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The Effects of Accent Familiarity on Lexical Processing

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LING3200: LINGUISTICS DISSERTATION

2019

Word Count: 11,998 words

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Abstract

The speech that we hear and produce is extremely variable as a result of a range of both linguistic and social factors. Previous research has concentrated on how this variation affects speech production and more work is needed to understand how it is processed (Thomas, 2002). Within this area, this undergraduate dissertation experiment investigates how familiarity with different accents of English affects lexical processing, using an auditory lexical decision task. Previous research by Floccia et al. (2006) used this method to find that unfamiliar French regional accents were responded to significantly slower than familiar and native regional accents. This study builds on earlier research by testing accents and a population which have not yet been investigated in this way as well as by exerting higher levels of control over lexical characteristics of the stimuli. The experiment elicited listener response times and accuracy rates for lexical decisions made on the final word of 60 sentences produced by speakers of three accents – Yorkshire English (native), Liverpool English (familiar) and Indian English (unfamiliar) – from participants born and raised in Yorkshire. The results found a statistically significant effect of accent on both reaction times and accuracy rates, suggesting that accent familiarity does affect lexical processing and supporting the idea that models of spoken word recognition need to account for the role that socioindexical variation plays during lexical access. However, the pattern of effects was not in line with those predicted by the alternative hypothesis and found by previous research as reaction times were significantly faster in the familiar accent condition than the native and unfamiliar accent conditions. Various explanations, including cultural prominence and differences in speech rate, are put forward to account for this and the implications for models of spoken word recognition are discussed.

Acknowledgements

I would like to thank my supervisor, Dr Gisela Tomé Lourido, for all of her kind help over the course of the year. This dissertation would not have been possible without all of the invaluable guidance and supervision that she has given me, and I will always really appreciate it.

Many thanks also to Dr Christopher Norton for his technical help with building the PsychoPy experiment.

I am extremely grateful for all of the people who kindly took their time out to participate in this research, both the speakers who produced the recordings and the listeners who completed the main experiment.

Finally, I would like to thank my amazing friends, family and boyfriend Josh for supporting me throughout my time at university. In particular, thank you to my Mum and Dad for always being my number one supporters and being there for me every step of the way. Being able to make you proud is what motivates me in all of the work that I do!

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1. Introduction

It is highly unlikely that multiple instances of the same word will ever be produced in exactly the same way (Sumner et al., 2014). This variability is due to linguistic factors such as articulatory constraints and phonological conditioning, as well as demographic factors such as a speaker's gender, social class and regional background. Despite this variation, humans are able to consistently recognise sounds produced by different speakers and identify them as combinations which form particular words without great difficulty. More research is needed to understand how we manage this as most sociophonetic work on interspeaker variation has focused on how speech production differs between individuals, rather than how these differences are processed (Drager, 2010). Within this area, the current study will investigate how familiarity with different varieties of English affects lexical processing by using a lexical decision task. Such work will contribute to multiple areas of study (Foulkes et al., 2010) – phonetics, sociolinguistics and psycholinguistics – by providing empirical evidence exploring how the brain deals with social variation in the speech that we hear.

This piece of research will also have implications for models of spoken word recognition. A range of accounts have been proposed to explain the processes and representations involved in understanding the spoken word. There is debate among these models regarding the extent to which socioindexical information is contained within these representations and subsequently used during lexical processing. Socioindexical information refers to linguistic features of speech which correlate with non-linguistic factors such as the geographical origin of the speaker (Foulkes, 2010). By producing empirical evidence for whether or not a listener's familiarity with different accents affects the speed and accuracy of lexical access, this experiment will contribute to the debate.

The effects of accent familiarity on lexical processing were investigated using an auditory lexical decision task. This method, in which participants must decide whether spoken words are real words or non-words, is used to study lexical processing as the decisions require each word to be fully processed (Goldinger, 1996a). The spoken stimuli in the lexical decision task were produced by speakers of accents which differed in familiarity levels for the participants, who were all native speakers of Yorkshire English. Participants were presented with auditory stimuli produced by a speaker of their native Yorkshire

English accent, a Liverpool English accent which was assumed to be familiar to them and an Indian English accent which was assumed to be unfamiliar to them. The three familiarity levels and use of an auditory lexical decision task were taken from a previous, similar experiment conducted by Floccia et al. (2006). The dependent variables that were measured to determine the effects of the different accents on lexical processing were reaction times and accuracy rates.

Previous research in this area has found that increased familiarity with variation has a facilitatory effect on lexical processing (Floccia et al., 2006; Adank et al., 2009; Clopper, 2017). Based on these findings, it was predicted that the reaction times would be slower and accuracy rates would be lower for the unfamiliar accent compared to the familiar and native accents. This would be indicative of a processing cost caused by unfamiliar accents. It would also be evidence for the idea that socioindexical information does play a role during lexical processing and should therefore be accounted for in models of spoken word recognition.

The literature review that follows will provide an overview of existing models of spoken word recognition and experimental findings on how variation is dealt with during language processing, before focusing on how increased experience with this variation affects performance. This chapter concludes by introducing the present study and explaining how it builds upon and contributes to the previous research. Following this, the methodology chapter will outline the methods used to collect the data required to be able to answer the research question. Within this section, details of the recruitment of participants and the process of designing and recording stimuli precede a description of the experimental procedure. Next, the results chapter starts by reporting participants' accuracy rates for both real words and non-words for each level of the independent variable. The reaction times are then analysed for all correct answers, using both descriptive statistics and inferential analyses of variance. The discussion chapter summarises the results of the experiment, explaining how they relate to existing literature and proposing possible explanations for why such results were obtained. Finally, conclusions will be drawn based on the findings of the experiment and their implications for the field of study. This is accompanied by discussion of potential limitations of the study and suggestions for future research.

2. Literature Review

2.1 Variation and Spoken Word Recognition

2.1.1 Models of Spoken Word Recognition

In order to recognise a spoken word, a listener must be able to match the input they hear to a word representation and its meaning which are stored in the mental lexicon (Frauenfelder and Tyler, 1987). A range of psycholinguistic models have been proposed to explain the processes behind the activation of and discrimination between these representations. One of the main, current issues in this area of work is that there is no clear consensus among these models as to how variation in the speech signal affects these processes, with disagreement over whether word representations contain information about the many different ways in which a single word can be produced (Weber and Scharenborg, 2012).

There are two distinct ways in which theories of spoken word recognition deal with variation in the input. The traditional, dominant models are abstract accounts, meaning they assume that representations of what we hear are stored as abstract forms which do not incorporate any lexically irrelevant surface details which vary between speakers (Connine and Pinnow, 2006; Dahan and Magnuson, 2006). The first model developed specifically for processing spoken language was Marslen-Wilson and Welsh's (1978) Cohort Model. In this model, a candidate set of possible words is activated based on the incremental phoneme input and then one word is selected once all others can be safely eliminated. For example, hearing the sound /b/ would activate a cohort of all possible words beginning with that sound, including 'brother', 'bean' and 'bang'. As more input is received, the possible candidates are narrowed down further. For example, if the next phoneme was /ɹ/, this would eliminate 'bang' and 'bean' but 'brother' would still be a possible candidate, alongside words such as 'bread' and 'breakfast'. Eventually, enough information is received for the word to be uniquely identified, in this example /bɹʌð/ would be enough to uniquely identify 'brother' as no other words begin with these four sounds. Semantic and syntactic properties are then integrated after the word has been selected (Marslen-Wilson and Welsh, 1978).

The other central model is the TRACE model (McClelland and Elman, 1986), a connectionist model in which words are recognised through the activation of three layers of units containing features, phonemes and words. Each level contains nodes which interact with each other through inhibitory and excitatory connections until one word receives the most activation and is consequently accepted by the processor (McClelland and Elman, 1986). For example, the phoneme /b/ would activate certain nodes such as 'voicing' at the feature level, then this information would interact with the phoneme level which receives feedback from the word level. This model explains our ability to understand words despite speaker variation through mechanisms for competitive selection which allow different variants to all be recognised as instances of one abstract form (McClelland and Elman, 1986). The main difference between the TRACE model and the Cohort model is that whilst the Cohort model takes an autonomous, bottom-up approach to spoken word recognition, the TRACE model incorporates top-down processing as it assumes that knowledge from the higher lexical level can flow down and influence processing at the feature and phoneme levels. In both of these models the listener's mental representation of the word 'brother' would be made up of the abstract phonemes (/b/ /ɹ/ etc.) with any speaker-specific details discarded. Therefore, these representations do not contain any information resulting from interspeaker variation and discard it as irrelevant during the earliest stages of processing (Luce and McLennan, 2005; Connine and Pinnow, 2006).

In contrast, episodic models argue that variability is stored in memory and used during spoken word recognition so should be incorporated within models that try to explain it (Goldinger, 1996b). For example, Goldinger (1996b:1166) proposed an exemplar-based account in which "episodic memory traces of spoken words retain the surface details typically considered as noise". According to this view, representations in the mental lexicon contain fine-grained detail about how words are produced, including information about variation which is explained by the speaker's geographical origin. Exemplar-based models also assume that when we hear language, we form perceptual categories, which are sets of "all experienced instances of a category" (Johnson, 1997:146). This approach therefore explains our ability to deal with variation in the speech signal as being facilitated by perceptual sets containing phonetically detailed examples that we have previously heard, which are stored in memory and activated when the variant is heard on future occasions. Docherty and Foulkes (2014) explain this process using the example of the word ‘cat’. According to exemplar models, the lexical representation for the word ‘cat’ is made up of all of the exemplars of the word that the listener has heard and produced previously. Therefore, the variability present in these exemplars, such as whether the word final /t/ is produced as a voiceless alveolar plosive [t] or glottal plosive [ʔ], is stored in memory (Docherty and Foulkes, 2014). Knowledge about socioindexical variation is built up through exemplars being grouped together according to speaker characteristics, for example whether the variant was produced by a male or a female, so the likelihood of a variant being produced by a particular kind of speaker can be inferred (Docherty and Foulkes, 2014). Exemplar-based models are useful for understanding the effects of accent familiarity on language processing as they assume that more exposure to a particular regional variant means that we will have more exemplars of that variant in our episodic memory. This suggests that the variants in the regional variety we are most familiar with will then be processed with greater ease.

