memorised the specific items. The present study aimed to replicate and extend these findings, and this was achieved by adding a cross-modal priming task to Bujok's learning task. In the present study, participants were auditorily presented with primes that contained *learned*, or *related* vowel shifts, or primes that were *unrelated* to the target words. The hypothesis was that, if a learning effect was to be found, the *learned* and *related* primes would influence the participants' reaction times during the lexical decision task. The replicated task demonstrated a learning effect, as the participants clearly improved over time. The cross-modal priming task showed the lowest reaction times for *learned* primes, followed by higher reaction times for *related* and *unrelated* primes. Whereas the *related* and *unrelated* primes did not influence the participants' reaction times, the *learned primes* clearly did. Thus, we can ascertain that when learning an accent, people do not learn the specific items, but are able to generalise the rules and relate them to novel words.

1. Introduction

As billions of people live on this planet, it is inevitable that we meet new people in our lives. We talk to many people daily, who all use language differently. According to the linguistic organisation Ethnologue (2020), English is the most widely spoken language in the world. Around 1.27 billion people speak English either as their native language or as their second language. The English language has been spreading globally since the British colonisation of the Americas. As the language has spread across countries and cultures, different forms of the language have been adopted. A total of 67 countries register English as their official language (Lingoda, 2021), but interestingly, the British Library (2019) records 70 different accents and dialects in the United Kingdom alone. For example, a strong accented form of English is spoken by people in the North-East of England: the Geordie or Newcastle accent. This distinctive accent can be difficult to understand as it has some strong lexical, phonological, and grammatical differences to standard English. The final vowel, for example, is given greater stress than in standard English, making "sugar" sound like "/ʃʊga/" and "water" like ˈ/wɔd̰ɐː/'. Secondly, many people are familiar with the London Cockney accent. In this accent, glottal stops are used to replace a /t/. For example, "water", would be pronounced as "/wɔ:ʔə/". Another strong form of English is Scottish English. Speakers of Scottish English may say "the weins wouldnae stop greetin", whereas speakers of standard English are more likely to say "the children would not stop crying". In Scottish English, a negative is formed by adding the suffix "nae" or "na" to the auxiliary verb. It is evident that Scottish English not only has some different vocabulary, but also some different grammatical constructions. Incidentally, these grammatical constructions are a result of the influence of the Scottish dialect, influenced by Gaelic. As we see from the above, even though we can communicate in English with millions of people, we still face numerous challenges as the language has many different accents and dialects throughout not only the different regions in the UK, but also throughout the different English-speaking countries.

This implies that every person has their own idiosyncratic way of speaking, and this may lead to misidentifications or misunderstandings. Despite inter-speaker variability, we can adapt to these unfamiliar accents, allowing us to communicate with people all over the world. But how does this work? How do we adapt to novel accents? Many studies have attempted to explain this phenomenon. Nonetheless, many questions still remain regarding adaptive learning.

The aim of the present study is to further investigate how phonological learning works, by examining a novel and unfamiliar accent in Dutch. The introduction begins by discussing evidence on accented speech adaptation. It then gives an overview of mechanisms that underly this process and discuss generalisability. The introduction ends by showing the current research gap and providing a brief description of the materials, followed by a statement of the hypotheses for the present experiment. Section 2 describes the methodology, which is followed by the analysis of the results. The final section discusses the findings of the present study and gives suggestions for future research.

1.1 Adaptation to accented speech

Previous research has shown that people are able to quickly adapt to a novel accent (Bujok, 2019; Clarke & Garrett, 2004; Dahan, Drucker & Scarborough, 2008; Floccia, Goslin, Girard & Konopczynski, 2006; Maye, Aslin & Tanenhaus, 2008; Skoruppa & Peperkamp, 2011). For example, Clarke and Garrett (2004) investigated the adaptation of foreign-accented speech, by measuring the participants' reaction times (RT) to a cross-modal matching task.

The participants listened to low probability sentences (e.g., “She must have known about the pie”) in Spanish- or Chinese-accented speech in English. A cross-modal matching task followed after each sentence, asking the participants to judge whether the presented picture matched the last word of the accented utterance. They found fast adaptation, meaning that within the first minute of exposure, the participants responded as quickly to accented speech as to normal speech. Clarke and Garrett (2004) concluded that English-speaking adults recognise words in Spanish- and Chinese-accented English as quickly as in non-accented English. However, Floccia et al. (2006) reached a different conclusion. They investigated the processing costs of regional accents, by asking participants to listen to accented French sentences and to indicate whether the last word of the sentence was a real word or not. In the first study’s second experiment, Floccia et al. (2006) presented words in isolation to examine the processing costs of listening to an unfamiliar accent. They found differences in the speed of adaptation for non-native accents and regional accents. Thus, in their first study they found a perturbation in speech processing for regional accents (Floccia et al., 2006). A follow-up study suggested that non-native accents are even more difficult to process than regional accents because regional accents typically alter only vowels and non-native accents typically alter both vowels and consonants (Floccia, Butler, Goslin & Ellis, 2009). A study on adaptation to foreign accents by Trude, Tremblay and Brown-Schmidt (2013) confirmed the finding by Floccia et al. (2009) that non-native accents are more difficult to process than regional accents. The aim of the study by Trude et al. (2013) was to find out if the participants were able to learn a non-native accent. The study showed that listeners could adapt to non-native accents, but this adaptation seemed limited. The participants listened to a native Québec French speaker who spoke in English, while pronouncing /i/ as /I/ before consonants (e.g., pronouncing *weak* as *wick*). In one of these experiments, all shifted words were non-words (e.g., *weed* was pronounced as *wid*). After listening to the Québec French speaker, the participants were subsequently visually presented with the unaccented word (e.g., *weed*) and a lexical competitor (e.g., *weak*), and were asked to indicate which word had been presented auditorily. In this experiment, participants were unable to apply knowledge of the accent to rule out lexical competitors. Therefore, Trude et al. (2013) found that to some extent, participants were unable to adapt to this vowel shift, which contrasts with the study by Clarke and Garrett (2004). Trude et al. (2013) did, however, find an improvement in the adaptation to the accent over the course of the five experiments conducted. They suggest that this difficulty in adapting to the foreign accent might be due to participants not being used to hearing this accent and foreign accents having an increased variability in comparison to native accents. Clarke and Garrett (2004) mentioned that most of the participants they tested were familiar with the Spanish and Chinese English accents, which could be an explanation why Trude et al. (2013) did not find full adaptation to the Québec French accent.

Thus, speaker familiarity seems to be hindering a thorough investigation of accent adaptation. A study by Maye, Aslin and Tanenhaus (2008), which controlled speaker variability by creating an artificial accent, used a different approach to the investigation of the adaptation to a novel accent. Maye et al. (2008) created a novel accent by systematically lowering vowels in the frequencies of the first two formants (F1 and F2) to examine the listener’s perception of downward vowel shifts. For example, the vowel /I/ was lowered to /ɛ/, altering the pronunciation of the word *witch* to *wetch*. This resulted in an artificial accent similar to a regional American English dialect. During the first experiment, the participants were exposed to the unfamiliar accent, by listening to a twenty-minute version of *The Wizard of Oz.* In this way, by presenting participants with a story, Maye et al. (2008) created a more natural setting. The advantage of a natural setting in comparison to presenting words in isolation (as seen in the study by Floccia et al., 2006) is that a more realistic adaptation is then elicited. In contrast to Clarke and Garrett (2004), but comparable to Floccia et al. (2006), Maye et al. (2008) investigated the adaptation of a novel accent by using a lexical decision task. The twenty-minute story of *The Wizard of Oz* was followed by an auditory lexical decision task. The participants were asked to judge whether the words presented were real words or non-words. Consequently, the participant's RT was measured. Although Floccia et al. (2006) were unable to provide evidence for adaptation to regional accents, Maye et al. (2008) found clear evidence for adaptation. They demonstrated that after twenty-minutes of exposure to the artificial accent, participants classified the non-words they had heard in the 20-minute film (such as *wetch*) as real words, indicating their adaptation to the artificial accent.

In summary, differences in the speed of accent adaptation have been found. Previous studies concluded fast adaptation within a minute of exposure (Clarke & Garrett, 2004), whereas other studies did not find full adaptation on an accent (Trude et al., 2013). Speaker variability, for example whether the accent is regional or non-native, has been shown to influence the speed of accent adaptation. Accent adaptation can be investigated by asking the participants to listen to different accents or to an artificially created accent, and by using different methods, such as presenting words in isolation (Trude et al., 2013) or presenting the participant with a story (Maye et al., 2008).

1.2 Mechanisms underlying phonological learning

Previous research has shown that we can adapt to regional (Dahan et al., 2008; Floccia et al., 2006), foreign (Clarke & Garrett, 2004), and artificial languages (Maye et al., 2008; Skoruppa & Peperkamp, 2011). But *how* do we adapt to these novel accents? Culter, Mehler, Norris and Segui (1987) suggest that phoneme identification is influenced by lexical knowledge and they investigated novel accent adaptation by examining the relationship between phoneme identification and the mental lexicon. They presented participants with a phoneme detection task in French and measured their RTs. The participants were instructed to press a key when they heard a specific phoneme. After presenting the participants with words (e.g., *date*) and non-words (e.g., *dac*) auditorily, the researchers found slower RTs when non-words were presented. This means that we store sounds and words in our mental lexicon and that they are accessed when we are exposed to speech.

Moreover, Norris, McQueen, and Cutler (2003) and Maye et al. (2008) also argue that perceptual learning is driven by lexical knowledge. Norris et al. (2003) auditorily presented three groups of participants with words and non-words. They created an ambiguous sound (referred to it as /?/ by Norris et al. (2003)), which could be interpreted either as /f/ or /s/ and formed words and non-words containing this particular sound. The participants listened to Dutch words ending either in /f/ or /s/ (i.e., *witlof* and *naaldbos*), that contained the altered coda /?/. For the first group of participants, the /?/ was shifted slighty towards the /s/, making *witlof* sound more like *witlos*. Therefore, all words ending in /f/ were ambiguous (e.g., *witlo?*) and words ending in /s/ were unambiguous (e.g., *naaldbos*). By contrast, in the second group the /?/ was shifted slightly towards /f/, making *naaldbos* sound more like *naaldbof*. Therefore, all words ending in /s/ were ambiguous (e.g., *naaldbo?*) and words ending in /?/ were unambiguous (e.g., *witlof*). The control group listened to words that all ended in /?/, ensuring both interpretations were equally likely. In the following lexical decision task, the participants were asked to indicate whether the previously presented words were real words or non-words. During the second task, the participants were asked to indicate whether the previously heard words ended in /f/ or in /s/. The results showed that the participants who had heard /?/ at the end of words ending in /f/, were more likely to categorise these sounds as an /f/, compared to the participants who heard /?/ in words that ended in /s/. Norris et al. (2003) suggest that the participants use their lexical knowledge to adjust their evaluation of the perceived sounds. This leads to the idea that we also use our mental lexicon to adapt to novel accents.

Secondly, Maye et al. (2008) showed that we adapt to a novel accent to such a degree that after 20 minutes of exposure to accented speech, previously identified non-words were identified as real words. This process requires lexical knowledge. For example, the participants were asked to listen to a story about a ‘wicked witch’ in non-accented American English, and in the following lexical decision task, the participants identified *wetch* as a non-word. In the second part of the experiment, downward vowel shifts were used to create a novel accent, modifying the story about the ‘wicked witch of the west’ to a story about a ‘weckud wetch of the wast’. A few days later, the participants listened to the accented story and took part in a lexical decision task. Whereas first the participants identified *wetch* as a non-word, the second time the participants identified *wetch* as a real word, indicating that the accented words are remapped in their mental lexicon.

The studies above provide evidence that top-down knowledge is used to map accented speech on words that are familiar. Various studies have investigated the mechanisms underlying this process. The next section will provide an overview of various models of speech recognition.

1.2.1 Models of speech recognition

First, it is important to know how we process language. When we learn a language, we store all the information (e.g., the meaning of words or pronunciation) in our brain. This is known as our mental lexicon, and it allows us to retrieve information about sounds or words when we need it. This complex process has been investigated by many researchers, who have attempted to describe how we search for lexical items in our mental lexicon. The first model of lexical retrieval in spoken language was designed by Marslen-Wilson and Welsh (1978). The Cohort model (1978) involves three stages of lexical retrieval: access, selection and integration. During the first stage, the mental lexicon is accessed to link the sounds we hear to phonemes and words we have stored in our brain. During selection, all words with the same onset are activated in our mental lexicon. For example, when hearing /kɑ/, words such as *cat* and *candle* are activated. Words that deviate from the onset, such as *cranberry*, are deactivated and removed from the model. During the final stage, syntactic and semantic elements are considered. All words that do not fit the context are removed from the model until eventually, the final word will be selected.

Later, researchers found that other elements may also have an impact on the process of word recognition. The Cohort model could, for example, not account for word competition, as words are activated equally according to the model. This would mean that all words, whatever their length or complexity, are processed similarly. Moreover, other studies demonstrated that several factors, such as frequency and rhyme (see Norris, McQueen & Cutler, 2002), can also influence word recognition (Taft & Hambly, 1986). Taft and Hambly (1986) tested the predictions of the Cohort model in four experiments. In three of these, the findings were inconsistent with the predictions of the Cohort model. One of the experiments investigated the effect of high and low frequency words. In this experiment, two words that have the same onset, but differ in frequency were paired (e.g., *difficult* and *diffident*). The words were auditorily presented to two different groups, followed by a lexical decision task. Taft and Hambly (1986) demonstrated that high-frequency words (e.g., *difficult*) were recognised faster than low frequent words (e.g., *diffident*). They also suggest that the Cohort model needs to be modified if it is to account for the findings of their experiments. A different study that provides evidence for frequency influencing activation is a study by Dahan, Magnuson and Tanenhaus (2001). In this study, participants were asked to look at a picture (e.g., a picture of a bench), which was followed by three other pictures, of which two shared the same onset (e.g., *bell* and *bed*). One of these two pictures was a high-frequency word (in this case *bed*) and the other one was a low frequent word (in this case *bell*). Dahan et al. (2001) monitored the participants' eye movements and found that participants were more likely to fixate their eyes longer at the low frequency words, rather than at the high frequency words. This suggests that frequency also affects lexical access during visual input processing.

A model that does include factors such as word frequency is the TRACE model (McClelland & Elman, 1986). The TRACE model consists of three levels: words, phonemes, and features (Figure 1). Within each level, nodes are activated and connected to nodes in other layers, making the model interactive. When, for example, hearing a voiced sound, not only the feature voice in the bottom layer is activated, but in the layer above, the phonemes that contain this feature are also activated. Consequently, this activation will be passed to the top level for all words that contain the activated phonemes.

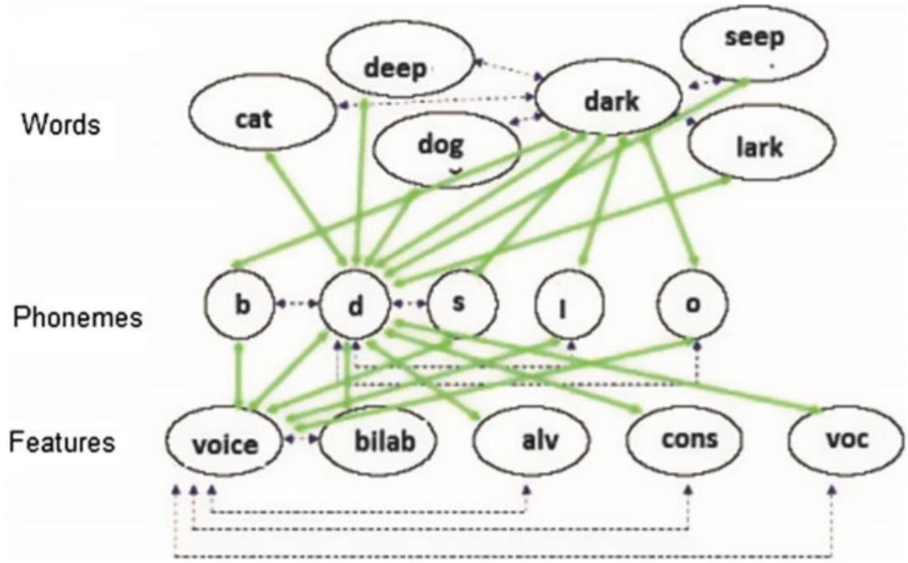

Figure 1. An example of interaction in the TRACE Model by Sarma and Sarma (2014).

The figure above illustrates how words in the top layer compete with each other. When, for example, hearing /d/, not only words that start with this phoneme are activated, but also words that sound similar or that are semantically related. This results in not only *dog* being activated, but also words such as *dark* and *cat*. In contrast, as more features are activated, not only excitatory connection, but also inhibitory connections are formed between words. Therefore, within a layer, the weaker connections are inhibited, and only relevant words remain for competition. However, when ambiguous words are presented, such as *bank*, not only the land alongside a river, but also a place for money will be activated. Thus, the best possible candidate can have more than one option. This explains how other features can influence word recognition, such as word frequency (in this case a place for money is used more often than the land alongside a river).

Furthermore, Cole and Jakimik (1980) investigated how we use syllables to recognise words. The participants listened to a story and were instructed to press a button when they heard a mispronunciation. They measured the participants' RT and examined whether the position of mispronunciations affected the participants' RTs. They found that participants detect mispronunciations present in the second syllable faster than when a mispronunciation is present in the first syllable. The findings confirm that a larger set of competitors is present at the beginning of the word and fewer competitors are present in the second syllable, which is in line with activation theories (Marslen-Wilson & Welsh, 1978; McClelland & Elman, 1986).

Dahan et al. (2001) implemented the TRACE model in their data and successfully provided evidence for the model being able to account for frequency. Even though connectionist models can explain frequency and lexical competition, the TRACE model (McClelland & Elman, 1986) cannot account for features such as ambiguity and probability. When an ambiguous word is encountered, the TRACE model (McClelland & Elman, 1986) cannot explain why one interpretation is activated faster than a second interpretation, as the model considers only bottom-up knowledge to be part of the activation process. The TRACE model (McClelland & Elman, 1986) suggests that each word is represented by a single node that has an activation value. For this reason, the model does not take contextual factors and prior knowledge into account. A second limitation to the model is the fact that RTs have not been proven to be linked to activation, which, according to these kinds of models, should predict human behaviour. Thus, the value of activation in speech recognition models can be questioned. A view that deviates from interactive connectionist models is Shortlist B (Norris & McQueen, 2008). In contrast to connectionist models, such as the TRACE model (McClelland & Elman, 1986), that have an activation-based approach, Shortlist B consists of a Bayesian approach that does not take activation as a focal point. Instead, the Bayesian model replaces activation with probability, ensuring that ambiguity is considered. If an ambiguous word is encountered, the Bayesian model suggests that people do not randomly select one interpretation but select the interpretation that is most likely to occur (Norris & McQueen, 2008). Prior experience is therefore essential for optimal word recognition. In summary, Shortlist B (Norris & McQueen, 2008) assumes that words are recognised by combining bottom-up processing with prior lexical probabilities, whereas the TRACE model (McClelland & Elman, 1986) only considers bottom-up processing to be required for the activation of words.

By creating word frequency effects and taking into account neighbourhood influences (i.e., words that are similar and differ in only one feature or phoneme), the Bayesian model is said to make a more accurate prediction of people’s behaviour. Norris and McQueen (2008), however, emphasize that it is important to continue research on this topic and include all effects of frequency, context, and probability, as an optimal modal for word recognition has not yet successfully been designed.

1.2.2 Generalisability

Multiple studies have investigated how words are activated when we are exposed to an unfamiliar accent. Maye et al. (2008) and Norris et al. (2003) suggest that we use our lexical knowledge to remap words in our mental lexicon when we hear accented speech. As we saw above, Maye et al. (2008) exposed participants to an unfamiliar accent and showed that participants could even identify a non-word, such as *wetch*, as a real word. In addition, Maye et al. (2008) provided evidence for the ability to generalise the accent to words that had not been presented before. They added similar *wetch* items that had not occurred in the story and found that the participants also identified these words as real words, indicating that participants learned the accent and were able to generalise the accent to novel words. These authors concluded that people can generalise to words that contain the same vowel shift as in the presented accent to novel words. No generalisation effect was found for words that had a different vowel shift. Therefore, people can adapt to previously unheard words, which also indicates that the adaptation was not due to memorisation of the presented items.

Like Maye et al. (2008), Skoruppa and Peperkamp (2011) also investigated the adaptation to a novel accent by presenting a story. They altered the vowels in Standard French, creating a novel French accent. The French participants listened to four stories in the altered French accent and were asked to ignore the accent and memorise the stories. After each story, the participants answered some questions about the content of the story. Instead of using a lexical decision task like Maye et al. (2008), Skoruppa and Peperkamp (2011) presented participants with a forced-choice identification task. After listening a second time to each story, they were presented with a list of pairs of words and indicated which one had the accent that was used in the story. The results showed that they could identify the accented words they were exposed to and could even match novel words to the accented speech. Thus, the participants were able to generalise the accent to novel words.

The studies above have also focussed on novel accent learning, by exposing the participants to available contextual information (Maye et al., 2008; Skoruppa & Peperkamp, 2011). For example, Maye et al. (2008) presented their participants with a twenty-minute story of the wizard of Oz. The participants could then deduce the meaning of the accented words from the words around it. *The wicked witch*, for example, was altered to *the weckud wetch*, making it possible to infer the meaning from the context. Other researchers, such as Clarke and Garrett (2004), also made it possible for the participants to retrieve contextual information. They presented the accented words in complete sentences, and like Maye et al. (2008), they demonstrated accent adaptation. Although Maye et al. (2008) aimed to investigate the mechanisms underlying phonological learning, it remains unclear which mechanisms led to the ability to generalise the adaptation to previously unheard words. To further investigate these mechanisms, Bujok (2019) exposed participants to words in an unfamiliar accent and measured the participants' brain activity. The words were presented in isolation instead of embedded in sentences or in a story, ensuring that the meaning of these words could not be derived from the context, which could provide further information on how phonological learning works without available contextual information. During the experiment, Bujok (2019) presented participants with a novel Dutch accent. The novel Dutch accent was created by lowering the frequencies of the F1 and F2 in six vowels (see Figure 2). For example, the participants were auditorily presented with the word *zin*. In the novel accent, /ɪ/ was altered to /ʏ/, resulting in the participants to perceive *zun* instead of *zin*. At the same time, the participants were shown two words on the screen. They were asked to select the correct visual form of the word they heard, which is similar to the task in the study by Trude et al. (2013). The participants had to choose whether they heard *zin* or whether they heard the matching distractor *zien*. If they selected the wrong answer (in this case *zien*), they received corrective feedback (see Figure 3). Bujok (2019) suggested phonological learning was based on feedback processing and internal monitoring, and he investigated the corresponding neural signatures by measuring the electrophysiological activity (EEG). If we make errors, but receive feedback on our mistakes, our internal monitoring system receives and processes this information and makes sure we learn from our mistakes and improve over time. Throughout the experiment, the participants improved and responded more correctly to the trials, which resulted in a learning effect. Even though Bujok (2019) looked at processing words in isolation, an explanation of how the shift was perceived could not be given. This led to the question as to whether participants memorised the specific presented items or generalised the rules to novel items.

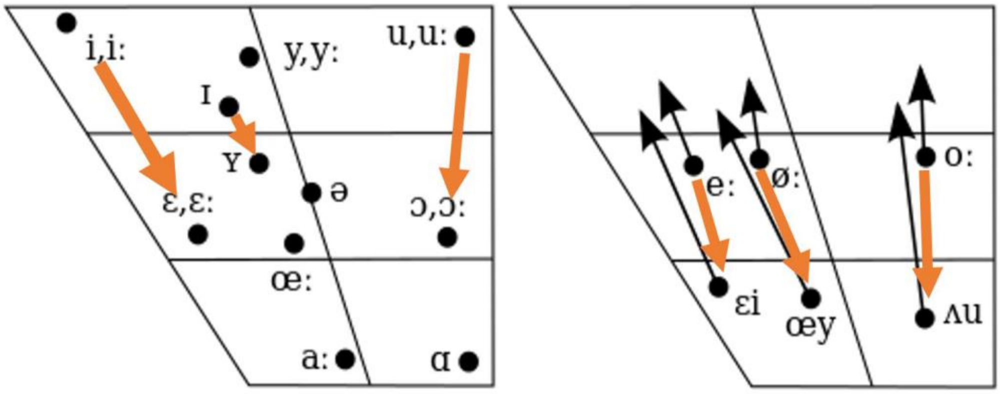

Figure 2. An overview of the vowel shifts by Bujok (2019).

The measured brain activity showed that internal monitoring and feedback processing were both present during the experiment. Internal monitoring was present from the start of the experiment, which suggests that the participants were learning the accent. The brain activity that accounted for feedback processing was also present, which suggests that the participants were processing the accent and improving over time. As fewer mistakes were made, participants were able to remap the accented phonemes to their mental lexicon, indicating that participants could successfully adapt to the novel accent. However, it remains unclear whether the participants improved throughout the task by working out the rules of the altered vowels (ɪ -> ʏ), or by memorising the specific items that had been presented.

1.3 The present study

The present study will replicate the experiment by Bujok (2019), by adding a second experiment to the study. This experiment, a cross-modal priming task, will further investigate whether the observed learning effect is a result of participants working out the rules or of participants remembering the specific presented items. In contrast to the monosyllabic words used during the learning task, the new items will only consist of bisyllabic words. By presenting primes that contain the vowel shifts that have been learned during the first experiment, the priming task will examine whether these shifts can be generalized to lexical items that have not been encountered before. The participants will take part in both tasks and will be presented with the novel Dutch accent, that was created by Bujok (2019). Figure 2 gives an overview of the six vowel shifts that the participants are to learn during the experiment. The current study will focus on phonological learning by presenting words in isolation, creating a setting to investigate whether the learning effect can be generalised to novel words in the absence of contextual information, as seen in the study by Bujok (2019).

Furthermore, previous studies have also used priming as a window into our mental lexicon. These studies have shown that certain words (e.g., *cat*) can activate other words that have a similar structure or contain a part of the word (e.g., *cat* or *category*), or can even activate related words (e.g., *dog*). These studies demonstrated facilitation effects for words that are visually presented and followed by semantically related words, compared to unrelated words (Meyer & Schvaneveldt, 1971; see also McNamara, 2005). Not only has semantical priming been proven to affect RTs, but also studies that investigate form-priming have shown facilitation effects. For example, a study by Norris, McQueen, and Cutler (2002) auditorily presented primes that were either related or unrelated to the next target word that was visually presented in the lexical decision task. The related words rhymed with their primes (e.g., *ramp* and *lamp*). The participants responded faster to related primes than to unrelated primes, indicating that a facilitation for rhyming was found. Thus, different forms of priming have been proven to influence RTs.

The current study will look at the influence of accented primes, that will be either learned in the learning task, or related or unrelated to the target words (this is explained in further detail below and in the method section). Witteman, Weber and McQueen (2013) also looked at accented primes. They investigated whether a strong German accent in Dutch would have a different influence on the recognition of words than a weak accent. To test this hypothesis, Witteman et al. (2013) created a cross-modal priming experiment. Two groups of participants with either limited or extensive prior experience with German-accented Dutch were asked to listen to the accented words. Participants with limited prior experience were only primed by weak accented words, whereas participants with extensive prior experience were primed by both weakly and strongly accented words. In other words, a greater influence of priming was measured for participants who were more familiar with the accent.

Taking form-priming and accents into account, a remaining question is whether an effect of priming is still found when an artificially created novel accent is presented and the primes have different degrees of form-overlap with the target words. The primes in the present study all contain a specific vowel shift. The present study will therefore examine the influence of form overlap on the effect of priming, by measuring the participant's RT.

The first research question of this study is: "*To what extent do participants develop accent adaptation during the course of the task?*". An important first step is to measure whether the replicated experiment in the current study evokes the same learning effect as was found in the study by Bujok (2019). If a learning effect is found, it will be further investigated by analysing the effect of prime words during a cross-modal priming task. During the learning task, the participants will be presented with the novel accent. The participants will hear an accented word (e.g., *zun*) and at the same time they will see two words on the screen (e.g., *zien* and *zin*). The participants will be asked to indicate which word they heard, by pressing either the left or the right button, corresponding to the left or right word on the screen. At the end of every trial, corrective feedback will be given.