More recently, several researchers have called for the development of hybrid models of spoken word recognition in which representations encode both the abstract phoneme categories making up a word as well as the specific details about how these sounds are produced (Cutler et al., 2010; Pierrehumbert, 2016; Hay et al., 2019). This is the result of empirical evidence supporting the existence of both abstract and episodic word representations in the mental lexicon. Evidence for abstract representations comes from experiments which have found that listeners generalise changes in perceptual boundaries to words that they have not previously experienced. For example, McQueen et al.’s (2006) perceptual learning experiment found that shifts in the category boundary for fricatives made during a training period were then generalised across the mental lexicon, to fricatives in words that were not present in the training set. Generalisation to new words suggests that changes to the perceptual boundary were made to abstract representations of the fricatives before lexical access, rather than only being linked to the episodic exemplar traces for those particular words once they had been retrieved (McQueen et al., 2006). The call to develop hybrid models by combining this idea of abstraction with episodic approaches comes from many studies which have found that socioindexical information is also used during the processing of sounds and words, supporting the need for word representations which contain speaker-specific details. These findings will be discussed in the following sub-section.

2.1.2 Experimental Findings

Recent sociophonetic work over the last two decades has produced findings which are inconsistent with purely abstract models as they show that socioindexical information is used during speech processing.

Several studies have found that social characteristics of speakers such as gender, age and social class can influence phonological categorisation (Strand, 1999; Hay et al., 2006; Koops et al., 2008). Regional origin has also been shown to influence speech perception, for example Niedzielski (1999) used a matched guise technique and found that participants who listened to the same speaker reported hearing different vowels depending on whether they were told that the speaker was from Canada or Detroit. This highlights the problem with dominant, abstract models, which do not have architectures that are able to accommodate such a role of indexical variation (Luce and McLennan, 2005).

As well as affecting language processing at the phonetic level, research has shown that indexical information in the speech signal is also used at the lexical level. Many studies have found that processing of words produced by multiple speakers is slower and less accurate than processing of words produced by the same speaker (Mullennix et al., 1989; Martin et al., 1989; Goldinger et al., 1991). For example, Goldinger et al.'s (1991) research found that recall was significantly less accurate for words in lists produced by multiple speakers compared to words from lists produced by one speaker. Such evidence suggests that more processing resources are required to process words containing interspeaker variation (Martin et al., 1989). There is also evidence that phonetic information signalling a speaker's geographical origin is used when deciding the meaning of ambiguous words. Cai et al. (2017) found that upon hearing the word 'bonnet', participants were more likely to retrieve the dominant American meaning of a piece of headwear if the speaker had an American accent than when the speaker had a British accent. They concluded that once listeners have identified a speaker's regional accent, they "use their experience of that dialect to guide meaning access for all words spoken by that person" (Cai et al., 2017:73). This evidence that speaker-specific information is used for word processing is not compatible with purely abstract models in which this information would be discarded before lexical access (Cutler et al., 2010).

Evidence that information related to interspeaker variation is used during language processing indicates the need for representations in models of spoken word recognition to account for the "adaptive nature of perception" (Luce and McLennan, 2005:605). The disagreement among models as to how representations are stored must be settled (Weber and Scharenborg, 2012) and the present experiment will contribute to the debate by providing empirical evidence for how the brain deals with regional accent variation, and differing levels of experience with it, during lexical processing. Such evidence has important implications for the way that we understand representations and processes in spoken word recognition (Jusczyk and Luce, 2002).

2.2 Accent Familiarity

The effects of accent variation on speech perception have received less attention than other types of variation, such as speaker identity and speech rates (Floccia et al., 2006). The evidence reviewed so far has suggested that non-linguistic features which were once assumed to be discarded during lexical processing are stored in memory and used when accessing a word from the mental lexicon. Building on this idea, that variation does affect phonetic and lexical processing, the focus of this work now turns to the effects of how familiar individuals are with this variation.

2.2.1 Foreign Accents

Research into the effects of foreign accents on speech perception has consistently found that foreign accents are more difficult to process than native accents (Lane, 1963; Munro and Derwing, 1995; Trude et al., 2013). For example, Lane (1963) found that in adverse listening conditions, foreign-accented speech was 40% less intelligible than native speech when the signal-to-noise ratio was matched. However, increased familiarity with a foreign accent has been found to reduce these processing costs. Clarke and Garrett (2004) state that as the amount of exposure to a particular accent increases, ease of processing speech produced in that accent increases. This is shown by studies which have found that providing a training condition in which participants gain experience with the foreign accent leads to improved performance in the test condition (Bradlow and Bent, 2003).

Such research suggests that increased familiarity improves ease of processing a non-native accent.

There is evidence to suggest that the processes involved in adapting to a foreign accent differ to those involved in adapting to a regional accent (Goslin et al., 2012; Romero-Rivas et al., 2015). For example, Goslin et al. (2012) used electroencephalogram (EEG) imaging to measure electrical activity in the brain during processing of regional and foreign accents and found that foreign accents elicited a reduced N400 event-related potential compared to regional accents. This is a negative-going deflection that peaks around 400 milliseconds after the onset of the stimulus, usually elicited by a semantic anomaly (Kutas and Federmeier, 2011). This implies that the processes involved in accessing semantic information differ between hearing words in regional-accented speech and foreign-accented speech. Therefore, the processing of regional accents needs further investigation as it cannot be assumed that it involves the same mechanisms found by research on foreign accent processing.

2.2.2 Regional Variation

In addition to variation resulting from foreign-accented speech, regional variation among native speakers can also pose challenges for processing language. Less research has looked at the effects of regional accent variation as most research in this area has focused on how we deal with foreign accents (Floccia et al., 2006). As a result, there is insufficient understanding as to how regional accent variation affects speech processing (Clopper and Bradlow, 2008).

Various studies have focused on how children process regional accents, finding that their performance is better for familiar than unfamiliar varieties (Nathan et al., 1998; Floccia et al., 2009; van Heugten and Johnson, 2016). For example, Nathan et al. (1998) found that 4-year-old children’s scores on a definition task were halved when the stimuli were presented in an unfamiliar Glaswegian accent compared to when stimuli were presented in their native London accent. As well as this, Harte et al.’s (2016) review of research on the effects of accent familiarity on children’s language processing found a developmental trend, with the ability to understand unfamiliar accents improving as children get older.

Therefore, more research is needed to investigate whether these effects persist into adulthood.

Existing research on the effects of regional accent familiarity in adverse listening conditions has found that higher intelligibility levels are maintained for familiar compared to unfamiliar accents (Clopper and Bradlow, 2008; Adank et al., 2009; Mattys et al., 2012). Adank et al. (2009) used a sentence verification task in which sentences in a Glaswegian or Standard Southern British English (SSBE) accent were presented with different signal-to-noise ratios. The participants were SSBE speakers for whom the Glaswegian accent was unfamiliar and Glaswegian speakers for whom both accents were assumed to be familiar. They found that the SSBE listeners made more errors and had slower response times at moderate signal-to-noise ratios for sentences in a Glaswegian accent, whereas for Glaswegian listeners there was no significant difference in their performance for the different accents (Adank et al., 2009). In everyday listening situations, listeners do not have to deal with white noise in the speech stream so this experiment will instead test how regional accent familiarity affects speech perception in normal listening conditions which should more closely reflect everyday spoken word recognition.

Very few experiments have studied adults to investigate the processing cost of unfamiliar regional accents in normal listening conditions. The small number of experiments which have, also found a facilitatory effect of increased familiarity on lexical processing. For example, Evans and Iverson’s (2004) experiment found that speakers whose accent was more southern compared to other speakers in the community were faster and more accurate at identifying southern-accented words embedded in noise than speakers whose accent was more northern. Similarly, Clopper (2017) found that responses in a speeded lexical classification task were faster and more accurate when the stimuli were in a local, familiar accent compared to a non-local, unfamiliar accent. Both of these studies suggest that participants find accents which are more similar to their own easiest to process.

As far as the researcher is aware, the only known experiment so far to use a lexical decision task to investigate the effects of regional accent familiarity on lexical processing was conducted by Floccia et al. (2006). This study investigated response times to three French regional accents with different levels of familiarity for the participants. The results showed that an unfamiliar regional accent elicited a 30-millisecond delay in response times compared to those for the native accent and a familiar French regional accent. However, there was no significant difference between the reaction times for the native and familiar accents. This study will follow on from Floccia et al.'s (2006) study by also using a lexical decision task to investigate the effects of three varieties of English with differing levels of familiarity on lexical processing.

2.3 The Current Study

This study builds on Floccia et al.'s (2006) research by using the same method to test accents and a population which have not yet been studied in this way. As aforementioned, the literature in this area is so far scarce and Floccia et al.'s (2006) study is the only experiment so far to investigate the effects of accent familiarity on lexical processing with this design. Therefore, this study will test the replicability of these previous findings to see if further evidence of a processing cost for unfamiliar accents in an auditory lexical decision task can be provided.

The present study will exert higher levels of control over lexical characteristics of the stimuli. For example, in Floccia et al.'s (2006) study different carrier sentences were used in the three conditions. This study uses the same carrier sentences in each condition with different target words, to ensure that the content of the carrier sentences is not the cause of any differences in processing between the conditions. As well as this, this study will exert more control over linguistic characteristics of the target words. In Floccia et al.'s (2006) study the target words were matched for frequency, however this is not the only factor that affects the speed of spoken word recognition so other features such as orthographic and phonological neighbourhood were controlled for.

2.3.1 The Accents

This study investigated the processing of three varieties of English which were categorised as native, familiar and unfamiliar to the participants.