The second research question is divided into three sub-questions. Research sub-question 2A is: "*To what extent can the learning effect be generalised to other lexical items*?". Sub-question 2B is: "*How do different types of primes influence the reaction times in the lexical decision task differently?*" and sub-question 2C is "*How does the effect of priming develop during the cross-modal priming task?*". To answer the first sub-question, 2A, the cross-modal priming task will be analysed to clarify whether the learning effect that was found in the experiment by Bujok (2019) results from the participants memorising the specific items or from the participants' ability to generalise the rules and apply them to previously unheard words. This will be examined by analysing the effect of the primes during the cross-modal priming task. During this task, the participants will first hear one of the different types of primes, followed by a visual presentation of a word. After hearing each prime, the participants will be asked to press one of two buttons, depending on whether the word on the screen is a real word or not. The first type of prime is the learned prime (e.g., munder instead of minder in the ɪ -> ʏ vowel shift). The related prime is formed by replacing the stressed vowel by another vowel that was part of the set of shifted vowels (e.g., maunder instead of minder, which is related to the oː -> ɑu vowel shift (see Table 1)). The final unrelated prime does not contain any of the presented vowel shifts in the learning task. As the participants will be asked to make lexical decisions, a control condition of non-words (an altered target word with matching primes) has been added to the task. All target words (e.g., minder), have an altered onset, resulting in the target words being perceived as non-words (e.g., jinder). Consequently, the learned and related primes have the same onset as the altered target word (e.g., junder and jaunder). During the task, the participants' RT will be measured to determine the effect of the primes, and the error rates will be measured to analyse whether the participants have learnt the accent. If an effect of priming is found for primes that resemble the target word, the participants will have been able to generalise the rules to novel words. If this effect is absent, it is possible that the participants only memorised the specific items during the first task.

To answer the second sub-question, 2B, which investigates how different types of primes influence the RTs in the lexical decision task differently, we will analyse the RTs of the different primes. When a prime that is similar to the target word (i.e., learned or related) is presented prior to the lexical decision task, the target word will be activated in the mental lexicon before it is presented visually (Meyer & Schvaneveldt, 1971). Other evidence indicated that words, and remapped words (in this case the learned accented vowels), are activated simultaneously in the mental lexicon (Marslen-Wilson & Welsh, 1978; McClelland & Elman, 1986). By presenting a prime that is similar to the target word in the lexical decision task, we expect a priming effect only for learned and related primes. The learned primes contain the vowel shift that has been learned in the learning task, whereas the related primes consist of the same number of letters as the target words, but have a different vowel shift than the participants learned to pair with one of the vowels. As related primes do not contain the encountered learned vowel shifts, it may take more time to access the matching target word in the mental lexicon than the time it would take to access the target word for the learned primes. Thus, if these primes indeed influence activation of the target words, shorter RTs are expected during the lexical decision task when learned and related primes are presented, compared to when unrelated primes are presented. We expect the learning effect to facilitate adaptation to novel words as previous research has suggested (Maye et al., 2008; Skoruppa & Peperkamp, 2011).

Furthermore, we will shed light on how quickly we adapt to the novel accent. So far, it has been considered that during the learning task the participants either memorise the specific presented items, or are able to generalise the rules to novel words. However, it is also possible that the participants do not identify the rules during the learning task, but only in the course of the cross-modal priming experiment. Therefore, research sub-question 2C is: "*To what extent does the effect of priming develop during the cross-modal priming task?*". The present study will compare the RTs of the first half of the trials to the second half of the trials and investigate whether the participants' knowledge improves over time. As previous studies have also found evidence for rapid accent adaptation (e.g., Clarke & Garrett, 2004), we also expect the accent to be learned during the learning task and do not expect an increase in RTs in the lexical decision task over time.

Research question 3 focuses on the location of the vowel shift of the bisyllabic primes. Research question 3 is: "*To what extent does the location of the vowel shift influence RT during the lexical decision task?*". On the one hand, the TRACE model (McClelland & Elman, 1986) suggests that words are activated incrementally. When we hear a sound, countless connections are rapidly made with nodes in other layers (see Figure 1), which activate competitors. When a word is accessed, a larger number of competitors is present than when only the second part of the word is accessed. Moreover, based on the idea that mispronunciations are detected faster in the second syllable of a word than in the first syllable (Cole & Jakimik, 1980), we expect this to be similar for vowel shifts. The primes in the present study all contain vowel shifts; these are either in the first or in the second syllable. As the TRACE model (McClelland & Elman, 1986) claims that only a small set of word candidates is accessed after hearing the first syllable, shorter RTs are expected for words with a vowel shift in the second syllable, compared to a vowel shift in the first syllable. Thus, if shorter RTs are found for words that contain the vowel shift in the second syllable, it would confirm that more competitors are activated simultaneously if the vowel shift is present in the first syllable, rather than if the vowel shift is present in the second syllable. A decrease in RTs when presenting words with stress in the second syllable would confirm the added value of activation theories. On the other hand, models such as Shortlist B (Norris & McQueen, 2008) reject the activation theory and suggest that probability is more likely. RTs would therefore not only be influenced by the number of competitors, but also by prior knowledge and contextual factors (for example, prior knowledge of the structure or of phonetic categories could help access phonemes or words faster). If no effect of the location of the stress is found on RTs, probability, as described in Shortlist B (Norris & McQueen, 2008), might account for the lack of detecting a difference in RTs. Models that have activation as a focal point could then be rejected.

The purpose of this study is to gain more insight into how we adapt to novel accents. It is not fully understood how phonological learning works and how quickly can we adapt to a novel accent. To come a step closer to answering these questions, this study will expand on the work carried out by Bujok (2019) and explore the relationship between phonological learning and cross-modal priming. We will attempt to replicate the learning effect found in Bujok's experiment, and subsequently analyse the effect in the cross-modal priming task.

2. Methods

2.1 Participants

A total of 23 participants took part in the experiment at the Centre for Language Studies Lab at the Radboud University in Nijmegen. All participants were asked to sign an informed-consent form and were paid for their participation. The participants, who were all native speakers of Dutch, were between 19 and 30 years old and did not have a background in Linguistics. Considering some dialects could contain one of the vowel shifts used in the current study, participants from Noord-Holland, Zuid-Holland, Utrecht, Flevoland, Drenthe and Groningen did not take part in the experiment. A total of 11 men and 12 women participated; the mean age was 24 (SD = 2.9). Furthermore, the participants were healthy, right-handed, had corrected-to-normal vision and had no history of mental issues, hearing impairments or language impairments (i.e., dyslexia).

2.2 Materials

The experiment was divided into two sections. In the first section, the participants took part in a behavioural task, as seen in Bujok's study (2019), although we did not replicate the EEG version of the study. During the learning task, the participants were familiarised with the artificially created accent and, following this, the participants took part in the cross-modal priming task. The two tasks are discussed separately in the following sections.

2.2.1 Learning task

The materials in the learning task were taken from the study by Bujok (2019). Bujok (2019) created a novel accent, by lowering the F1 and F2 frequencies of three monophthongs and three diphthongs in Dutch. An overview of the six created vowel shifts is shown in Figure 2. For each vowel shift, 16 frequently used monosyllabic words were selected as target words (see Appendix I), resulting in a total of 96 target words. During the task, the participants were repeatedly auditorily presented with items that contained one of the six vowel shifts. Upon the presentation of the auditory stimulus, two visual words were presented on the screen. The participants were then asked to select the word that they had just heard.

Half of the target words were selected as training items and the other half were selected as test items. Throughout the task, the participants encountered each training item six times and each test item four times. For the training items, each auditorily presented target word was a non-word, which the participants had to associate to an existing word (i.e., the participants heard *bluk* and the matching target word was *blik*). The paired distractors were created by changing the vowels of the target words, and ensuring the distractors were real words (e.g., *bleek*). In contrast to the training items, the auditorily presented test items were real words, ensuring these words would interfere with the participants' lexical knowledge. The paired distractors were also real words. The first half of the test items contained distractors that were identical to the auditorily presented test items. For example, the participants heard *lust*, the matching target word was *list,* and the paired distractor was also *lust.* One could argue that after a participant encounters a test item was paired with an identical distractor multiple times, the participant could see through it and work out that the correct response is never the word you hear. To avoid this, the other half of the test items were paired with distractors that were different to the auditorily presented test items. For example, the participants heard *grot*, the matching target word was *groet*, and the paired distractor was *groot*. As the paired distractors could be identical to the auditorily presented items, the test items should be more difficult and more realistic than the target items. A total of 432 items were created (i.e., there were 96 training items and 48 test items in each of the three rounds). Appendix I shows an overview of all items that were used in the learning task.

2.2.2 Cross-modal priming task

A set of new items was created for the second task. Because the learning task contained only monosyllabic words, the cross-modal priming task only contained bisyllabic words, to ensure the participants had not seen or heard the accented words before. The materials in this task also conformed to the vowel shifts that were created in the learning task (see Figure 2). During the experiment, participants would first hear one of the primes, followed by a visual presentation of the matching target word. For each of the six vowel shifts, 10 target words and 10 target non-words were created, resulting in a total of 120 target items.

All bisyllabic target items contained one stressed vowel and a second non-stressed vowel, depending on the position of the stress of the syllable. The target vowel always appeared in a CVC context. For each target word, three prime words were created. Each prime was a non-word and presented in one of three conditions: either *learned*, *related* or *unrelated*. For the *learned* condition, the primes were created by changing the vowel in the stressed syllable to a vowel conforming to the vowel shifts in Figure 2 (i.e., the target word *minder* was changed to *munder*). The stressed vowel in the *related* condition was based on one of the other vowels that was used during the learning task (i.e., the target word *minder* was changed to *maunder*). For the *unrelated* condition, the primes were created by using only the onset phoneme of the target words and changing them to bisyllabic non-words (i.e., the target word *minder* was changed to *movrik*). Then, the *unrelated* primes were matched to a target word that did not have the same onset. A summary of the stimuli used is shown in Table 1, and the full list of items used during the cross-modal priming task is shown in Appendix II. All of the items described so far were used as primes with word targets. The control condition in the lexical decision task contained only non-words and was created by changing the onset of each target word and all the matching primes (for a summary, see Table 2). All non-words were pronounceable and not reminiscent of Dutch words.

Table 1
Examples of words and primes.

SHIFT	TARGET	PRIME LEARNED	PRIME RELATED	PRIME UNRELATED
i - ɛ	kiezer	kezzer	kauzer	worzui
ɪ - ʏ	minder	munder	maunder	geumto
u - ɔ	bezoek	bezok	bezauk	nienkof
eː - ɛi	beestje	beistje	baustje	weimet
øː - œy	meubel	muibel	maubel	vlormek
oː - ɑu	hoogte	haugte	hogte	melfros

Table 2
Examples of non-words and primes.

SHIFT	TARGET	PRIME LEARNED	PRIME RELATED	PRIME UNRELATED
i - ɛ	hiezer	hezzer	hauzer	dorzui
ɪ - ʏ	jinder	junder	jaunder	leumto
u - ɔ	lezoek	lezok	lezauk	lienkof
eː - ɛi	neestje	neistje	naustje	teimet
øː - œy	keubel	kuibel	kaubel	blormek
oː - ɑu	koogte	kaugte	kogte	velfros

2.2.3 Recordings

Each word that was auditorily presented in the learning task was recorded using Audacity software (2000), and edited using Praat software (2016). Similar to the original learning task, recordings for the cross-modal priming task were made in a soundproof booth using Audacity software (2000). The same speaker as in Bujok's experiment (2019) was asked to read a list of words, which consisted of all target words, primes and practice items. All items were manually edited using Praat software (2016). After manually selecting word boundaries, the segmentation was improved by adjusting boundaries to zero crossing using a Praat script. The average duration of all audio files was 773ms (*SD* = 105.39, range = 448ms - 1097ms).

Apart from recording new items for the cross-modal priming task, we also recorded new practice items for the learning task. Prior to the learning task, the participants took part in a practice round. During the practice round, the participants encountered six items to help them become familiar with the accent and the stimuli. The practice items, however, contained the same vowel shifts as the items in the experiment and could facilitate the learning process.

Therefore, the current study created four new practice items with a different vowel shift (see Appendix I). The same female Dutch native speaker as in Bujok's experiment (2019) was asked to record the new practice items.

2.3 Procedure

The experiments took place at the Centre for Language Studies at Radboud University. Prior to the experiment, the participants were given information about the experiment (see Appendix III) and were asked to sign a consent form (see Appendix VI).

2.3.1 Learning task

During the learning task, the participants were presented with the items on a computer in a soundproof booth. The experiment was performed using Presentation® software (Version 22.1, Neurobehavioral Systems, Inc., Berkeley, CA). The participants all used headphones and were asked to respond using a button box. The button box had five buttons, but only the outer two and the middle one were used during the experiment. A central fixation cross was shown for between 400 and 800ms prior to the presentation of each item. The participants' RT was measured from the start of each item. Each participant encountered all the items. The lists were created by randomising all items per block and ensuring no vowel was repeated. The same lists for the participants were used in the learning task as in the experiment by Bujok (2019).

Each item was presented auditorily and visually simultaneously and the visual stimuli stayed on the screen until the participant had pressed a button. If the participants pressed one of the buttons within the permitted response time, feedback was presented for 1,500ms in the centre of the screen. After presenting feedback, a blank screen was shown for 700ms prior to presenting the next item. If during the first round the participants responded within 1,300ms, corrective feedback was given. If they exceeded the permitted response time, they would see *SNELLER AUB (quicker please)* for 1,500ms instead of seeing the corrective feedback *GOED* or *FOUT (correct or incorrect)*. During the second round, to receive feedback the participants had to respond within 1,200ms, and in the last round within 1,100ms. To measure brain activity, it is essential that the participants' make errors. The time limit was therefore added to the learning task by Bujok (2019). The current study chose to keep the time limit, because it not only increases the probability of the participants making errors, but it also encourages them to perform better over time.

The task consisted of three rounds. All 432 items were divided over the three rounds and each round contained two blocks. To familiarise the participant with the accent, 48 training items were shown in the first block of each round. In the second block, a mix of the same 48 training items as in the first block, and the remaining 48 test items were presented. Thus, each round contained 144 items. As the participants could only take a break after a block of both training and test items, the participants were only aware of there being three rounds. An example of a training item is shown in Figure 3.

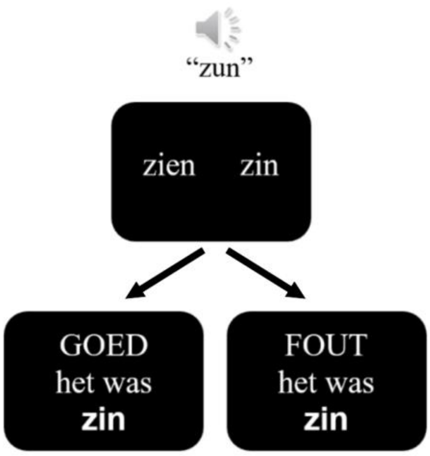

Figure 3. An example of a training item during the learning task.