The native condition used the regional accent spoken by the participants in the main experiment – Yorkshire English. Since it was ensured that all of the participants were born and raised in Yorkshire, it was assumed that the accent used by the Yorkshire speaker who produced the sentences in the native condition matched their own. Distinctive features of the Yorkshire accent including H-dropping and definite article reduction, the tendency to either omit 'the' or replace it with a glottal stop (Cooper, 2013; 2017). The Yorkshire accent is also characterised by many supralocal northern features such as the [a] vowel in the BATH lexical set and the merged [u] vowel for the STRUT/FOOT lexical sets (Wells, 1982; Ferragne and Pellegrino, 2010).

The variety used in the familiar condition was Liverpool English. This variety was assumed to be familiar to all participants because it tends to be easily recognised by most UK speakers and according to Honeybone and Watson (2013:3) "Liverpool English is recognised more consistently than most other varieties". Montgomery (2012), proposed that the ability for speakers to easily recognise regional accents originating from places not geographically close to them is explained by the cultural prominence effect. This is the idea that regional accents from areas "most established in the national consciousness" (Montgomery, 2012:658) are easily recognised. Since the Liverpool accent is highly stigmatised and often reported in media coverage about British accents, it has high cultural prominence (Montgomery, 2012). This effect was supported by Leach et al.'s (2016) perceptual dialectology research which found that the Liverpool accent was correctly identified the most frequently, even by those who lived far away. Characteristic features of this variety include the aspiration or affrication of plosives (Sangster, 2001) and no contrast between vowels in the SQUARE and NURSE lexical sets (Wells, 1982; Watson, 2007).

The Indian English accent was chosen for the unfamiliar condition because this is a variety the participants are unlikely to have as much experience with. It is not as stigmatised as the Liverpool English accent so receives less media attention, therefore it can be inferred that Indian English has less cultural prominence to the listeners, which Montgomery (2012) describes as a key measure of familiarity levels. Characteristic features of the Indian English accent include use of dental plosives such as [t̪] and [d̪] in place of dental fricatives as well as retroflex variants of plosives which would be realised as alveolars in other accents of English (Sailaja, 2012).

The participants' familiarity levels with each of these three accents of English were measured using a language background questionnaire to ensure that they were native, familiar and unfamiliar to them.

2.3.2 Research questions and hypotheses

To contribute further to this area of knowledge, the research question for this study will be: does accent familiarity affect lexical processing? The alternative hypothesis is that listeners' responses on a lexical decision task will be faster and more accurate when they are presented with auditory stimuli produced by the speaker of a familiar or native accent than when they are presented with auditory stimuli produced by the speaker of an unfamiliar accent. The null hypothesis is that there will be no significant difference between listeners' reaction times and accuracy rates on the lexical decision task in the three different accent conditions.

3. Methodology

3.1 Participants

The participants who took part in the lexical decision task were 18 monolingual, native speakers of English, aged 18-50. Of these participants, 11 were female and 7 were male. Participants had to be over the age of 18 for ethical reasons and no older than 50 due to the possible deterioration of hearing abilities (Pearson et al., 1995). All participants were born and raised in Yorkshire, as ascertained by the language background questionnaire, in order to ensure that the accent used by the Yorkshire stimuli speaker was native to them.

Participants were recruited using a convenience sample of readily available and eligible participants. These were a mixture of students at the University of Leeds or friends and family living in Doncaster. A snowball sampling method was also used as some participants were recruited through asking original participants if they knew any other eligible individuals. All participants were required to read an information sheet (see Appendices A and B) and complete a consent form (see Appendix C) to confirm that they gave informed consent to participate in the study.

All participants were also required to complete a language background questionnaire (see Appendices D and E) to check for qualifying criteria such as being a monolingual, native speaker of English and having no history of any hearing difficulties. This was also used to understand their demographic backgrounds and measure their familiarity with each of the accents being tested. The former was done by asking the participants where they had lived at different stages of their lives to ensure that the Yorkshire accent was local and native to them. Familiarity levels were measured using an open question: ‘For each accent below, please indicate whether you have experience with it or not. If you have, please describe what type of experience this is in much detail as possible.’

Qualitative data elicited by this question was explored to check that it supported the three levels of familiarity assigned to the accents making up the experimental conditions. Responses for the Yorkshire accent included “all the time, everyone around me has this accent as I was brought up in Yorkshire”. For the Liverpool accent, descriptions of experience included “I have one friend from Liverpool who I see about once a week” and “have heard it on TV, sportspeople and actors in TV programmes e.g. ‘Bread’, but don’t really know anybody well personally with that accent”. Furthermore, descriptions of experience with the Indian English accent supported its ‘unfamiliar’ status, for example “I grew up in an area with very little ethnic diversity, so I struggle to understand Indian English accents” and “rarely – TV or uni students”. If responses on the language background questionnaire suggested that a participant had significant experience with Indian English, for example a close friend or relative who they see regularly, their results would not have been kept for analysis as attributing the Indian English accent condition as unfamiliar to them would have been inaccurate.

3.2 Stimuli

3.2.1 Recording Speakers

The stimuli for the auditory lexical decision task were recordings of sentences which ended in either a real English word or a pseudoword. They were produced by a female, native speaker of each of the three accents being tested and original recordings were created as for speech perception experiments, real voices are preferable to artificially generated voices (Thomas, 2002).

The speaker of the native condition stimuli was a 21-year-old female who has lived in Halifax, West Yorkshire since birth before moving to Leeds, West Yorkshire for university so is a native speaker of the Yorkshire accent. The speaker of the familiar condition stimuli was a 20-year-old female who was born and raised in Liverpool before moving to Leeds for university so can be assumed to have a native Liverpool accent. The speaker of the unfamiliar condition stimuli was a 20-year-old female who is bilingual in English and Hindi. She lived in Jaipur, India from birth before moving to Leeds for university but has learnt English since the age of 2 through education and media so can be assumed to have an Indian English accent. These speakers were matched for age and gender to ensure that differences in responses to the three speakers in the lexical decision task were due to the different familiarity levels with the accents rather than responses to differences between males and females or older and younger speakers.

The speakers were recorded in the recording studio in the Linguistics and Phonetics department at the University of Leeds, using the computer application Audacity. Participants were asked to sit approximately 25cm away from the microphone and their speech was recorded using the control room PC and M-Audio unit. They were given a paper copy of the 20 sentences that they needed to produce and instructed to produce each sentence twice in order to ensure that there was a back-up version in case the first production was not of suitable quality. They were asked to speak as clearly and naturally as possible and before recording commenced, each participant was instructed on how to produce the non-words through copying the experimenter's pronunciation and checking if they had any questions about the productions. The audacity recordings were saved as .wav files and processed using the computer application PRAAT (Boersma and Weenik, 2018).

The first stage of post-recording processing involved converting each recording from a stereophonic version to a monoaural version using a PRAAT script so that the sound participants heard from each headphone was the same. Next, the recordings were cut as close as possible to the edges where the sound started and finished using the 'extract selected sound (from 0)' and manual cutting tools on PRAAT (Boersma and Weenik, 2018). A margin of 50 milliseconds of silence was then added to the start and end of each recording in order to ensure that all recordings in all conditions started at the same point. Finally, recordings were normalised for intensity so that they all had a normalised amplitude of 65 decibels. This was necessary as some speakers may have spoken louder or sat closer to the microphone than others and it was important to make sure that any differences in reaction times were due to differences in accent familiarity, rather than acoustic features such as amplitude.

3.2.2 Lexical Characteristics of Stimuli

A total of 60 target words, 30 real and 30 pseudowords, were carefully selected to be used at the end of the sentences in the lexical decision task. All of these target words, as well as the words used for the training condition, were matched for a range of linguistic factors which have been previously found to influence processing speed. The English Lexicon Project corpus (Balota et al., 2007) was used to match all of the real words to have an orthographic neighbourhood of 0-20 and phonological neighbourhood of 30-50. This was important as previous research by Ziegler et al. (2003) found that in auditory lexical decision tasks, increased phonological neighbourhood has an inhibitory effect and increased orthographical neighbourhood has a facilitatory effect. The English Lexicon Project corpus (Balota et al., 2007) was also used to ensure that all of the target words were monosyllabic and consisted of 3 phonemes and 4 letters because word length has also been found to affect the speed of spoken word recognition (Luce, 1986; Pitt and Samuel, 2006). All real words were then matched for frequency using the SUBTLEX-UK Zipf scale (Van Heuven et al., 2014). The target words chosen all have a Zipf-value of 4-7 which means they are classed as high frequency words. The occurrence of these words in the SUBTLEX-UK corpus (Van Heuven et al., 2014) ranges from 3038 to 42777. This was necessary because frequency has consistently been found to influence reaction times in both visual and auditory lexical decision tasks (Grainger, 1990; Goldinger, 1996a). All of the words are emotionally neutral as it has been found that emotionally positive or negative words, for example 'joy' or 'terror', can facilitate word recognition (Kousta et al., 2009). They were also all concrete nouns as previous research has found that abstract words elicit slower reaction times than concrete words (Schwanenflugel, 1991). Table 1 summarises the average lexical characteristics of the target real words selected from this filtering process.

Lexical Feature	**Mean**	**Standard Deviation**
Zipf-value	4.7	0.4
Occurrence in SUBTLEX-UK corpus	15326.3	17176.8
Orthographic Neighbourhood	14.0	4.6
Phonological Neighbourhood	40.4	6.4

Table 1: *Means and standard deviations of the controlled lexical features for the chosen target real words.*

The non-words were generated using the ARC Nonword Database (Rastle et al., 2002) which also allows control over linguistic factors which affect spoken word recognition. This was important as word length and neighbourhood have been found to affect response times to non-words as well as real words (Yap et al., 2015). As a result, all of the target non-words match the target real words as they also have an orthographic neighbourhood of 0-20 and phonological neighbourhood of 30-50. They were also matched for length, so all non-words contain four letters and three phonemes. The non-words were all phonotactically legal in English so that they were not too difficult for the speakers to produce and care was taken to ensure that none of them were pseudohomophones, non-words that sound the same as real words (Yap et al., 2012). Table 2 summarises the average lexical characteristics of the chosen non-words.