The participants were first presented with a practice round containing four items and were informed of the existence of a maximum permitted duration for responses. A brief break followed for the participants to ask questions before the main experiment began.

The participants were informed that they would hear an unusual accent, but no further details about the items were given. They were asked to answer as quickly as possible and to make as few errors as possible. They were also made aware of the fact that corrective feedback was only given if they responded within the permitted response time, and that the permitted response time would decrease over time. Each round took 10 to 12 minutes, approximately.

2.3.2 Cross-modal priming task

After the learning task, the participants were given a break while the experimenter set up the second experiment. The cross-modal priming task was also performed in the soundproof booth using Presentation® software (Version 22.1, Neurobehavioral Systems, Inc., Berkeley, CA) and the same headphones and button box were used. During the cross-modal priming task, the target words were presented on the screen and the primes were auditorily presented prior to the target words.

Prior to the experiment, six different lists were created, each containing 60 items of 30 words and 30 non-words. In the learning task each participant encountered the same items, whereas in the cross-modal priming task each participant encountered a certain selection of all the items. Each target word was matched with one of the three primes, and this differed in each list. For example, if the target word was *vlieger,* the matching *learned* prime was *vlegger* in one list and the matching *related* prime *vlauger* was used in another list. The *unrelated* prime was matched by selecting an *unrelated* prime that matched a different target word, to ensure the onset was not identical to the target word and the availability of the onset could not facilitate or interfere with the participants' RT (see Table 1 and Table 2). Each participant was shown one of the six versions of the list. To create different randomizations for all participants, the Mix program by Van Casteren and Davis (2006) was used. The program ensured that the six different versions of the lists were kept intact, although the order of each list was randomised. Each type of prime only appeared once in a row and each vowel shift did not appear in more than two consecutive trials. Furthermore, non-words or words only appeared three or fewer times in a row.

At the beginning of the experiment, a brief instruction was presented in the centre of the screen. To start the experiment, the participants had to press the middle button of the button box after reading the instructions. Similar to the learning task, a fixation cross was shown between 400 and 800ms prior to presenting the items. The participants would first hear one of the primes, immediately followed by a visual representation of the target word. The visual stimuli would appear on the screen as soon as the audio fragments ended. However, some challenges were faced when attempting to synchronise the audio offset and the visual onset. The computer needed time to process the audio and video (in this case the text on the screen), and subsequently, a small delay appeared (varying from 0 to 30ms). A summary on how this delay was prevented, is added to Appendix IV.

The participants then had to press either the outer right button, or the outer left button, depending on whether the auditorily presented word was a real word or a non-word. Half way through, the buttons were swapped, ensuring the response buttons were counterbalanced. The cross-modal priming task contained 60 items which were presented in sequence without allowing the participants to take a break. The task took about five minutes.

After the learning task and the cross-modal priming task, the participants were asked to fill in the language background questionnaire that had also been used in the study by Bujok (2019). The questionnaire contained questions about which languages and dialects the participants use in their daily life and other questions about the strategies they had used during both experiments. A few questions were added to the questionnaire (see Attachment V). For example, six new words that contained all vowel shifts were presented and the participants were asked to write down how they thought the speaker would have pronounced the words. This was added to confirm that the participants had learned the presented accent after both experiments. The cross-modal priming task took about five minutes and most participants managed to do both tasks and fill in the questionnaire within 50 minutes of their time.

2.4 Design and analysis

2.4.1 Learning task

The dependent variables in the learning task were the participants' RTs and error rates. Several independent variables that could affect the RTs and the error rates were also measured. The independent variables were the number of the round (*one* to *three)*, the type of block (*training block* and *mixed block)*, correctness (*correct response* or *error)*, the variable type of trial (*training* or *test item*), and whether or not the distractor was identical to the pronounced form.

In order to find out if priming affects the learning effect, the learning task was analysed prior to the cross-modal priming task. Furthermore, the participants' RTs and error rates were analysed using SPSS software (2020) and Microsoft Excel (2018) in order to investigate whether the participants learned the novel accent or simply memorised the items. The learning task data was analysed as seen in Bujok (2019). First, the participants' responses were checked for accuracy. Two participants' data were removed as they did not score above 75% in the last round, indicating that they had not taken the feedback into account that was shown after each item. After removing the two participants' data, a three-way Repeated Measures ANOVA was performed. The first within-subject factor was rounds and consisted of three levels (*round one, round two* and *round three.*). The second within-subject factor was correctness, consisting of two levels (*correct response* and *error*). The third within-subject factor, block type, also consisted of two levels (*training block* and *mixed block*). When pairwise comparisons were performed to investigate interaction effects, Bonferroni was selected as the Confidence interval adjustment option. Next, multiple ANOVAs, with correctness as a factor, were performed to analyse the RTs within the mixed blocks and compare the RTs for the different types of test items, as test items could contain either different or identical distractors. Multiple ANOVAs were also performed to analyse the difference in error rates over the rounds and to compare the error rates in the first half of the task to the error rates in the second half of the task. For analysis, mean RTs and mean error rates for each participant were taken. If Mauchly's test of Sphericity indicated that the assumption of sphericity had been violated, a Greenhouse-Geisser correction was performed.

2.4.2 Cross-modal priming task

In the cross-modal priming task, the same dependent variables as in the learning task were measured, which are the participants' RTs and error rates. The independent variables were the target type (*word* or *non-word*), the prime type (*learned*, *related* or *unrelated*), correctness (*correct response* or *error)*, and whether the position of the stress was in the first or in the second syllable.

Before analysing the data of the cross-modal priming task, it was essential that the data had been thoroughly cleaned to increase the quality of the data. Two participants' data were removed because they did not score above 75% in the learning task. Next, the remaining outliers were detected. For all participants and for all items, a mean RT and a standard deviation (SD) were measured. Participants and items were removed if they deviated more than 2.5 SD from the item mean. After removing the outliers, mean RTs were calculated for each participant to detect bad cases. The bad cases were also removed if the RTs deviated more than 2.5 SD from the participants' mean. After performing the procedures above, 12.8% of the data had been discarded.

To investigate whether priming affects the learning effect, a two-way Repeated Measures ANOVA was performed on the RTs of the priming task using SPSS (2020), and graphs were created and edited using Microsoft Excel (2018). The Repeated Measures analysis consisted of two factors: prime type and target type. Prime type consisted of three levels (*learned*, *related* and *unrelated*) and target type consisted of two levels (*word* and *non-word*). When pairwise comparisons were performed, Bonferroni was selected as the Confidence interval adjustment option. Mean RTs for each participant and factor were taken for analysis. Finally, one-way ANOVAs were performed to analyse the location of the stress and to analyse whether the effect of priming was different for the first half of the items compared to the second half of the items.

3. Results

3.1 Learning task

3.1.1 Reaction times

A three-way Repeated Measures ANOVA was performed to analyse the RTs. Firstly, the ANOVA showed that the reaction times decrease over rounds [$F(2,40) = 81.754$, $p < .01$, $\eta_p^2 = .803$] (see Figure 4). Mauchly's test, $X^2(2) = 3.807$, $p = .149$, did not indicate any violation of sphericity. A post hoc pairwise comparison using the Bonferroni correction showed that participants reacted faster in each subsequent round. Participants took longer to react in the first round when compared to the second round (991ms vs 871ms, $p < .01$) and third round (992ms vs 824ms, $p < .01$), and showed longer reaction times in the second round when compared to the third round (871ms vs 824ms, $p < .01$).

Secondly, the three-way Repeated Measures ANOVA shows a significant main effect regarding the correctness of the reaction times, indicating that participants took longer to react when responses were incorrect than when they were the correct responses [$F(1,20) = 12.546$, $p < .01$, $\eta_p^2 = .385$]. The mean reaction times over rounds are shown in Figure 4. No interaction effect was found for correctness and round [$F(2,40) = .486$, $p = .619$, $\eta_p^2 = .024$].

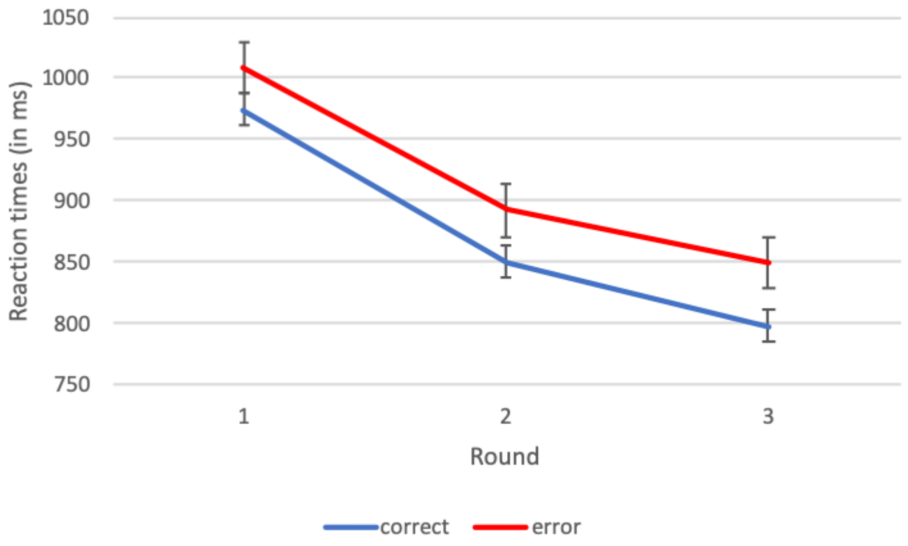

Figure 4. Mean reaction times of correct responses over rounds.

Thirdly, the three-way Repeated Measures ANOVA showed a significant main effect of block type. Reaction times in training blocks (*M* = 879ms, *SD* = 17.3) were generally lower than in mixed blocks (*M* = 912ms, *SD* = 12.9) [$F(1,20) = 10.022$, $p < .01$, $\eta_p^2 = .334$]. The mean reaction times over blocks are shown in Table 3. No interaction was found between block type and round [$F(2,40) = 1.826$, $p = .174$, $\eta_p^2 = .084$] and no interaction was found between block type and correctness [$F(1,20) = .071$, $p = .792$, $\eta_p^2 = .004$]. Furthermore, no interaction was found between correctness, block type and round [$F(2,40) = .189$, $p = .829$, $\eta_p^2 = .009$].

Table 3
Mean error rates over blocks, with standard deviations between brackets.

ROUND	**TRAINING BLOCK**	**MIXED BLOCK**	**DIFFERENCE**
1	975 ms (90)	986 ms (87)	-11 ms
2	829 ms (77)	880 ms (60)	-51 ms
3	784 ms (58)	822 ms (50)	-38 ms

In addition, an ANOVA within mixed blocks demonstrates a significant main effect of test item type [$F(1,119) = 9.36$, $p < .01$, $\eta_p^2 = .073$]. Figure 5 shows that participants reacted faster to test items that had different distractors (i.e., the pronounced form of the target word *lies* was /lɛs/ and the distractor was *lees*) than to those with identical distractors (i.e., the pronounced form of the target word *niet* was /nɛt/ and the distractor was also *net*). This effect, however, turned out to be non-significant when only correct responses were analysed (p = .496).

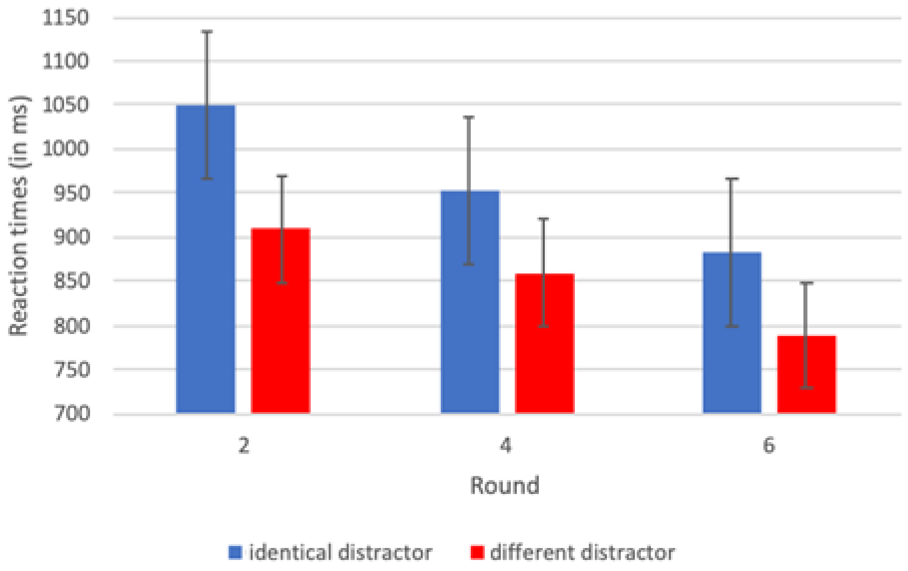

Figure 5. Mean reaction times for different test item types for the rounds (RTs include correct and incorrect responses).

3.1.2 Accuracy

An analysis on error rates demonstrates a decrease in error rates for the rounds [$F(2,60) = 11.838$, $p < .01$, $\eta_p^2 = .283$], as shown in Figure 6. The mean error rate was 29.8% in round one, 20% in round two and 15.6% in the final round ($p < .05$). A decrease in error rates was also found for the blocks [$F(5,120) = 8.344$, $p < .01$, $\eta_p^2 = .258$]. The mean percentages of error rates per block type are shown in Table 4. Moreover, a main significant effect for trial type was found, indicating that the participants had higher error rates for test items (M = 27.2%, SD = 13.7) when compared to training items (M = 19.1%, SD = 8.1) [$F(1,40) = 5.386$, $p < .05$, $\eta_p^2 = .119$].

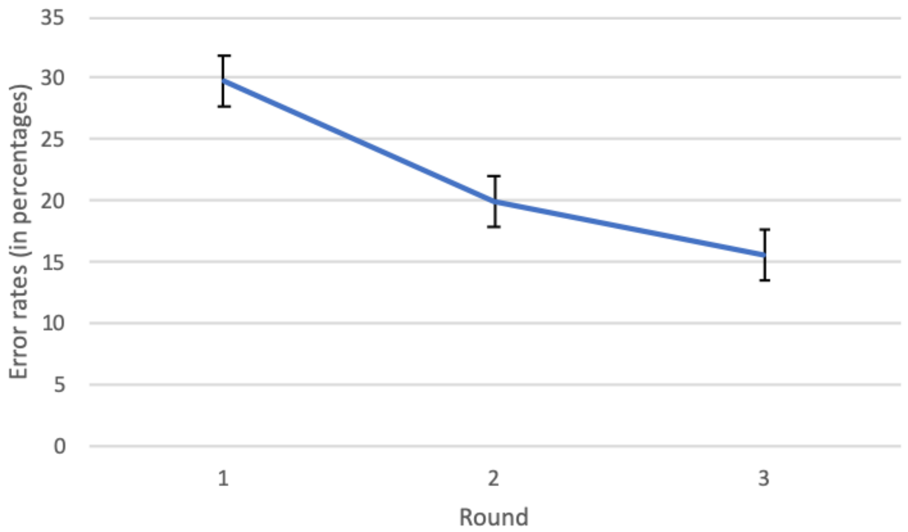

Figure 6. Mean error rates per round.