Lexical Feature	**Mean**	**Standard Deviation**
Orthographic Neighbourhood	8.3	4.2
Phonological Neighbourhood	33.4	3.5

Table 2: *Means and standard deviations of the controlled lexical features for the chosen target non-words.*

These carefully selected target words were used to create a total of 60 sentences for the lexical decision task, 20 sentences for each condition. Within each condition, the last word in 10 of the sentences was a real English word and the last word in the other 10 sentences was a pseudoword. In each condition, the 20 sentences were formed from 5 different carrier sentences, each with 4 different endings. The same 5 carrier sentences were used in all conditions, so it can be assumed that the content of the carrier sentences did not cause any differences between conditions. This is a development from Floccia et al.'s (2006) study in which different carrier sentences were used in each condition and could have contributed to differences in results between the conditions. The ending of the sentences was ambiguous until the last word was revealed, so that the participants could not guess what it would be from the context which could speed up their response time. The five carrier sentences used in this study can be seen in Figure 1. All sentences were 8-12 words long (mean length = 9.4 words) and contained 10-15 syllables (mean = 13.2 syllables).

All stimuli sentences for each condition, including the training condition, can be found in Appendices F-I. By ensuring that target words and carrier sentences were matched across all three conditions, it can be assumed that the only differences between the words produced across conditions that could affect lexical processing are due to the geographical origins of the speaker.

1. When she got to the bottom of the hill, Jane noticed a ____.
2. Sally had produced a beautiful painting of a ____.
3. Yesterday evening, all of the teenagers went to the ____.
4. When John looked in the cupboard, he found a ____.
5. The girls were not surprised when they saw the ____.

Figure 1: *carrier sentences used to create stimuli for the lexical decision task.*

3.3 Procedure

The main experiment was an auditory lexical decision task, conducted using the computer software PsychoPy (Peirce, 2007). A within-subjects design was employed as all participants took part in all three levels of the accent independent variable: native, familiar and unfamiliar.

Before conducting the main experiment, a pilot study was carried out in order to check for any problems or unusual findings. This allowed the opportunity to make any adjustments to ensure that the main experiment was designed in the best possible way to be able to answer the research question. This was conducted with a male participant who was born and raised in Yorkshire but was over the age of 50 so could not take part in the main experiment. This meant the data from the pilot study would still provide a meaningful insight into the experimental design because the different accent conditions were the same familiarity levels for the pilot participant as the main experiment participants. No methodological issues or unusual results arose from the pilot study, so it was decided that the experimental design was suitable to proceed.

All participants completed the same experiment on a HP laptop using the same PsychoPy file. They either completed the experiment in the University of Leeds phonetics lab or in their home in a quiet room. In both settings it was ensured that the room was quiet with a closed door, no external noise and no other people present. This high level of control was exerted to improve reliability by ensuring that extraneous variables did not distract participants and affect their performance. All participants wore over-ear JVC HA-RX500 stereo headphones to ensure that they could all listen to the sentences in the same high quality. They were advised to adjust the audio volume to a comfortable level, if necessary, during the training sentences.

Lexical decisions were made in a forced-choice alternative task using the arrow keys on the laptop keyboard. If the participant thought the final word of the sentence was a real English word, they were to press the left arrow key. If they thought the final word was a pseudoword, they were instructed to press the right arrow key. The time taken to press a button indicating their decision was assumed to reflect the time taken for them to process the word. A forced-choice alternative lexical decision task was chosen rather than the go/no-go lexical decision task which was used by Floccia et al. (2006) because go/no-go methods do not provide any data about how non-words are responded to. The current study wanted to collect non-word data as "non-word response times data help provide meaningful and complementary insights into the lexical processing architecture" (Yap et al., 2015: 609). It would also allow this study to provide further evidence for or against previous research which has found that non-words are responded to slower than real words (Forster and Chambers, 1973; Theios and Muise, 1977).

Participants were first presented with an instructions screen (Figure 2) and told to press the space bar when they had read the instructions and were ready to proceed. There was then a training period in which participants were presented with 5 practice trials of sentences produced by a Standard Southern British English (SSBE) speaker in order to ensure that they understood the task requirements (see Appendix H). This was to prevent training effects, for example performance in the first few trials could be worse than performance later on in the experiment because of it taking time for the participants to get used to how to respond. A speaker of SSBE was chosen to record the practice sentences because this accent was not being tested in this study so exposure to it would not increase exposure and therefore familiarity levels with the accents presented in the main experiment. As well as this, speakers of other accents are assumed to be equally familiar with SSBE as they are with their own dialect due to geographic mobility and its dominant use in national media (Adank et al., 2009). After the training period, participants were notified that the main experiment was about to start.

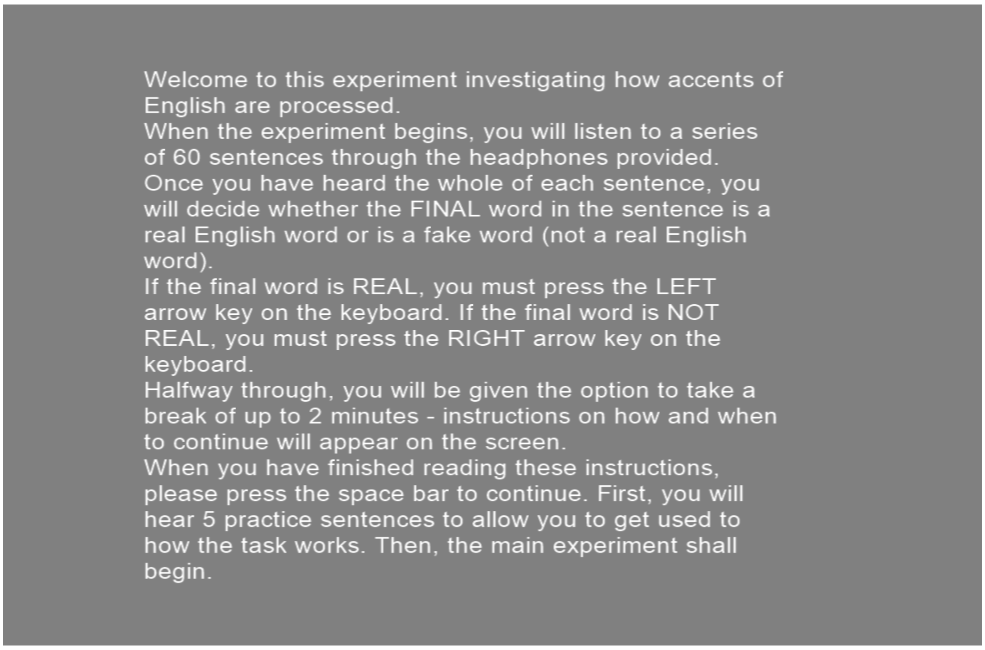

Figure 2: *screenshot of the instructions given to participants at the start of the experiment.*

Each sentence was played with a 6 second inter-stimulus interval. If participants tried to respond before they had heard the entirety of the sentence, their response would not be counted. If no response was given, the next sentence would still be played automatically after 6 seconds had passed. Whilst each recording was playing, a reminder of which key should be pressed for each type of word was presented on the screen to reduce the load of attentional resources used for remembering the rules of the experiment (Figure 3). The reaction time was measured from as soon as the recording of the sentence ended until the left or right arrow key was pressed. Halfway through, participants were presented with the option to take a break of up to 2 minutes to help minimise fatigue. After 2 minutes, the experiment would continue automatically, or the participants could press the ‘space’ bar to continue if they were ready to do so before the end of the 2 minutes.

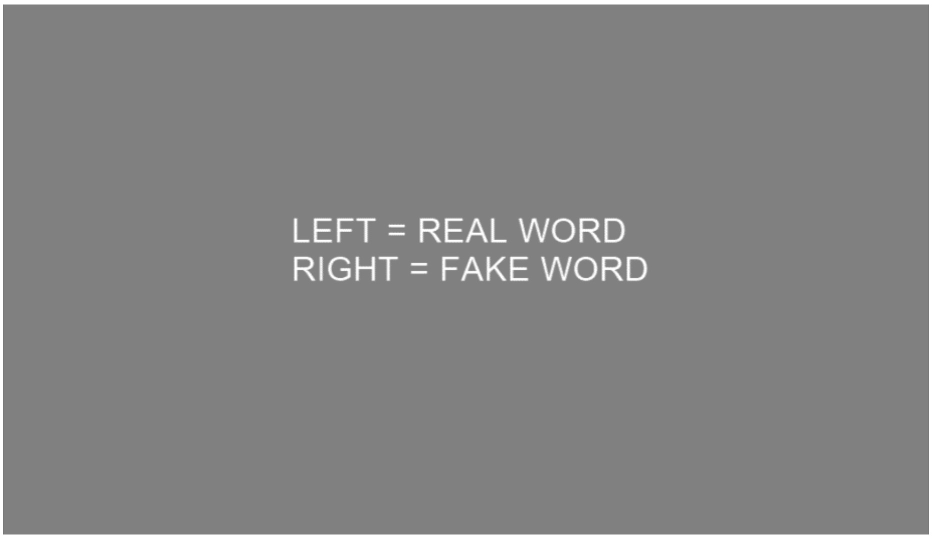

Figure 3: *screenshot of what the task looked like for participants whilst they were listening to the stimuli sentences.*

The order of presentation of the stimuli was fully randomised by PsychoPy (Peirce, 2007) rather than the different conditions being presented in blocks. This is because in Floccia et al.’s (2006) research which used the same experimental conditions as this study, they found that when stimuli were presented in blocks rather than a randomised order there was no longer a significant difference between reaction times for the different accent conditions. They assumed that this was due to complete adaptation to the accent throughout the block, therefore eliminating the processing cost (Floccia et al., 2006). According to Clarke and Garrett (2004), after hearing 2-4 sentences in a foreign accent, a listener fully adapts to the variation and their performance returns to baseline. Assuming that this pattern is similar for regional accents, in a blocked experiment the effects of accent familiarity on lexical processing may only be apparent for the first 3 sentences, which would result in a limited amount of data which could be analysed to answer the research question. The randomised order was different for all participants in order to prevent order effects such as the fatigue or practice effect influencing the results.

4. Results

Descriptive and inferential statistical analysis was conducted using IBM SPSS Statistics 25 (IBM Corp, 2017) to investigate the effects of accent familiarity on two dependent variables, accuracy rate and reaction time. A significance level of $p < 0.05$ was used for all inferential tests.

4.1 Accuracy Rate

Out of the 1080 required lexical decisions from all participants and across all conditions, 10 were not responded to. Trials which received no response were discarded before analysis of accuracy rates as these would not provide any meaningful insight into lexical processing, leaving the results from 1070 trials to be reported here.

Figure 4 shows a histogram and normality curve for the distribution of accuracy rate data from all participants. Accuracy rate was measured as the participant's number of correct responses out of total responses given in the lexical decision task. The bell-shaped curve on the histogram in Figure 4 suggests that this data is normally distributed (Fendler and Muzaffar, 2008). This was confirmed by a Kolmogorov-Smirnov test for normality which produced a significance value of $p > 0.05$.

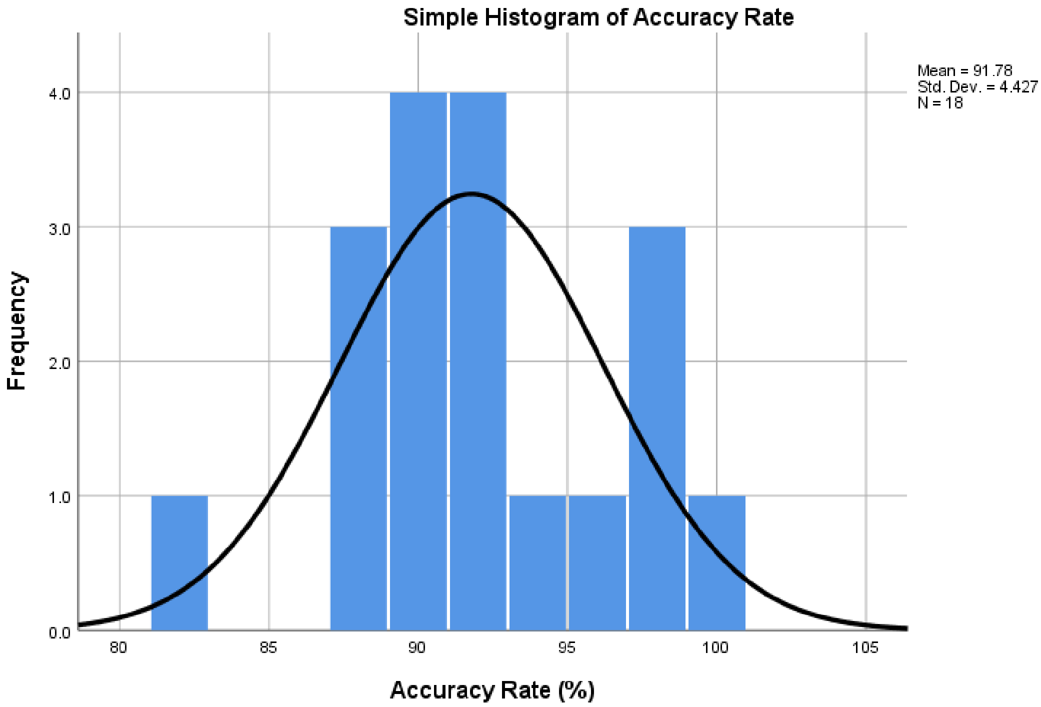

Figure 4: *histogram with normality curve showing the distribution of average accuracy rate data from all participants.*

The overall average accuracy rate on the lexical decision task for all participants was 91.9%, with 87 incorrect responses out of the 1070 provided. These were due to participants either responding to real words with a non-word response or non-words with a real word response.

Table 3 and Figure 5 show that overall, mean accuracy rates were highest in the familiar accent condition and lowest in the unfamiliar accent condition. Table 3 also shows a much higher standard deviation in the unfamiliar condition, suggesting there was greater variation in accuracy rates for this accent. This may be a result of the evidence in Figure 5 of a large difference in accuracy rates between words and non-words in the unfamiliar condition.

Accent condition	**Mean accuracy rate (%)**	**Standard Deviation**
Native	90.2	3.7
Familiar	96.7	0.8
Unfamiliar	88.9	11.7

Table 3: *mean accuracy rates (%) and standard deviations for each accent condition.*

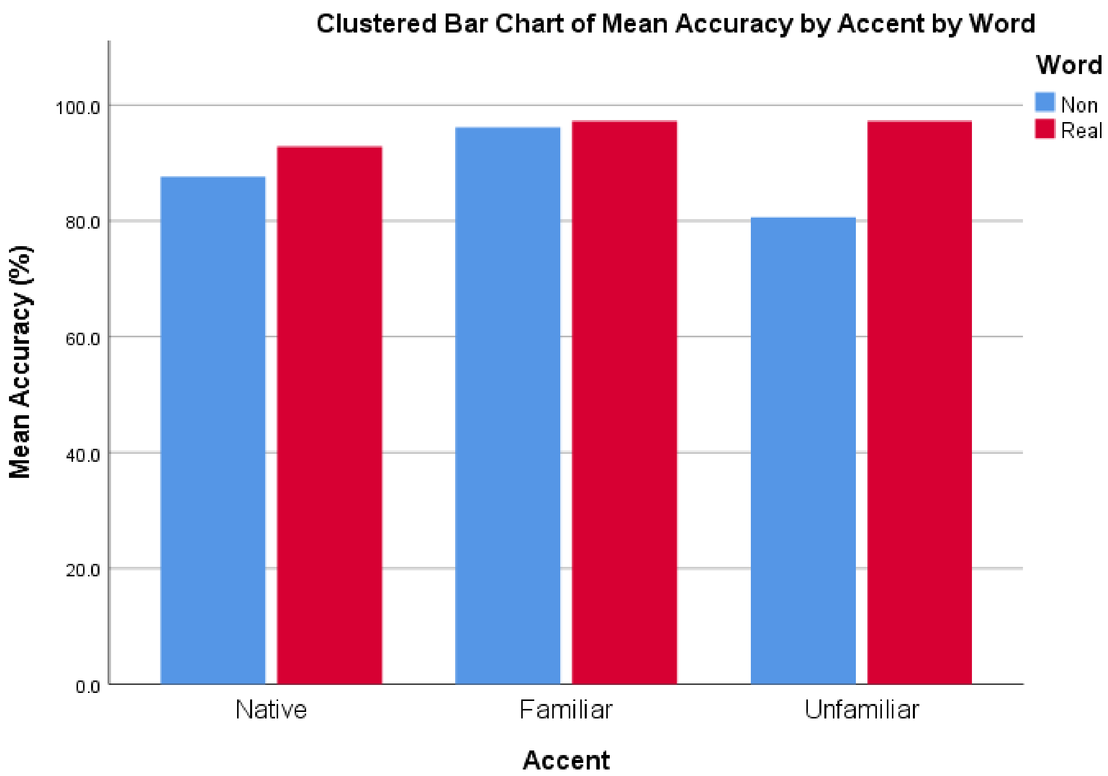

Figure 5: *mean accuracy rates (%) for each accent condition and both word types.*

In terms of word type, Figure 5 suggests that in all accent conditions, average accuracy rates were higher for real words than non-words. This is supported by table 4 which shows that overall, the mean accuracy rate was 6.8% higher for real words than for non-words.

Word Type	**Mean accuracy rate (%)**	**Standard Deviation**
Real words	95.3	6.1
Non-words	88.5	12.2

Table 4: *mean accuracy rate (%) and standard deviations for both word types*.

Since the dataset for accuracy rates was normally distributed, the assumption of normality required by parametric inferential tests was met. Consequently, a two-way repeated measures analysis of variance (ANOVA) could be used to investigate the effects of accent and word type on accuracy rate. The assumption of sphericity was met for the main effect of accent and the accent x word interaction as the significance level of the Mauchly's test of sphericity was $p > 0.05$. This means it can be assumed that the relationship between the different conditions is similar. For the main effect of word type, Mauchly's test of sphericity did not need to be applied as there were only two levels of this independent variable, word and non-word.

The results of the two-way repeated measures ANOVA revealed that there was a statistically significant main effect of accent on accuracy rate, F (2, 34) = 12.41, $p < 0.001$, $\eta_p^2 = 0.42$. Bonferroni post hoc tests showed that the accuracy rates were significantly higher in the familiar condition than in the native and unfamiliar conditions, with no significant difference in accuracy rates between the native and unfamiliar conditions.

There was also a significant main effect of word type, F (1, 17) = 13.21, $p < 0.003$, $\eta_p^2 = 0.44$. Bonferroni post hoc tests showed that this effect of word type meant that participants' mean accuracy rates were significantly higher for real words than for non-words.

There was a significant within-subjects interaction between accent and word type, F (2, 34) = 11.24, $p < 0.001$, $\eta_p^2 = 0.40$. This suggests that the effect of word type on accuracy rate was significantly different depending on the accent condition. A profile plot for this interaction can be seen in Figure 6. The distance between the two lines representing the familiar and native accent conditions clearly shows the significant main effect of accent. Word type seems to yield a similar pattern of accuracy rates in these two conditions, with the percentage of correct responses decreasing slightly for non-words compared to real words when the stimuli are in a native or familiar accent. The much steeper line representing the unfamiliar accent condition shows that word type had a stronger effect on accuracy rate when the stimuli were in the unfamiliar Indian English accent. This is supported by the mean accuracy rates in the unfamiliar accent condition (see Appendix K), which decrease by 16.6% for non-words compared to real words. In comparison, there is only a 2.9% decrease between real words and non-words in the native condition and 1.1% decrease in the familiar accent condition.