Table 4
Mean error rates over blocks, with standard deviations between brackets.

ROUND	TRAINING BLOCK	MIXED BLOCK	DIFFERENCE
1	24.2% (8.8)	32.6% (11.8)	-8.4%
2	19% (8.6)	20.5% (11.8)	-1.5%
3	15.6% (10.2)	15.7% (9.5)	-0.1%

3.2 Cross-modal priming task

A two-way Repeated Measures ANOVA showed a main significant effect of the target word type on reaction times [$F(1,19) = 68.756$, $p < .01$, $\eta_p^2 = .783$]. The mean RTs for non-words were 98ms higher than for words ($p < .01$). Figure 7 demonstrates the mean RTs for the types of target words and primes.

Secondly, the Repeated Measures ANOVA demonstrated a main significant effect of prime type on reaction times [$F(2,38) = 6.082$, $p < .05$, $\eta_p^2 = .242$]. Mauchly's test, $X^2(2) = .327$, $p = .849$, did not indicate any violation of sphericity. A post-hoc pairwise comparison using the Bonferroni correction showed that the learned primes had shorter reaction times than related primes (525ms vs 546ms, $p < .05$) and unrelated primes (525ms vs 546ms, $p < .05$). The mean reaction times between related primes and unrelated primes did not differ significantly ($p = 1$).

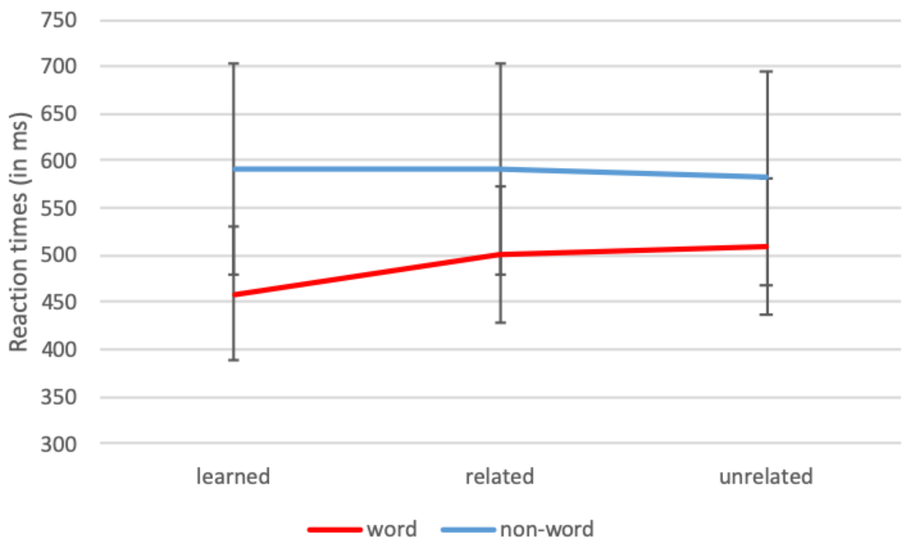

Figure 7. Mean reaction times of correct responses as a function of target word type and prime type.

Furthermore, an interaction effect was found between the target type and the prime type [$F(2,38) = 6.614$, $p < .05$, $\eta_p^2 = .258$]. Mauchly's test, $X^2(2) = 1.102$, $p = .576$, did not indicate any violation of sphericity. There were no differences between the prime types for the non-words. Detailed analysis on non-words showed that *learned* and *related* primes did not significantly differ in RTs ($p = .947$), *learned* and *unrelated* primes did not differ in RTs ($p = .51$) and *related* and *unrelated* primes did not differ in RTs ($p = .478$). For words, however, an effect of prime type was present. A significant difference in RTs for *learned* primes and *related* primes was found ($p < .05$). Participants reacted 42ms faster to *learned* primes than to *related* primes. Secondly, a significant difference in RTs for *learned* and *unrelated* primes was found ($p < .05$). Participants reacted 50ms faster to *learned* primes than to *unrelated* primes. The RTs for *learned* and *unrelated* primes did not significantly differ ($p = .356$). The mean reaction times and standard deviations for each type of target word (*word* and *non-word*) and prime type (*learned*, *related* and *unrelated*) are shown in Table 5.

Table 5
Mean reaction times for both target types and all prime types, with standard deviations between brackets.

PRIME TYPE	WORD	NON-WORD	DIFFERENCE
Learned	460ms (53)	591ms (105)	-131ms
Related	501ms (88)	591ms (112)	-90ms
Unrelated	510ms (75)	582ms (119)	-72ms

Moreover, when analysing the stress of a syllable, small differences were found in RTs between the first syllable (M = 499ms, SD = 76.8) and the second syllable (M = 472ms, SD = 66.82) when analysing only real words (see Figure 8). A one-way ANOVA, however, showed only a significant difference of RTs between words and non-words [$F(1,76) = 23.637$, $p < .01$, $\eta_p^2 = .237$], but no significant difference for the location of the stress [$F(1,76) = .484$, $p = .489$, $\eta_p^2 = .006$].

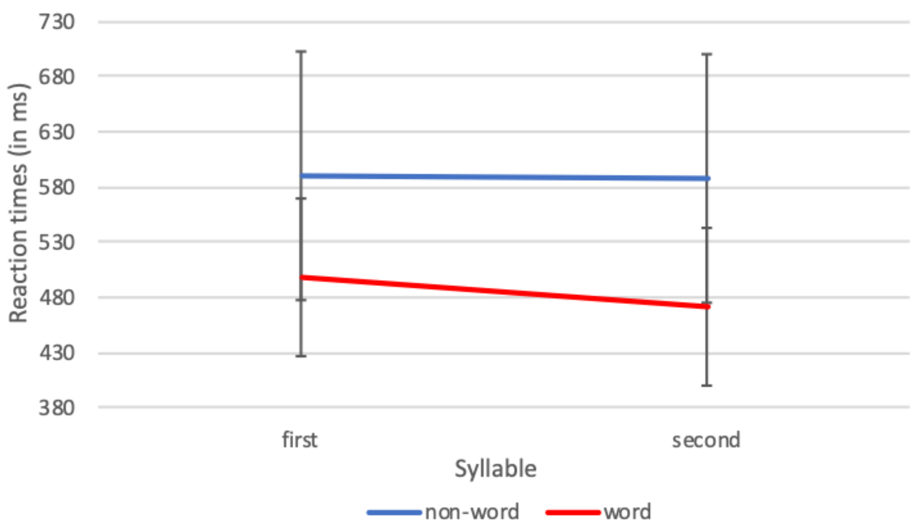

Figure 8. Mean reaction times of correct responses as a function of the location of the stress and target type.

Finally, the effect of priming on real words in the first half of the experiment was compared to the effect of priming in the second half of the experiment. For the first half, lower RTs for *learned* primes (M = 465ms, SD = 72.6) were found compared to *related* (M = 503ms, SD = 96.5) and *unrelated* primes (M = 503ms, SD = 88.2). These differences, however, were not significant [$F(1,57) = 1.297$, $p = .281$, $\eta_p^2 = .044$]. *Learned* primes also showed lower error rates (M = .03%, SD = .06) compared to *related* (M = .09%, SD = .17) and *unrelated* primes (M = .08%, SD = .11), but these differences were also non-significant [$F(1,57) = 1.374$, p = .261, $\eta_p^2 = .046$].

When comparing the effect of the different types of primes in the second half of the experiment, lower RTs for *learned* primes (M = 462ms, SD = 74.6) were found compared to *related* (M = 506ms, SD = 95.5) and *unrelated* primes (M = 522ms, SD = 86.6). These differences, however, were non-significant [$F(1,57) = 2.551$, p = .087, $\eta_p^2 = .082$]. *Learned* primes also showed the lowest error rates (M = .03%, SD = .08) compared to *related* (M = .06%, SD = .11) and *unrelated* (M = .09%, SD = .15) primes, but these differences were also non-significant [$F(1,57) = 1.415$, p = .251, $\eta_p^2 = .047$].

3.3 Language background questionnaires

A total of 23 people participated in the experiment and filled in the questionnaire. After removing the participants who had made too many procedural errors during the tasks, the questionnaires of the remaining 20 participants were analysed. 12 participants stated that they recognised certain patterns and had tried to apply the rules during the experiment and two participants said they had consistently chosen the word that they did not hear. The mean correct responses to question 11 in the language background questionnaire (see Appendix V) was 4.8 out of 6. Further analysis of the responses shows that 85% of the participants correctly responded to what the prime should be when presented with the word *jeuk*. In contrast, only 65% correctly responded to the prime of the target word *mees*. These values are extreme values, and all values together are presented in Table 6. Incorrect responses have not been included in Table 6, but examples of incorrect responses are *juk* to the target word *jeuk*, *drog* to the target word *droog* and *kieur* to the target word *kier*.

Table 6

Correct responses per vowel shift of the primes in the language background questionnaire.

TARGET	PRIME	VOWEL SHIFT	CORRECT RESPONSES
Kier	Ker	i - ɛ	75%
Hik	Huk	ɪ - ʏ	85%
Vroeg	Vrog	u - ɔ	80%
Mees	Meis	eː - ɛi	65%
Jeuk	Juik	øː - œy	80%
Droog	Droug	oː - ɑu	80%

4 Discussion

The present study investigated how people adapt to a novel accent and how phonological learning works when words are presented in isolation. A study by Bujok (2019) created a novel Dutch accent, by lowering the frequencies of the first two formants (F1 and F2) in six vowels (see Figure 2). Both studies showed that participants made fewer mistakes during the task, indicating that the participants easily adapted to the novel accent. It remained unclear whether the participants either learned the rules (e.g., the ɪ -> ʏ vowel shift), or memorised the specific items. To investigate how the participants improved over time, the learning task, as seen in Bujok (2019), was replicated and a cross-modal priming task was added to the experiment. The first research question of this study was: "*To what extent do participants develop accent adaptation during the course of the task?*". The second research question investigated whether the learning effect could be generalised to other lexical items. This was carried out by examining the influence of the different types of primes during the second task. Next, the development of the priming effect was investigated and the location of the stress was analysed.

4.1 Findings

4.1.1 The learning effect

The first aim of the study was to find the same learning effect that was found in the study by Bujok (2019). The same learning task was set up in the current study, using the same vowel shifts and presenting items that had also been presented during Bujok's experiment. The only adjustments that were made to the task were applied to the practice items in order to prevent the participants from familiarising with the predetermined vowel shifts in advance. It was thought that the familiarisation with the accent in the practice round might have facilitated the participants' ability to adapt to the novel accent. To avoid this, the practice round contained vowel shifts that were not presented in the training and test items. If the answer was incorrect, the participants were presented with corrective feedback. To show a learning effect, fewer errors had to have been made in the last round at the end of the task compared to the first round, which showed that the participants had improved, and therefore, had learned the novel accent.

When comparing the results of the current study to the results of Bujok's study (2019), many similarities were found. First of all, both studies found a decrease in RTs over rounds. This shows that as the task continues, the participants responded faster to the items, not only over rounds but also over blocks. The RTs in the training blocks were also faster than in the mixed blocks in both experiments, which suggests that the mixed blocks were more difficult than the training blocks. In the current study, an effect of item type was found, indicating that items with distractors that were pronounced differently (i.e., the pronounced form of the target word *lies* was /lɛs/ and the distractor was *lees*) were reacted to faster than the items with distractors that were identical (i.e., in this case the target word would have been *les*). If the participants deduce that the pronounced form is never one of the presented words on the screen, this may cause confusion and longer RTs are expected for this type of item. The same effect was found by Bujok (2019), which provides more evidence for possible confusion and longer RTs for different distractor items. Furthermore, the current study showed that participants took longer to respond to incorrect items than to correct items.

Not only did the RTs decrease over rounds in both experiments, but a decrease in error rates over rounds was also found. The current study also demonstrated a decrease in error rates over blocks and lower error rates were found for training items than for test items. This provides more evidence for mixed blocks being more difficult than training blocks, as the training blocks only contain training items and the mixed blocks contain both training and test items. Furthermore, in both experiments, the mean RTs were lower than 1,000ms in all rounds and block types and even below 850ms in the final round, indicating that the participants' response time decreased over time and was therefore influenced by the tighter response deadline over the rounds. The permitted response time for both experiments was 1,300ms in the first round, 1,200ms in the second round and 1,100ms in the final round.

When considering all results of the learning task together, the results clearly show that the participants not only made fewer errors over time, but that their RTs also dropped over time and therefore the participants improved throughout the task, which confirms that the learning effect has been found and provides an answer to the first research question. Thus, sufficient accent adaptation has been developed throughout the task and the learning effect will be further investigated in the next section.

4.1.2 Generalisability

As the learning effect had been successfully reproduced, the next step was to further investigate this effect. The learning task did not demonstrate whether the participants had simply remembered the specific items or had learned the presented vowel shifts. Consequently, the second task was also analysed. The cross-modal priming task contained words that the participants had not been presented with at an earlier moment. The participants heard one out of three types of primes, followed by a visual presentation of a word or a non-word. The participants then had to press one button if the subsequent target was a non-word and a different button if it was an actual word. The hypothesis for the cross-modal priming task was that the participants would have different RTs for each prime. For the primes that contained the vowel shift that had been *learned* during the learning task, we expected the lowest RTs. For the primes that contained a *related* vowel shift, we expected higher RTs and the highest RTs were expected for the primes that were *unrelated* to the target words. Thus, a three-step difference in RTs was expected.

The answer to the first research question of the cross-modal priming task is shown in Figure 7. The results show a clear difference in RTs between the types of primes. The graph demonstrates that RTs to words were the lowest for *learned* primes, followed by higher RTs for *related* and *unrelated* primes. The *learned* primes clearly influence the RTs for words, as was expected. This adds to the idea that people remap the accented words in their mental lexicon, as previous research has suggested (Maye et al., 2008; Norris et al., 2003), and that the remapped accented words are activated faster than *related* and *unrelated* words. Thus, evidence has been provided that the participants learned the rules during the learning task and were able to generalise the rules to novel words during the cross-modal priming task.

The *related* primes, however, did not seem to influence the participants' RTs. Activation models, such as the TRACE model (McClelland & Elman, 1986), have suggested that different types of form-overlap can activate words in our mental lexicon. Norris et al. (2002) used primes that rhymed with the target words and Witteman et al. (2013) used strongly and weakly accented speech as a type of form-overlap, both of which demonstrated that form-overlap could facilitate word recognition. In contrast to these findings, the current study was unable to find an effect of form-overlap on word recognition. The current study examined *related* primes that had a different vowel in either the first or second syllable (e.g., maunder instead of minder, which is related to the oː -> ɑu vowel shift), but this did not prove to have facilitation effects. Words that contain different vowels could make the primes sound too different from the target words, resulting in an absence of facilitation effects. It is possible that other factors, such as a difference in onset or a different pronunciation, only have a facilitation effect on the activation of words.

Furthermore, an effect of the type of target word was found on the RTs. For all types of primes, the participants reacted faster to words than to non-words. As the participants had never seen or heard the non-words before, and the participants could therefore not rely on top-down knowledge for faster processing, it was expected that it would take them longer to react to non-words than to real words. Moreover, the absence of priming effects for non-words adds to the hypothesis that people can generalise the learned accent to novel words, as the participants were not able to generalise the learned accent to non-words. Thus, more evidence is provided for generalisability, which is in line with previous findings on adaptation to accents and on generalisation (Maye et al., 2008; Skoruppa & Peperkamp, 2011).

4.1.3 Development of the priming effect during the cross-modal priming task

Another aim in the current study was to find out whether the participants' knowledge improved over time. It is possible that the participants did not learn the accent during the learning task, but learned the accent later on during the cross-modal priming task. To investigate the participants' knowledge improvement, the effects of the different types of primes in the first half of the trials were compared to the effects of the different types of primes in the second half of the trials. The results of the cross-modal priming task, however, could not demonstrate that the effect of priming was different for the first half compared to the second half. As the *learned* and *unrelated* primes significantly differed when both of the halves were taken together, the lack of a significant difference here might be due to insufficient data. Moreover, a small increase in RTs and error rates was found over time for *unrelated* primes. This could be due to the participants being inattentive towards the end of the experiment, as many participants indicated not being as concentrated at the end of the cross-modal priming task as at the start of the learning task. Considering that the differences of the effect of *learned* and *unrelated* primes in the first half compared to the second half of the task were almost negligible, it can be said that the participants did not learn the rules during the cross-modal priming task. However, the participants did learn the accent during the learning task, as was expected. This further supports the claim that people can quickly apply the learned rules to novel words.

4.1.4 The location of the stress

The final research question was on the effect of the location of the stress. In the cross-modal priming task, bisyllabic words were used containing stress in either the first or the second syllable. The target vowel was always embedded in a stressed syllable and the unstressed syllable always contained a schwa vowel. As words are activated incrementally (McClelland & Elman, 1986) and studies have pointed out that mispronunciations are detected faster in the second syllable (Cole & Jakimik, 1980), the expectation of the cross-modal priming task was that when a vowel shift was present in the second syllable, they would activate the target word faster in their mental lexicon and react faster in the lexical decision task, rather when the shift was present in the first syllable. Shorter RTs for stress in the second syllable were therefore expected. The results, however, could not show shorter RTs. In fact, a small increase in RTs was found in the second syllable, compared to the first syllable, but this effect was not significant. Even though the location of stress and mispronunciation were expected to have similar effects on RTs, mispronunciation could also concern other aspects than stress and could therefore be processed in the mental lexicon differently. The findings also provide further evidence that accented words are remapped in the mental lexicon and are activated equally as fast as non-accented words (Maye et al., 2008; Norris et al., 2003). Thus, accented words are not perceived as mispronunciations. Furthermore, as no effect of the location of the stress was found, the current study could not provide evidence for activation-based models, such as the TRACE model (McClelland & Elman, 1986). As an effect of the location of the stress was absent, it has become clear, contrary to what the TRACE model suggests, that not only bottom-up knowledge is used for the recognition of words. Other factors, such as probability, which is proposed by Norris et al. (2003), could have a greater effect on the activation process, but this must be confirmed in future research.

4.1.5 Language background questionnaires

At the end of the experiment the participants were asked to fill in a language background questionnaire. For six new words, the participants were asked to write down how they thought the words would have been pronounced by the speaker in the experiment. The results showed that *hik* (pronounced *huk*) was answered correctly by 85% of the participants, in comparison to *mees* (pronounced *meis*), that was answered correctly by only 65%. The rest of the results were in between the two percentages above. Interestingly, the distance in F1-F2 vowel space is shortest for the ɪ - ʏ vowel shift (*hik*), compared to the other five vowel shifts. Thus, this vowel shift, ɪ - ʏ, could be regarded as the easiest to adapt to. Further research on different distances in F1-F2 vowel space could be performed to investigate the relationship between accent adaptation and vowel space.

Furthermore, most of the incorrect responses that were given contained vowels that were part of other primes and target words during the experiment. For example, most of the incorrect responses for the target word *jeuk* were *juk* instead of *juik*, which would have been the correct shift for *hik* (ɪ - ʏ). For *droog*, most of the incorrect responses were *drog*, which would have been the correct shift for *vroeg (*u - ɔ). Only a few participants filled in vowels that did not occur in the experiment. For example, for the target word *kier*, one of the alternative incorrect responses was *kieur*. The fact that most of the incorrect responses were other vowel shifts that were used during the experiment indicates that the participants did learn the rules of the vowel shifts, but that they might have been confused as to which shift was linked to which vowel.

4.2 Limitations

The current study could not find an effect of *related* primes on the participants' RTs in the cross-modal priming task. Thus, it would be necessary for a future experiment to have a significantly larger number of participants and items, in order to ensure sufficient data is collected to obtain a clear effect.

A second limitation of the present study is that we aimed to investigate the effect of the location of stress on the RTs. For the cross-modal priming task, more target words containing a vowel shift in the first syllable were created than target words containing a vowel shift in the second syllable. To confirm the results and conclusions of the present study, a future study should not only increase the number of participants and items, but also take the location of the stress into account and ensure it is counterbalanced.

A final modification that could be performed in a future study is to shorten the duration of the learning task. Many participants indicated that they were less concentrated at the end of the cross-modal priming task than at the start of the learning task. A clear learning effect was found in the learning task and, by presenting fewer items, a similar learning effect could still be found. Thus, to increase the chance that participants remain as concentrated in the cross-modal priming task as in the learning task, a suggestion for future research would be to shorten the duration of the learning task.

4.3 Suggestions for further research

First of all, the probability theory by Norris and McQueen (2008) could be implemented in a future experiment. The current study was unable to find an effect of the location of stress on the RTs, which adds to the limitations of activation theories, such as for the TRACE model (McClelland & Elman, 1986). The activation-based TRACE model considers only bottom-up knowledge to be part of the activation process, and claims words are activated incrementally with fewer competitors toward the end of the activation process. Having fewer competitors would mean that it would take less time to activate words. Evidence for the TRACE model would have been provided, if lower RTs had been found for primes with stress in the second syllable. The current study, however, could not provide evidence for this matter. The results reject activation-based approaches and suggest that other factors, such as prior knowledge and probability, also influence word recognition. Further research should present accented words in a different context during the learning phase, for example in a short story or in complete sentences, and include ambiguity, in order to attempt to provide further evidence for a Bayesian approach. For example, Maye et al. (2013) presented participants with an unfamiliar accent spoken in a short story and found that after hearing the story participants could identify accented words as real words, although they had previously identified them as non-words. Presenting words with available contextual factors could not only provide evidence for a Bayesian-based approach for word recognition, but could also provide an opportunity to further investigate the location of the stress. If the accented words are presented with available contextual factors, prior knowledge can be accessed and the influence of the location of the stress on RTs can be further examined.

Another question regarding accent adaptation for further research would be to investigate how a novel accent is learned after listening to multiple speakers who all use the same vowel shifts. Kraljic and Samuel (2006) used multiple speakers in their experiment and suggest that accent adaptation is then still possible. Fewer unique items could be presented, by providing the same number of items, but using different speakers for the same items. Would there be a difference in RTs and error rates if participants were exposed to multiple speakers, compared to if they were exposed to only a single speaker, as in the current study? The results of both studies could then be compared. Secondly, it would be interesting to investigate whether the results of the present study would also be achieved if another task were added using a different speaker. Are people able to generalise the learned accented words in the present study to novel words that are pronounced by a different speaker in a future study? Do people link the learned accented words to a certain speaker, or are they able to generalise the accent to other speakers? Future research could shed light on this matter and investigate what the effect is of multiple speakers during accent adaptation.

Furthermore, previous studies have not yet examined the relationship between accent adaptation and the difference in vowel space. The current study suggests that shorter distances in F1-F2 vowel space might be easier to adapt to. To investigate whether distance in F1-F2 vowel space influences the ability to adapt to a novel accent, further research on the different types of vowel shifts should be performed by, for example, creating a novel accent with large distances in vowel space (e.g., ɪ - ɔ) and small distances in vowel space (e.g., ɪ - ʏ). Their RTs would subsequently be compared.

To summarise, the results show a clear difference in RTs when comparing the effects of the different types of primes. The *learned* primes strongly influence the RTs of words and the current study can therefore conclude that the participants are able to generalise the rules of the vowel shifts to novel words, which is in line with earlier studies (Maye et al., 2008; Skoruppa & Peperkamp, 2011). However, no difference was found for *related* and *unrelated* primes. In contrast, other studies that investigated types of form-overlap (Norris et al., 2002; Witteman et al., 2013) were able to find an effect. This discrepancy could be explained by observing that not all types of form-overlap lead to facilitation effects. Furthermore, participants generally took longer to respond to non-words than to real words, which indicates that non-words take longer to process in the brain and are not influenced, or inhibited, by the presented primes. The fact that participants were not able to generalise the learned accent to non-words confirms that participants learn the rules during accent adaptation, rather than memorising the specific items. The current study could not provide evidence for activation-based models, such as the TRACE model (McClelland & Elman, 1986). Possibly, the activation of words requires a combination of bottom-up knowledge and prior knowledge, as suggested by Norris and McQueen in Shortlist B (2008). To further investigate the recognition process, the accented words should be presented with available contextual factors, such as in a story or in complete sentences. Participants could then easily access prior knowledge. Finally, the current study suggests multiple ideas and improvements for future research, such as shortening the duration of the learning task and counterbalancing the location of the stress.

5. Conclusion

The purpose of the current study was to find out how phonological learning works and to investigate how people adapt to novel accents. Previous research has shown that we can adapt to novel accents quickly (Bujok, 2019; Clarke & Garrett, 2004; Maye, Aslin & Tanenhaus, 2008; Skoruppa & Peperkamp, 2011), but questions about how exactly we adapt to novel accents and how quickly, remain. For example, Trude et al. (2013) were unable to find evidence of full adaptation to the Québec-French accent. Clarke and Garrett (2004) did find full adaptation, meaning that accented words were recognised as quickly as non-accented words. Clarke and Garrett (2004), however, argued that this could be due to the participants' previous knowledge of the Québec-French accent in their experiment, which would increase the chance that the participants would quickly learn the accent. In contrast to the study by Trude et al. (2013), Maye et al. (2013) found full adaptation to an artificially created accent when presenting the accent in the form of a short story. Thus it is evident that various factors, such as previous knowledge and context, can influence the speed of accent adaptation. The current study further examined this process by creating a novel Dutch accent and presenting the words in isolation during a learning task and a cross-modal priming task.

During the learning task, participants made fewer errors over time, indicating a learning effect of the presented vowel shifts. The same learning effect was also found in the study by Bujok (2019). The current study could therefore further investigate the replicated findings of Bujok's experiment, which was done by adding a cross-modal priming task to the learning task in order to answer the main question as to whether an accent is learned by generalising the rules to novel words. For the cross-modal priming task, the results show that participants responded faster to words that followed a *learned* prime, rather than a *related* or *unrelated* prime. The participants also responded faster to words than to non-words, confirming that people apply the learned rules to novel words. Furthermore, accent adaptation does not develop throughout the cross-modal priming task and no difference in the location of the stress was found. The current study contributes to the overall question of how accent adaptation works and contributes to new insights regarding the effect of priming on phonological learning.

After suggesting a few modifications to the current experiment for a future experiment, ideas for other research questions were suggested. Further research should be conducted to confirm the results of the present study (for example, that the location of the stress did not influence RTs). Other factors, such as different contexts and multiple speakers, could also be taken into account and further research on the different distances of vowel space in vowel shifts could also be conducted.

References

Anaconda Software Distribution. (2020). *Anaconda Documentation. Version 2-2.4.0.* Anaconda Inc. Retrieved from https://docs.anaconda.com/.

Boersma, P., & Weenink, D. (2016). Praat: doing phonetics by computer [Computer software]. *Version 6.0.55*. Retrieved from http://www.praat.org.

British Library. (2019). *Accents and dialects of England*. Retrieved from https://www.bl.uk/british-accents-and-dialects/articles/accents-and-dialects-of-england.

Bujok, R. (2019). *Adaptation to Accents by learning from Mistakes -Event Related Potentials during error-based Phonological Learning* (Master's thesis). Retrieved from https://www.ru.nl/publish/pages/982405/thesis_ronny_bujok.pdf.

Clarke, C. M., & Garrett, M. F. (2004). Rapid adaptation to foreign-accented English. *The Journal of the Acoustical Society of America*, *116*(6), 3647-3658.

Cole, R. A., & Jakimik, J. (1980). How are syllables used to recognize words?. *The Journal of the Acoustical Society of America*, *67*(3), 965-970.

Cutler, A., Mehler, J., Norris, D., & Segui, J. (1987). Phoneme identification and the lexicon. *Cognitive Psychology, 19*(2), 141-177.

Dahan, D., Drucker, S. J., & Scarborough, R. A. (2008). Talker adaptation in speech perception: Adjusting the signal or the representations?. *Cognition*, *108*(3), 710-718.

Dahan, D., Magnuson, J. S., & Tanenhaus, M. K. (2001). Time course of frequency effects in spoken-word recognition: Evidence from eye movements. *Cognitive Psychology*, *42*(4), 317-367.

Eberhard, D. M., Simons, G. F., & Fennig, C. D. (2020). *Ethnologue: Languages of the World. Twenty-third edition.* Dallas, Texas: SIL International.