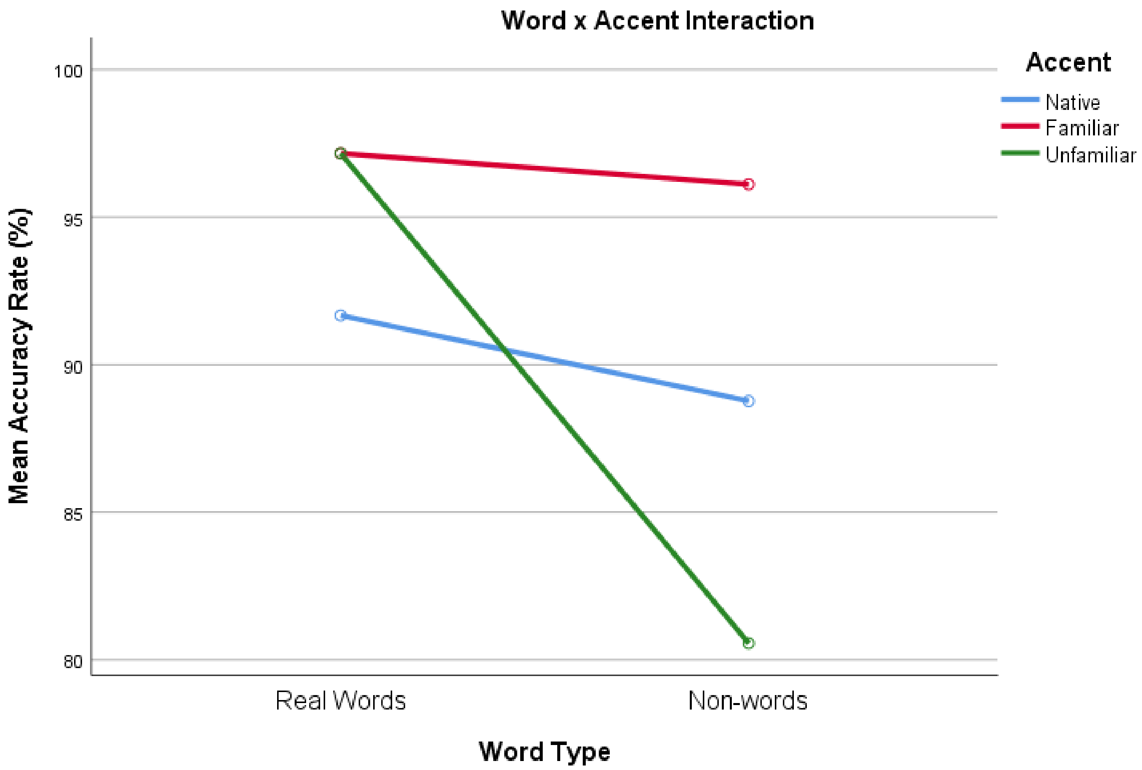

Figure 6: *profile plot for the interaction between word type and accent for accuracy rates.*

4.2 Reaction times

The 1,070 lexical decisions made were filtered further before analysis of reaction times. The 87 incorrect responses were removed and a further 32 reaction times were excluded as they were found to be outliers which could skew the results. In order to determine which results were outliers, Floccia et al.'s (2006) method of discarding any reaction times that were outside 2.5 standard deviations of each participant's mean was adopted. All of the outliers identified were at least 2.5 standard deviations longer than the participant's mean reaction time, rather than shorter. These could have been due to a temporary lack of concentration or distraction from the participant so were discarded so that they did not impact the validity of the results. A further three outliers, the only reaction times longer than 3 seconds in the entire dataset, were identified by a histogram of reaction time data and subsequently removed. The remaining 88.6% of the responses were used for the following analysis of reaction times.

Figure 7 shows that the data for reaction times were not normally distributed and are positively skewed towards the faster reaction times. This was confirmed by the Kolmogorov-Smirnov normality test which produced a significance value of $p < 0.001$.

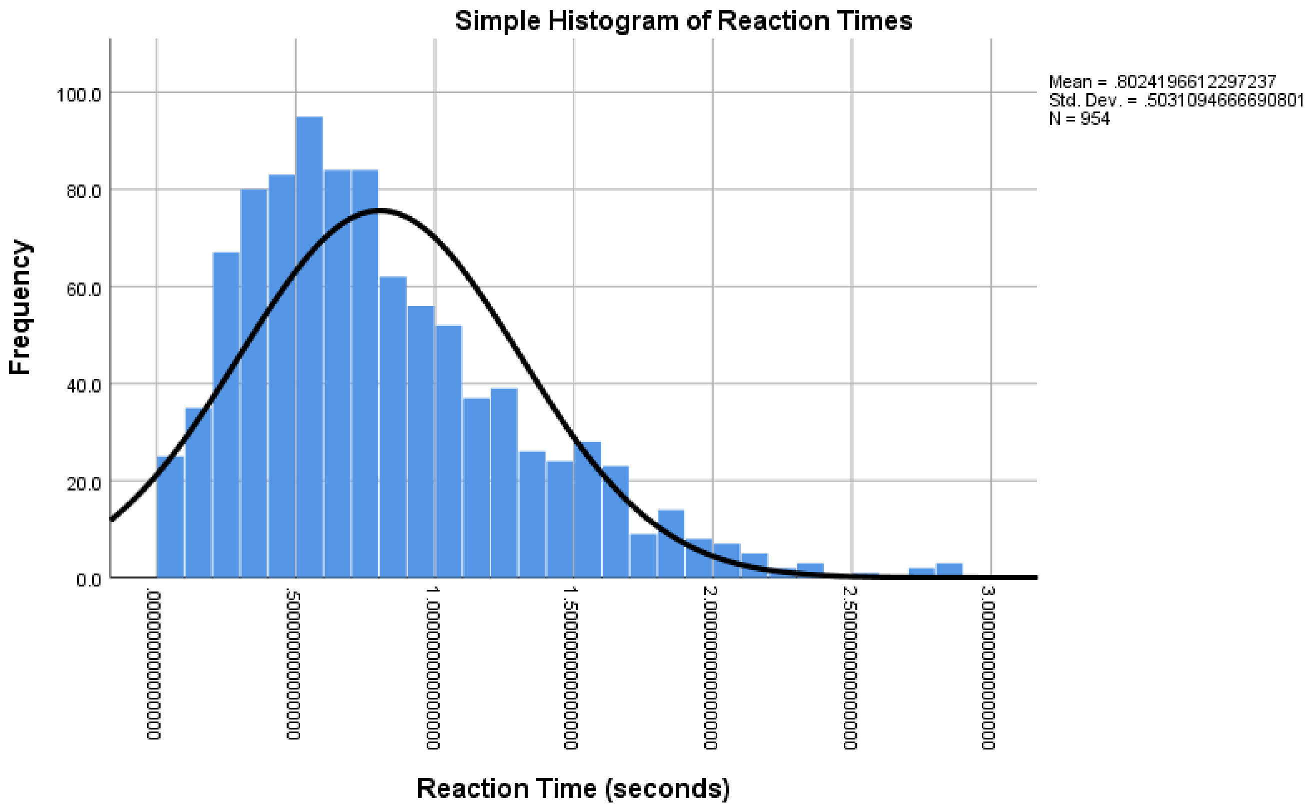

Figure 7: *histogram with normality curve showing the distribution of reaction time data from all participants.*

The boxplot in Figure 8 shows that reaction times were slightly faster for real words than non-words in all accent conditions. For non-words, there appears to be very little difference between reaction times in the different accent conditions (see Appendix J). For real words, reaction times seem to be faster in the familiar accent condition than the native and unfamiliar accent conditions. This inference is supported by Table 5 which shows the mean reaction times for real words in each condition. These results show that the average reaction time for real words was 80.4 milliseconds slower in the unfamiliar condition than the familiar condition and a further 76.6 milliseconds slower in the native condition compared to the unfamiliar condition.

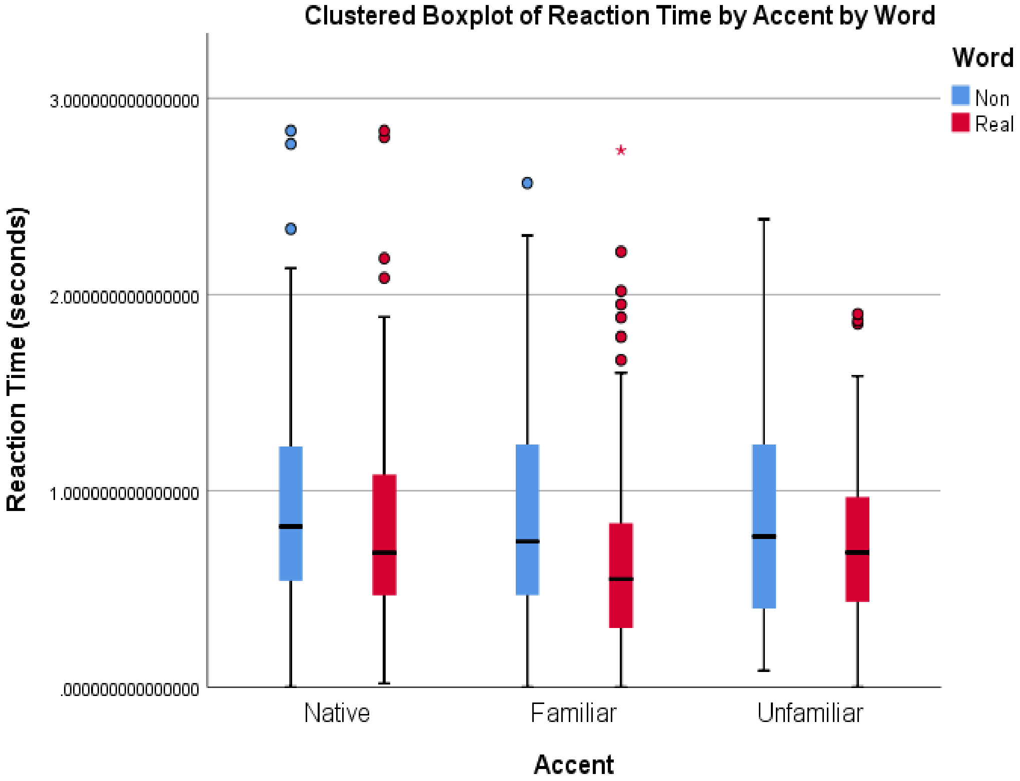

Figure 8: *boxplot of average reaction times for non-words and real-words in each accent condition.*

Accent	**Raw mean (milliseconds)**	**Standard Deviation**
Native	797.1	0.50
Familiar	640.1	0.50
Unfamiliar	720.5	0.39

Table 5: *raw mean reaction times (ms) and standard deviations for real words in each accent condition.*

A one-way repeated measures ANOVA was used to investigate whether the effects of accent familiarity on reaction times for real words were significant. As Figure 7 showed that the reaction time dataset was not normally distributed, a Box-Cox transformation (Box and Cox, 1964) was applied to alter the distribution of the data to a normal shape and meet the assumptions required by parametric tests. The assumption of sphericity was met as the significance level of the Mauchly's test of sphericity was $p > 0.05$. The reaction times for non-words were not analysed in this inferential test. This is because Figure 8 showed that accent did not seem to have an effect on reaction times for non-words and it is common practice in experiments using lexical decision tasks for non-word data to be discarded (Yap et al., 2015). Table 6 shows the transformed mean reaction times used in this part of the analysis.

The results of the one-way repeated measures ANOVA showed that there was a significant main effect of accent on the listeners' average reaction times in the lexical decision task, $F(2, 34) = 17.238$, $p < 0.001$, $\eta_p^2 = 0.50$. Indeed, Bonferroni post hoc tests showed that participants' reaction times were significantly faster in the familiar accent condition than the native and unfamiliar conditions. However, there was no significant difference in reaction times between the native and unfamiliar accent conditions.

Accent	**Transformed mean (milliseconds)**	**Standard Deviation**
Native	-337.5	0.50
Familiar	-603.9	0.50
Unfamiliar	-428.4	0.43

Table 6*: mean reaction times (ms) and standard deviations after a Box-Cox transformation (Box and Cox, 1964) for real words in each accent condition.*

5. Discussion

5.1 Implications of Results

Referring back to the initial research question, the results of this study suggest that accent familiarity does affect lexical processing. This is because there was a statistically significant effect of accents with differing familiarity levels on both reaction times and accuracy rates in an auditory lexical decision task. As a result, the null hypothesis that there would be no significant difference in reaction times or accuracy rates between the accent conditions can be rejected as inferential statistics suggest that the results did not occur by chance or as the result of a sampling error but were due to manipulation of the independent variable. However, the effects of accent familiarity were not in the direction stated by the alternative hypothesis. This predicted that the native and familiar accents would be processed faster and more accurately than the unfamiliar accent. However, this was not the case and the native accent stimuli were actually responded to significantly slower and less accurately than the familiar accent stimuli. This means that the alternative hypothesis must also be rejected.

The findings of the present study are consistent with those discussed in the literature review which assume that socioindexical variation in the speech signal is used rather than discarded during the early stages of processing. For example, Cai et al. (2017) found that listeners use information in the speech stream which signals where the speaker is from when selecting word meanings from the mental lexicon. The present study found that hearing stimuli produced by speakers of different accents affected the time taken to process the meaning of the presented words, providing further evidence that this information plays a role in lexical processing. Similarly, Luce and McLennan (2005:598) argued that “perception of both segments and words is directly affected by indexical variation”. This study has provided empirical evidence that indexical variation resulting from different regional accents of English affected perception of words in a lexical decision task.

However, accent familiarity was not found to affect lexical processing in exactly the same way as previous studies. The findings of this study are not consistent with those produced by Floccia et al.’s (2006) experiment which used a similar methodology and found that an unfamiliar French regional accent was processed significantly slower than a familiar and native regional accent but found no significant difference between the native and familiar accent conditions. In comparison, this experiment did not find any significant difference in reaction times or accuracy rates between native and unfamiliar accents which were both significantly slower and less accurate than a familiar accent. On a similar note, several studies mentioned in the literature review provided empirical evidence for a processing advantage associated with a participants' own accent compared to other accents (Evans and Iverson, 2004; Clopper, 2017; Adank et al., 2009). This was shown by faster and more accurate performance across several experimental paradigms including sentence verification tasks (Adank et al., 2009) and a speeded lexical classification task (Clopper, 2017). These effects are not further confirmed by this research, as the stimuli in the native Yorkshire English accent condition were the closest match to the accents of the participants but stimuli in a familiar, Liverpool English accent were responded to faster and more accurately.

In terms of word type, the effects of words and non-words found by this study are consistent with previous research which found that processing of non-words is slower and less accurate than that of real words (Forster and Chambers, 1973; Theios and Muise, 1977). This was the case for all three accent conditions.

Reconsidering the various models of spoken word recognition, this research contributes to the discussed literature which argues that models must "reconsider the way in which we think about representation and process in spoken word recognition" (Luce and McClennan, 2005: 592) to ensure that they can explain how the brain processes variation present in the speech signal. This is because with linguistic factors which affect lexical processing speed controlled for, manipulating the indexical variable of accent caused a significant difference in the dependent variables of reaction time and accuracy rate in the lexical decision task. This supports the main criticism of purely abstract models, that they do not have the mechanisms to deal with a role of socioindexical variation in lexical processing (Luce and McLennan, 2005). However, McQueen et al. (2010:1114) propose that "evidence that listeners can show sensitivity to episodic detail should not be taken as evidence against abstract representations". Taking this view, the results of this experiment do not oppose recent developments towards hybrid models of spoken word recognition, in which details such as socioindexical information can be stored alongside abstract information in representations (Cutler et al., 2010; Pierrehumbert, 2016; Hay et al., 2019). In terms of episodic models, exemplar-based models assume that ease of processing accents is modulated by experience as participants should have more exemplars stored in memory for the variants that they hear the most often, making these variants easier to process. However, this was not the case as the results suggested that the native variety which the participants have heard the most through growing up in Yorkshire was more difficult to process than the familiar Liverpool English accent. Possible explanations for why the native accent was not easiest to process are discussed in the following sub-section.

It must be noted that conclusions drawn from the inferential statistical analysis of reaction times should be taken with caution as the one-way repeated measures ANOVA was applied to data which had been altered to be normally distributed using a Box-Cox transformation (Box and Cox, 1964). Transformed data should be interpreted carefully as the transformation procedure can "fundamentally alter the nature of the variable" (Osborne, 2010:1). For example, Balota et al. (2013) found that analyses of raw reaction time data and transformed reaction time data produced conflicting results. However, the patterns found in the transformed data by inferential statistical analysis in this study did match those indicated by the raw data, with reaction times in the familiar accent condition being faster than those in the other two conditions. To avoid the risks of transformation affecting the results in studies like this, future research may wish to use a non-parametric test to analyse the raw reaction time data.

5.2 Possible Explanations for the Results

There are several possible explanations for the unexpected result of longer reaction times and lower accuracy rates in the native accent condition compared to the familiar accent condition.

One of the main possible explanations is that in this experiment, only one speaker of each accent was used to produce the stimuli in each condition. Therefore, differences in processing could have been a result of idiosyncratic differences between the speakers that are not linked to their geographical origin. The literature review mentioned research which has found that hearing the voice of multiple talkers negatively impacts accuracy rates in word recall tasks (Mullennix et al., 1989; Martin et al., 1989; Goldinger et al., 1991). Goldinger et al. (1991) describe a range of speaker-specific sources of variability other than accent which can affect speech perception, such as vocal tract shape, stress patterns and speech rate. In this study unique features of the Yorkshire speaker's voice, not directly linked to her regional accent, could have used extra processing resources and caused the longer reaction times and lower accuracy rates.

Indeed, a comparison of the three speaker's speech rates showed that this is a likely confounding factor which could explain why the native accent condition produced results which conflict with earlier research. Table 7 shows that on average, the length of the recordings was shortest for the native speaker and longest for the unfamiliar speaker, with an 820-millisecond difference between the two. Previous research has found that processing is more difficult with faster speech rates (Riggs et al., 1993; Wingfield et al., 1985; Vaughan and Letowski, 1997). Therefore, these differences in speech rate may explain the increased difficulty processing the native accent. The slower rate of the unfamiliar accent recordings may also explain why this accent was not more difficult to process than the native accent, as was the case in previous research (Floccia et al., 2006)

Accent Condition	**Mean Length of Recording (seconds)**	**Standard Deviation**
Native	2.561	0.31
Familiar	2.737	0.36
Unfamiliar	3.381	0.39

Table 7: *mean length of the recordings (seconds) and standard deviations for the speaker of stimuli in each accent condition.*

In addition, the accents chosen for each level of the independent variable could be a possible cause of the unexpected results. The native condition in this study was the Yorkshire accent as a singular category, represented by one speaker from Halifax in West Yorkshire. It must be considered whether all of the varieties used in the county of Yorkshire can be considered as fitting into the same category. Hiraga (2005:295) points out that "the general term 'Yorkshire accent' encompasses local varieties of this accent" and speakers from Yorkshire have been found to describe distinct accents for different parts of Yorkshire, dividing it into general areas such as North, South, East and West (Cooper, 2017). Responses to the question in the language background questionnaire asking participants to describe their experience with each of the accents provide evidence for this potential issue. For example, one participant from North Yorkshire stated "the area of Yorkshire I live in does not have as many people living there with a typically Yorkshire accent as in the recordings". Another participant from East Yorkshire said "the Yorkshire accent was very different to my own". This may mean that attributing this accent as 'native' to many of the participants, particularly those not from West Yorkshire as the speaker was, was inaccurate and could explain why their response times were not fastest for this accent.

The choice of Indian English for the unfamiliar accent condition should also be considered. It was surprising that the words in the unfamiliar accent condition were not responded to any slower than those in the native accent condition. This poses questions as to the extent to which Indian English was truly an 'unfamiliar' accent for the participants. A couple of responses in the language background questionnaire raised the possibility that the participants had more experience with Indian English than was initially assumed. For example, one participant from Sheffield said that they hear the Indian English accent "quite often in my hometown as there is a large Indian English community in my area". Another participant who was from Doncaster said that they have quite "slightly more exposure" to this accent "from TV and call centres". This evidence generates the possibility that the Indian English accent was not unfamiliar enough to elicit the same processing cost found for unfamiliar accents in previous studies.