Floccia, C., Goslin, J., Girard, F., & Konopczynski, G. (2006). Does a regional accent perturb speech processing?. *Journal of Experimental Psychology: Human Perception and Performance*, *32*(5), 1276.

Floccia, C., Butler, J., Goslin, J., & Ellis, L. (2009). Regional and foreign accent processing in English: Can listeners adapt?. *Journal of Psycholinguistic Research*, *38*(4), 379-412.

IBM Corp. Released 2020. *IBM SPSS Statistics for Windows, Version 27.0*. Armonk, NY: IBM Corp.

Kraljic, T., & Samuel, A. G. (2006). Generalization in perceptual learning for speech. *Psychonomic Bulletin & Review*, *13*(2), 262-268.

Lingoda. (2021). *English Speaking Countries List.* Retrieved from https://www.lingoda.com/en/content/english-speaking-countries/#:~:text=Learn%20About%20All%20The%20English%20Speaking%20Countries&text=In%20fact%2C%20English%20is%20recognized,as%2027%20non%2Dsovereign%20entities.

Marslen-Wilson, W. D., & Welsh, A. (1978). Processing interactions and lexical access during word recognition in continuous speech. *Cognitive Psychology*, *10*(1), 29-63.

Maye, J., Aslin, R. N., & Tanenhaus, M. K. (2008). The weckud wetch of the wast: Lexical adaptation to a novel accent. *Cognitive Science*, *32*(3), 543-562.

Mazzoni, D., & Dannenberg, R. (2000). Audacity [software]. *The Audacity Team, Pittsburg, PA, USA*.

McClelland, J. L., & Elman, J. L. (1986). The TRACE model of speech perception. *Cognitive Psychology*, *18*(1), 1-86.

McNamara, T. P. (2005). *Semantic Priming: Perspectives from Memory and Word Recognition*. Psychology Press.

Meyer, D. E., & Schvaneveldt, R. W. (1971). Facilitation in recognizing pairs of words: evidence of a dependence between retrieval operations. *Journal of Experimental Psychology*, *90*(2), 227.

Microsoft Corporation. (2018). *Microsoft Excel*. Retrieved from https://office.microsoft.com/excel.

Norris, D., & McQueen, J. M. (2008). Shortlist B: a Bayesian model of continuous speech recognition. *Psychological Review*, *115*(2), 357.

Norris, D., McQueen, J. M., & Cutler, A. (2002). Bias effects in facilitatory phonological

priming. *Memory & Cognition, 30*(3), 399-411.
Norris, D., McQueen, J. M., & Cutler, A. (2003). Perceptual learning in speech. *Cognitive Psychology, 47*(2), 204-238.
Sarma, M., & Sarma, K. K. (2014). Speech processing technology: basic consideration. In *Phoneme-Based Speech Segmentation using Hybrid Soft Computing Framework* (pp. 21-45). Springer, New Delhi.
Skoruppa, K., & Peperkamp, S. (2011). Adaptation to novel accents: Feature-based learning of context-sensitive phonological regularities. *Cognitive Science, 35*(2), 348-366.
Taft, M., & Hambly, G. (1986). Exploring the cohort model of spoken word recognition. *Cognition, 22*(3), 259-282.
Trude, A. M., Tremblay, A., & Brown-Schmidt, S. (2013). Limitations on adaptation to foreign accents. *Journal of Memory and Language, 69*(3), 349-367.
Van Casteren, M., & Davis, M. H. (2006). Mix, a program for pseudorandomization. *Behavior Research Methods, 38*(4), 584-589.
Witteman, M. J., Weber, A., & McQueen, J. M. (2013). Foreign accent strength and listener familiarity with an accent codetermine speed of perceptual adaptation. *Attention, Perception, & Psychophysics, 75*(3), 537-556.

Appendices

I. An overview of the stimuli used in learning task

Practice items:

VOWEL	TARGET	PRIME	DISTRACTOR
a	pan	paan	pen
a	klant	klaant	klont
u	huur	heur	hoor
u	puur	peur	peer

Training items:

TARGET	VOWEL	PRONOUNCED FORM	VOWEL	DISTRACTOR	VOWEL
zwiep	i	/zwɛp/	ɛ	zweep	e:
fries	i	/frɛs/	ɛ	fris	ɪ
dief	i	/dɛf/	ɛ	doof	o:
triest	i	/trɛst/	ɛ	troost	o:
vlieg	i	/vlɛx/	ɛ	vleug	ø:
klier	i	/klɛr/	ɛ	kleur	ø:
griep	i	/xrɛp/	ɛ	groep	u
mier	i	/mɛr/	ɛ	moer	u

TARGET	VOWEL	PRONOUNCED FORM	VOWEL	DISTRACTOR	VOWEL
blik	ɪ	/blʏk/	ʏ	bleek	e:
spin	ɪ	/spʏn/	ʏ	speen	e:
vis	ɪ	/vʏs/	ʏ	vies	i
zin	ɪ	/zʏn/	ʏ	zien	i
strip	ɪ	/strʏp/	ʏ	stroop	o:
nis	ɪ	/nʏs/	ʏ	neus	ø:
stil	ɪ	/stʏl/	ʏ	stoel	u
stip	ɪ	/stʏp/	ʏ	stoep	u

TARGET	VOWEL	PRONOUNCED FORM	VOWEL	DISTRACTOR	VOWEL
boer	u	/bɔr/	ɔ	beer	e:
sproet	u	/sprɔt/	ɔ	spriet	i
boeg	u	/bɔx/	ɔ	big	ɪ
troep	u	/trɔp/	ɔ	trip	ɪ
schoen	u	/sxɔn/	ɔ	schoon	o:
stoet	u	/stɔt/	ɔ	stoot	o:

stoer	u	/stɔr/	ɔ	steur	øː
hoes	u	/hɔs/	ɔ	heus	øː

TARGET	VOWEL	PRONOUNCED FORM	VOWEL	DISTRACTOR	VOWEL
vlees	e:	/vlɛis/	ɛi	vlies	i
geest	e:	/gɛist/	ɛi	gist	ɪ
kleef	e:	/klɛif/	ɛi	kloof	o:
scheel	e:	/sxɛil/	ɛi	school	o:
keer	e:	/kɛir/	ɛi	keur	øː
deel	e:	/dɛil/	ɛi	doel	u
pees	e:	/pɛis/	ɛi	poes	u
peer	e:	/pɛir/	ɛi	pier	i

TARGET	VOWEL	PRONOUNCED FORM	VOWEL	DISTRACTOR	VOWEL
sneu	øː	/snœy/	œy	snee	e:
steun	øː	/stœyn/	œy	steen	e:
feut	øː	/fœyt/	œy	fit	ɪ
geul	øː	/xœyl/	œy	gil	ɪ
deur	øː	/dœyr/	œy	door	o:
heup	øː	/hœyp/	œy	hoop	o:
zeur	øː	/zœyr/	œy	zeer	e:
geur	øː	/xœyr/	œy	gier	i

TARGET	VOWEL	PRONOUNCED FORM	VOWEL	DISTRACTOR	VOWEL
brood	o:	/brɑut/	ɑu	breed	e:
loon	o:	/lɑun/	ɑu	leen	e:
loof	o:	/lɑuf/	ɑu	lief	i
stroom	o:	/strɑum/	ɑu	striem	i
knoop	o:	/knɑup/	ɑu	knip	ɪ
strook	o:	/strɑuk/	ɑu	strik	ɪ
hoog	o:	/hɑux/	ɑu	heug	øː
zoon	o:	/zɑun/	ɑu	zoen	u

Test items:

TARGET	VOWEL	PRONOUNCED FORM	VOWEL	DISTRACTOR	VOWEL
friet	i	/frɛt/	ɛ	fret	ɛ
hiel	i	/hɛl/	ɛ	hel	ɛ
lies	i	/lɛs/	ɛ	lees	e:
niet	i	/nɛt/	ɛ	net	ɛ

riem	i	/rɛm/	ɛ	room	o:
stier	i	/stɛr/	ɛ	ster	ɛ
riek	i	/rɛk/	ɛ	reuk	øː
wiet	i	/wɛt/	ɛ	wit	ɪ

TARGET	**VOWEL**	**PRONOUNCED FORM**	**VOWEL**	**DISTRACTOR**	**VOWEL**
hit	ɪ	/hʏt/	ʏ	heet	e:
kist	ɪ	/kʏst/	ʏ	kiest	i
licht	ɪ	/lʏxt/	ʏ	lucht	ʏ
list	ɪ	/lʏst/	ʏ	lust	ʏ
mis	ɪ	/mʏs/	ʏ	mus	ʏ
pit	ɪ	/pʏt/	ʏ	put	ʏ
krik	ɪ	/krʏk/	ʏ	kreuk	øː
spil	ɪ	/spʏl/	ʏ	spoel	u

TARGET	**VOWEL**	**PRONOUNCED FORM**	**VOWEL**	**DISTRACTOR**	**VOWEL**
broek	u	/brɔk/	ɔ	breuk	øː
groet	u	/xrɔt/	ɔ	groot	o:
hoef	u	/hɔf/	ɔ	hof	ɔ
hoek	u	/hɔk/	ɔ	hok	ɔ
koek	u	/kɔk/	ɔ	kok	ɔ
proef	u	/prɔf/	ɔ	prof	ɔ
snoer	u	/snɔr/	ɔ	sneer	e:
soep	u	/sɔp/	ɔ	sip	ɪ

TARGET	**VOWEL**	**PRONOUNCED FORM**	**VOWEL**	**DISTRACTOR**	**VOWEL**
eend	e:	/ɛint/	ɛi	eind	ɛi
kreet	e:	/krɛit/	ɛi	krijt	ɛi
meel	e:	/mɛil/	ɛi	mijl	ɛi
peen	e:	/pɛin/	ɛi	pin	ɪ
reep	e:	/rɛip/	ɛi	rijp	ɛi
veeg	e:	/vɛix/	ɛi	voeg	u
week	e:	/wɛik/	ɛi	wiek	i
leek	e:	/lɛik/	ɛi	look	o:

TARGET	**VOWEL**	**PRONOUNCED FORM**	**VOWEL**	**DISTRACTOR**	**VOWEL**
beuk	øː	/bœyk/	œy	beek	e:
beul	øː	/bœyl/	œy	bil	ɪ
deuk	øː	/dœyk/	œy	doek	u
keus	øː	/kœys/	œy	kuis	œy
leuk	øː	/lœyk/	œy	luik	œy

leus	ø:	/lœys/	œy	luis	œy
reus	ø:	/rœys/	œy	roos	o:
zeug	ø:	/zœyx/	œy	zuig	œy

TARGET	**VOWEL**	**PRONOUNCED FORM**	**VOWEL**	**DISTRACTOR**	**VOWEL**
boot	o:	/bɑut/	ɑu	biet	i
stoot	o:	/stɑut/	ɑu	stout	ɑu
pook	o:	/pɑuk/	ɑu	piek	i
poos	o:	/pɑus/	ɑu	paus	ɑu
soos	o:	/sɑus/	ɑu	soes	u
goot	o:	/gɑud/	ɑu	goud	ɑu
moot	o:	/mɑut/	ɑu	mout	ɑu
schoot	o:	/sxɑut/	ɑu	scheut	ø:

II. An overview of stimuli used in cross-modal priming task

Practice items:

VOWEL	TARGET	PRIME LEARNED
a	zijspan	zijspaan
u	patuur	pateur

VOWEL	TARGET	PRIME UNRELATED
a	joman	riefpon
u	bestuur	blastiep

Test items:

i - ɛ vowel shift

	VOWEL		TARGET		PRIME	
Target	**Learned**	**Related**		**Learned**	**Related**	**Unrelated**
i	ɛ	ɑu	kiezer	kezzer	kauzer	kolbijf
i	ɛ	ɑu	vlieger	vlegger	vlauger	vloker
i	ɛ	ɔ	vertier	verter	vertor	vebbol
i	ɛ	ɔ	briefje	brefje	brofje	biebder
i	ɛ	ɛi	techniek	technek	techneik	tiftiel
i	ɛ	ɛi	gieter	getter	geiter	guizer
i	ɛ	œy	wieltje	weltje	weiltje	waumei
i	ɛ	œy	verliefd	verlefd	verluifd	vultuis
i	ɛ	ʏ / ɵ	plezier	plezer	plezur	plifpol
i	ɛ	ʏ / ɵ	verlies	verles	verlus	veibol

ɪ - ʏ vowel shift

	VOWEL		TARGET		PRIME	
Target	**Learned**	**Related**		**Learned**	**Related**	**Unrelated**
ɪ	ʏ	ɑu	schipper	schupper	schauper	schormen
ɪ	ʏ	ɑu	minder	munder	maunder	movrik
ɪ	ʏ	ɔ	splinter	splunter	splonter	spleiftek
ɪ	ʏ	ɔ	conflict	confluct	conflොct	caufier
ɪ	ʏ	ɛ	gewicht	gewucht	gewecht	giellon
ɪ	ʏ	ɛ	winter	wunter	wenter	workui
ɪ	ʏ	ɛi	gebit	gebut	gebeit	goolstuin

ɪ	ʏ	ɛi	gezin	gezun	gezein	geumto
ɪ	ʏ	œy	kwispel	kwuspel	kwuispel	kwievoog
ɪ	ʏ	œy	begrip	begrup	begruip	belpog

u - ɔ vowel shift

	VOWEL		TARGET		PRIME	
Target	**Learned**	**Related**		**Learned**	**Related**	**Unrelated**
u	ɔ	ɑu	bezoek	bezok	bezauk	benruip
u	ɔ	ɑu	proever	prover	prauver	prautim
u	ɔ	ɛ	gevoel	gevol	gevel	geilaun
u	ɔ	ɛ	verzoek	verzok	verzek	vobuif
u	ɔ	ɛi	hoepel	hoppel	heipel	holek
u	ɔ	ɛi	beroep	berop	beruip	baumier
u	ɔ	œy	voedsel	vodsel	vuidsel	vieke
u	ɔ	œy	broeder	brodder	breider	bropek
u	ɔ	ʏ / ɵ	woede	wodde	wuide	weimet
u	ɔ	ʏ / ɵ	groente	gronte	grunte	graubis

eː - ɛi vowel shift

	VOWEL		TARGET		PRIME	
Target	**Learned**	**Related**		**Learned**	**Related**	**Unrelated**
eː	ɛi	ɑu	beestje	beistje	baustje	bortin
eː	ɛi	ɑu	leegte	leigte	laugte	lostig
eː	ɛi	ɔ	bever	beiver	bovver	bieftos
eː	ɛi	ɔ	regel	reigel	ruggel	ruinser
eː	ɛi	ɛ	lepel	leipel	leppel	lienkof
eː	ɛi	ɛ	bezem	beizem	bezzem	biemmorf
eː	ɛi	œy	kweker	kweiker	kwuiker	kwoften
eː	ɛi	œy	teken	teiken	tuiken	tiefel
eː	ɛi	ʏ / ɵ	veger	veiger	vogger	vulgorp
eː	ɛi	ʏ / ɵ	hemel	heimel	haumel	huitif

øː - œy vowel shift

	VOWEL		TARGET		PRIME	
Target	**Learned**	**Related**		**Learned**	**Related**	**Unrelated**
øː	œy	ɑu	peuter	puiter	pauter	persau
øː	œy	ɑu	meubel	muibel	maubel	mulnel
øː	œy	ɔ	sleutel	sluitel	slottel	sliesdo
øː	œy	ɔ	teugel	tuigel	toggel	tultiel
øː	œy	ɛ	jeugdig	juigdig	jegdig	joldeut
øː	œy	ɛ	vreugde	vruigde	vregde	vrunsel
øː	œy	ɛi	kleuter	kluiter	kleiter	kleiptoeg
øː	œy	ɛi	vleugel	vluigel	vleigel	vlormek
øː	œy	ʏ / ɵ	gedreun	gedruin	gedrun	gielos

øː	œy	ʏ / ɵ	leuning	luining	lunning	lopgeuf

oː - ɑu vowel shift

	VOWEL		TARGET		PRIME	
Target	Learned	Related		Learned	Related	Unrelated
oː	ɑu	ɔ	hoogte	haugte	hogte	heipten
oː	ɑu	ɔ	gewoon	gewon	gewein	gopaut
oː	ɑu	ɛ	betoog	betaug	beteg	beemkrup
oː	ɑu	ɛ	molen	maulen	mellen	mielber
oː	ɑu	ɛi	persoon	persaun	persein	polnun
oː	ɑu	ɛi	bodem	baudem	beidem	buifkrom
oː	ɑu	œy	mode	maude	muide	melfros
oː	ɑu	œy	poster	pauster	puister	piegdeis
oː	ɑu	ʏ / ɵ	stroper	strauper	strupper	straunem
oː	ɑu	ʏ / ɵ	geloof	gelauf	gelúf	guimog

Non-words:

i - ɛ vowel shift

	VOWEL		TARGET		PRIME	
Target	Learned	Related		Learned	Related	Unrelated
i	ɛ	ɑu	hiezer	hezzer	hauzer	holbijf
i	ɛ	ɑu	plieger	plegger	plauger	ploker
i	ɛ	ɔ	kertier	kerter	kertor	kebbol
i	ɛ	ɔ	friefje	frefje	frofje	fiebder
i	ɛ	ɛi	wechniek	wechnek	wechneik	wiftiel
i	ɛ	ɛi	fieter	fetter	feiter	fuizer
i	ɛ	œy	nieltje	neltje	neiltje	naumei
i	ɛ	œy	kerliefd	kerlefd	kerluifd	kultuis
i	ɛ	ʏ / ɵ	flezier	flezer	flezur	flifpol
i	ɛ	ʏ / ɵ	nerlies	nerles	nerlus	neibol

ɪ - ʏ vowel shift

	VOWEL		TARGET		PRIME	
Target	Learned	Related		Learned	Related	Unrelated
ɪ	ʏ	ɑu	plipper	plupper	plauper	plormen
ɪ	ʏ	ɑu	jinder	junder	jaunder	jovrik
ɪ	ʏ	ɔ	glinter	glunter	glonter	gleiftek
ɪ	ʏ	ɔ	honflict	honfluct	honfloct	haufier
ɪ	ʏ	ɛ	kewicht	kewucht	kewecht	kielllon
ɪ	ʏ	ɛ	dinter	dunter	denter	dorkui
ɪ	ʏ	ɛi	bebit	bebut	bebeit	boolstuin
ɪ	ʏ	ɛi	lezin	lezun	lezein	leumto

ɪ	ʏ	œy	twispel	twuspel	twuispel	twievoog
ɪ	ʏ	œy	megrip	megrup	megruip	melpog

u - ɔ vowel shift

	VOWEL		TARGET	PRIME		
Target	Learned	Related		Learned	Related	Unrelated
u	ɔ	ɑu	lezoek	lezok	lezauk	lenruip
u	ɔ	ɑu	vroever	vrover	vrauver	vrautim
u	ɔ	ɛ	revoel	revol	revel	reilaun
u	ɔ	ɛ	nerzoek	nerzok	nerzek	nobuif
u	ɔ	ɛi	moepel	moppel	meipel	molek
u	ɔ	ɛi	leroep	lerop	leruip	laumier
u	ɔ	œy	toedsel	todsel	tuidsel	tieke
u	ɔ	œy	kroeder	krodder	kreider	kropek
u	ɔ	ʏ / ɵ	toede	todde	tuide	teimet
u	ɔ	ʏ / ɵ	broente	bronte	brunte	braubis

eː - ɛi vowel shift

	VOWEL		TARGET	PRIME		
Target	Learned	Related		Learned	Related	Unrelated
eː	ɛi	ɑu	neestje	neistje	naustje	nortin
eː	ɛi	ɑu	peegte	peigte	paugte	postig
eː	ɛi	ɔ	hever	heiver	hovver	hieftos
eː	ɛi	ɔ	hegel	heigel	huggel	huinser
eː	ɛi	ɛ	nepel	neipel	neppel	nienkof
eː	ɛi	ɛ	tezem	teizem	tezzem	tiemmorf
eː	ɛi	œy	tweker	tweiker	twuiker	twoften
eː	ɛi	œy	heken	heiken	huiken	hiefel
eː	ɛi	ʏ / ɵ	meger	meiger	mogger	mulgorp
eː	ɛi	ʏ / ɵ	nemel	neimel	naumel	nuitif

øː - œy vowel shift

	VOWEL		TARGET	PRIME		
Target	Learned	Related		Learned	Related	Unrelated
øː	œy	ɑu	heuter	huiter	hauter	hersau
øː	œy	ɑu	keubel	kuibel	kaubel	kulnel
øː	œy	ɔ	pleutel	pluitel	plottel	pliesdo
øː	œy	ɔ	zeugel	zuigel	zoggel	zultiel
øː	œy	ɛ	reugdig	ruigdig	regdig	roldeut
øː	œy	ɛ	greugde	gruigde	gregde	grunsel
øː	œy	ɛi	bleuter	bluiter	bleiter	bleiptoeg
øː	œy	ɛi	bleugel	bluigel	bleigel	blormek
øː	œy	ʏ / ɵ	fedreun	fedruin	fedrun	fielos
øː	œy	ʏ / ɵ	seuning	suining	sunning	sopgeuf

oː - ɑu vowel shift

	VOWEL		TARGET		PRIME	
Target	**Learned**	**Related**		**Learned**	**Related**	**Unrelated**
oː	ɑu	ɔ	koogte	kaugte	kogte	keipten
oː	ɑu	ɔ	tewoon	tewon	tewein	topaut
oː	ɑu	ɛ	getoog	getaug	geteg	geemkrup
oː	ɑu	ɛ	golen	gaulen	gellen	gielber
oː	ɑu	ɛi	tersoon	tersaun	tersein	tolnun
oː	ɑu	ɛi	todem	taudem	teidem	tuifkrom
oː	ɑu	œy	vode	vaude	vuide	velfros
oː	ɑu	œy	moster	mauster	muister	miegdeis
oː	ɑu	ʏ / ɵ	broper	brauper	brupper	braunem
oː	ɑu	ʏ / ɵ	teloof	telauf	telúf	tuimog

III. Informatiedocument

INFORMATIEDOCUMENT

Naam onderzoek: *Welk woord hoor je?*
Verantwoordelijke onderzoeker: *Mirjam Broersma*

Doel en procedure van het onderzoek
Tijdens dit experiment krijgt u in een computertaak een aantal woorden te horen. Na elk woord komen er twee opties in beeld en moet u aangeven welk woord u heeft gehoord. Als u wilt, kunnen we na afloop uitleggen waar we onderzoek naar doen.

Risico's en ongemakken
Er zijn geen risico's voor uw gezondheid of uw veiligheid.

Vertrouwelijkheid van de onderzoeksgegevens
De gegevens die we in dit onderzoek verzamelen, zullen door wetenschappers gebruikt worden voor artikelen en presentaties. Natuurlijk maken we deze gegevens volledig anoniem en bewaren we ze volgens de aan de Radboud Universiteit geldende regels. Uitgangspunt is dat de geanonimiseerde data tenminste 10 jaar ten behoeve van de wetenschappelijke gemeenschap opvraagbaar zijn.

Vrijwilligheid
U doet vrijwillig mee aan dit onderzoek. Daarom kunt u op elk moment tijdens het onderzoek uw deelname stopzetten. Alle gegevens die we bij u verzameld hebben, worden dan definitief verwijderd.
Zelfs tot 24 uur na afloop van het onderzoek kunt u ons doorgeven dat u niet meer mee wilt doen.

Vergoeding
Als dank voor uw medewerking, ontvangt u van ons 10€ .

Nadere inlichtingen
Als u graag verdere informatie over het onderzoek wilt hebben, nu of in de toekomst, kunt u contact opnemen met Mirjam Broersma (telefoon: 024-3616075; e-mail: m.broersma@let.ru.nl).

Voor eventuele klachten over dit onderzoek kunt u contact opnemen met:

Margret van Beuningen, secretaris Ethische Toetsingscommissie Geesteswetenschappen
Radboud Universiteit
Postbus 9103
6500 HD Nijmegen
Tel: 024-3615814
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IV. Parameters and formulas

To control the 0-30ms delay, two wait functions were built in the Presentation script: the first function before presenting the audio and the second function before presenting the visual stimuli. The wait functions were calculated for each item, by calculating the expected timings using Spyder by Anaconda software (2020) and using the durations of the audio files. To calculate the parameters, such as the audio onset latency and the monitor's refresh rate, several different formulas were used (see below). Multiple Time Stamps were built in and written to the Output file and compared to the built-in calculated RTs by Presentation® software, to check whether the delays had been minimised. All things considered, the perfect transition of the audio offset and visual onset was not met. However, as after calculating the wait formulas the delay was almost negligible (0 – 5ms), the RTs calculated by Presentation® software were used to analyse the data instead.

audio_onset_latency = 2

response_time_monitor = 10.5

audio_processing_time = 14

monitor_refresh_rate = 60

- t_video_start_monitor = refresh rate x ceil ((audio_duration + t_audio_onset_latency + 13) / refresh interval

- t_video_start = t_video_start_monitor - 8 ms (half of the refresh rate)

- t_audio_start = t_video_start_monitor + response_time_monitor - audio_duration – t_audio_onset_latency - 13 ms

V. Language background questionnaire

Vragenlijst taalachtergrond

1a. Leeftijd: Klik hier om te typen

1b. Geslacht: Klik hier om te typen

2. Studie: Klik hier om te typen

3. In welke landen, en in welke regio´s van Nederland heb je gewoond? Geef aan van welke leeftijd tot welke leeftijd je er gewoond hebt.

Land / Regio van Nederland	Van (leeftijd)	Tot (leeftijd)

4. Welke talen en dialecten spraken je ouders/verzorgers tegen je toen je een kind was?

Klik hier om te typen

5. Wat is je moedertaal?

Klik hier om te typen

6. Geef hieronder aan welke talen en Nederlandse dialecten je begrijpt, gebruikt, of geleerd hebt. Geef voor elke taal/dialect op een schaal van 1 tot 7 aan hoe goed je spreek- en luistervaardigheid is.

Minimaal	Zeer beperkt	Beperkt	Functioneel	Goed	Heel goed	Moedertaal-niveau
1	2	3	4	5	6	7

Taal/dialect	**Luisteren**	**Spreken**	**Algemeen**
Nederlands			

7. Geef hieronder weer aan welke talen en dialecten je begrijpt, gebruikt, of geleerd hebt. Geef voor elke taal/dialect het moment aan waarop je er voor het eerst mee in contact kwam.

Taal/dialect	**Leeftijd van eerste contact (bijv. 0 betekent vanaf geboorte)**	**Waar (bijv. thuis, familie, basisschool, middelbare school, universiteit)**
Nederlands		

8. Had je moeite met het lezen van de tekst op het scherm tijdens het experiment?

☐ Ja

☐ Nee

9a. Had je moeite met het verstaan van de woorden tijdens het eerste experiment?

☐ Ja, namelijk ... Klik hier om te typen

☐ Nee

9b. Had je moeite met het verstaan van de woorden tijdens het tweede experiment?

☐ Ja, namelijk ... Klik hier om te typen

☐ Nee

10. Heb je tijdens het experiment gebruik gemaakt van bepaalde strategieën? Zo ja, kun je omschrijven wat je hebt gedaan?

Klik hier om te typen

11. Hoe zou de spreker de volgende woorden uitspreken?

1. jeuk

Klik hier om te typen

2. mees

Klik hier om te typen

3. kier

Klik hier om te typen

4. hik

Klik hier om te typen

5. droog

Klik hier om te typen

6. vroeg

Klik hier om te typen

12. Heb je verder nog opmerkingen over het experiment of over je taalachtergrond?

Klik hier om te typen

Bedankt!

VI. Consent form

Radboud Universiteit

TOESTEMMINGSVERKLARING

Naam onderzoek:
……
……..
Verantwoordelijke onderzoeker:
………………………………………………………………………………………………………..

Verklaring deelnemer
Ik heb uitleg gekregen over het doel van het onderzoek. Ik heb vragen mogen stellen over het onderzoek. Ik neem vrijwillig aan het onderzoek deel. Ik begrijp dat ik op elk moment tijdens het onderzoek mag stoppen als ik dat wil. Ik begrijp hoe de gegevens van het onderzoek bewaard zullen worden en waarvoor ze gebruikt zullen worden. Ik stem in met deelname aan het onderzoek zoals beschreven in het informatiedocument.

Naam: ……………………………………………………………........
Geboortedatum: ……………………………………….....

Handtekening: ....

Datum: ………………………………………...................

Verklaring uitvoerend onderzoeker
Ik verklaar dat ik de hierboven genoemde persoon juist heb geïnformeerd over het onderzoek en dat ik mij houd aan de richtlijnen voor onderzoekers zoals verwoord in het protocol van de Ethische Toetsingscommissie Geesteswetenschappen

Naam: ……………………………………………………………...... …..

Handtekening: ....

Datum:………………………………......................