Finally, Montgomery's (2012) discussion of the role of cultural prominence in measuring accent familiarity could explain why this study found that the familiar Liverpool English accent was recognised significantly faster and more accurately than the other two accents. This variety has the most cultural prominence out of the three accents tested because it is talked about in the media a lot and is highly stigmatised (Montgomery, 2012). This is supported by Leach et al.'s (2016) research in which no statistically significant effect of geographical proximity was found for the two accents with the most cultural prominence, Liverpool English and Manchester English. This showed that these accents were the most accurately identified by all listeners, regardless of how close they lived to the respective cities. In this study, the accent with the most cultural prominence was processed with more ease than the accent with the most geographical proximity for participants. This raises questions about the importance of cultural prominence as a measure of accent familiarity in addition to where a listener lives.

6. Conclusion

6.1 Concluding Remarks

This study aimed to contribute to research on the role of socioindexical information during spoken word recognition, by investigating the effects of familiarity with different accents of English on lexical processing. Based on the results of the lexical decision task, it can be concluded that a listener's familiarity with linguistic variation resulting from a speaker's geographical origin does significantly affect lexical processing.

The results found a statistically significant effect of accent on lexical decision task performance, with faster and more accurate responses elicited by the familiar Liverpool accent stimuli compared to the native Yorkshire and unfamiliar Indian English stimuli. On this basis, the null hypothesis was rejected. However, results were inconsistent with patterns shown by previous research (Floccia et al., 2006), which found that responses to a native accent were also significantly faster and more accurate than those to an unfamiliar accent. This meant that the alternative hypothesis, which was postulated based on previous findings, also had to be rejected. Possible explanations for this include idiosyncratic features of the native accent speaker's voice and effects of cultural prominence.

Very few studies in this area have focused on how varieties of native accents are dealt with in normal listening conditions, by adults rather than children. Since this study has provided results which conflict with those found previously, there is not yet a large enough body of literature with consistent findings for the effects of accent familiarity on lexical processing. Therefore, further research is needed to confirm the specific ways in which experience with variation is used during spoken word recognition.

In terms of wider psycholinguistic theory, the evidence contributed by this experiment supports the growing call from researchers for the development of hybrid models of spoken word recognition that include mechanisms which explain how the brain adapts to variation in the speech signal and how experience with different accents can modulate the effects of this variation.

6.2 Evaluation of Methods

Reflecting on the methodology used, the choice of a lexical decision task was effective as it provided an insight into internal language processes which cannot be seen otherwise. This is because the lexical decision task assumes that when the manipulation of a variable causes a difference in reaction times, this is evidence that the variable has affected the difficulty of accessing the word's lexical representation (Balota and Chumbley, 1984). The reaction times and accuracy rates produced quantitative data to be compared objectively and provide insight into the difficulty level of processing these three accents. The lexical decision task also allowed for high levels of control over the lexical characteristics of the stimuli to be exerted which was an improvement on Floccia et al.'s (2006) research. Consequently, it could be assumed that differences in responses between accent conditions were not due to differences in factors such as orthographical neighbourhood or word length, increasing internal validity. As well as this, a standardised procedure with a high level of control over extraneous variables was used for all participants. Participants all completed the same experiment with the same stimuli in a controlled environment with no distractions. This meant that test-retest reliability was high as it is unlikely that extraneous variables in the environment affected participants' performance.

However, the data collected was subject to various methodological limitations which should be improved upon in follow-up studies.

Despite the efforts made to match lexical characteristics of stimuli across conditions, it cannot be guaranteed that there were no differences between the target words that could have influenced processing. The frequency of the target words was potentially problematic. Even though all words had a score of 4-7 on the SUBTLEX-UK Zipf scale (Van Heuven et al., 2014) so were classed as high frequency words, the range of actual occurrences in the SUBTLEX-UK corpus was from 3038 to 42777. As aforementioned, increased frequency of words has been found to reduce processing time in many experiments investigating spoken word recognition (Grainger, 1990; Goldinger, 1996a). Therefore, this large difference in frequency between words could have meant that the lower frequency words were processed faster than the higher frequency words. This must therefore be considered when drawing conclusions based on the results of this study and future research could use more limited frequency ranges when creating stimuli.

Furthermore, this research decided that a forced-choice alternative lexical decision task would be more appropriate than the go/no-go lexical decision task which was used by Floccia et al. (2006) because it allowed the investigation of responses to non-words. However, research by Perea et al. (2002) found that go/no-go lexical decision tasks elicit faster and more accurate responses as they require fewer processing resources than the forced-choice alternative method which requires participants to remember which button corresponds to which decision. This would reduce the error rate as it has been found that many errors in lexical decision tasks are due to participants pressing the wrong response button rather than an incorrect classification of the word (Perea et al., 2002). Since the results of this study did not find differences in reaction times for non-words as a result of accent, perhaps a go/no-go lexical decision task could be used if the study was repeated so that the effects of accent familiarity on lexical processing can be investigated without the potential influence of added processing demands.

6.3 Suggestions for Future Research

Since Floccia et al.'s (2006) study is the only other experiment to use a lexical decision task to investigate the effects of accent familiarity on lexical processing, more research is needed in this area to see whether their results or the results of this study can be confirmed further.

The results of this study have suggested that this field of research may benefit from further enquiry into the effects of cultural prominence on the processing of regional accents. The results showed that the accent with the most cultural prominence, Liverpool English, was processed with more ease than the accent with the highest geographical proximity to participants, Yorkshire English. Therefore, when testing and measuring accent familiarity in future research, the level of cultural prominence an accent has to listeners should be taken into account alongside its geographical proximity to them.

It has also been recognised in this research that the accents assigned to each familiarity condition in future experiments of this kind should be carefully considered. If this study were to be repeated, the native accent condition would be more localised than 'Yorkshire', perhaps focusing on a sub-region such as West Yorkshire and only recruiting listeners from this more specific area. As for the unfamiliar accent condition, a variety that the participants definitely do not have a lot of experience with should be used, as responses to the language background questionnaire suggested that listeners were more familiar than initially expected with this variety due to media influences.

Future studies would also benefit from using more than one speaker in each accent condition to rule out the possibility of results being due to individual speaker differences unrelated to accent familiarity.

6.4 Implications

Overall, the findings presented by this undergraduate dissertation experiment contribute to our understanding of the effects of accent familiarity on lexical processing by showing that performance in a lexical decision task differs for stimuli in accents which participants have different levels of experience with. This provides useful insights for psycholinguistic models of spoken word recognition as this role of accent familiarity is not compatible with models which assume that word representations are purely abstract. The present study highlights the need for a continued focus on how we process variation in the speech we hear, to complement the body of research on the existence and correlates of this variation in speech production.

Word count: 11,998

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Appendices

Appendix A: Information Sheet given to Speakers.

<u>**Research project:** Processing of Accents</u>

You are being invited to take part in a research project. Before you decide to participate it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Feel free to ask if there is anything that is not clear or if you would like more information. Thank you for taking the time to read this.

1. What is the purpose of the project?
This project aims to look at how different accents affect the ability to process words.

2. Why have I been chosen?
We are recruiting female speakers of 3 different varieties of English. These varieties are Yorkshire English, Liverpool English and Indian English. It is up to you to decide whether or not to take part. Refusal to take part will not affect your rights in any way. If you decide to take part, you will be given this information sheet to keep and be asked to sign a consent form.

3. What will happen if I take part?
You will be asked to read aloud a series of sentences in the Linguistics and Phonetics recording studio. This should take no more than 30 minutes. Your production of these sentences will be recorded and played to participants in an experiment as part of this research project.

4. What happens when the research study stops?
If the experiment ends before we have finished the session, you will be told why. Once the data collection is completed, there will be some time spent in analysis and interpretation prior to the student's assessment. Our findings will appear in the lead researcher's dissertation and may later be shared with the academic and relevant professional communities through articles in academic journals, or presentations at conferences. You will be able to contact us after the data collection is finished if you have questions or would like to hear the outcome of the study.

5. Will our taking part in this project be kept confidential?
All information which is collected about you during the course of the research will be kept strictly confidential. Any responses/data you provide which are disseminated will be fully anonymised so that you cannot be recognised from them. All information and results are kept in a secure location.

6. What happens to the data collected after the research project is finished?
You may choose whether a) all data and your personal details are destroyed after the end of the period required by the University, or b) the data are added to a corpus of similar materials to facilitate ongoing research and teaching within the University of Leeds, for use by the student's supervisor and potential collaborators only. In this case, your details will be kept confidential and your anonymity protected. The data will not be used for research or teaching with which the student's supervisor has not been directly involved. Teaching materials will not be disseminated beyond relevant student cohorts.

7. What will happen if I change my mind about participating?
You are free to withdraw from participation at any time with no need for explanation and no penalty, up to one month after the point of data collection. If so, please contact the student

identified below who will immediately withdraw your data and personal information from their project; all such information in both electronic and/or hard copy will be destroyed.

8. Who is organising and funding the research?
This research is being undertaken by ------, based at the department of Linguistics and Phonetics at Leeds University, and is supervised by Dr Gisela Tomé Lourido. This project is being conducted as part of a module that has been reviewed and approved by the Faculty Research Ethics Committee at the University of Leeds (Ethics reference: PVAR 17-128).

Contact for further information:

Department of Linguistics and Phonetics, School of Languages, Cultures and Societies, Michael Sadler Building, University of Leeds, Leeds, LS2 9JT.
Email: ------

Appendix B: Information Sheet given to Listeners.

Research project: Processing of Accents

You are being invited to take part in a research project. Before you decide to participate it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Feel free to ask if there is anything that is not clear or if you would like more information. Thank you for taking the time to read this.

1. What is the purpose of the project?
This project aims to look at how different accents affect the ability to process words.

2. Why have I been chosen?
We are recruiting monolingual, native British speakers of English who are aged 18-50 and have been born and raised in Yorkshire so are assumed to have a native Yorkshire accent. It is up to you to decide whether or not to take part. Refusal to take part will not affect your rights in any way. If you decide to take part you will be given this information sheet to keep, and be asked to sign a consent form.

3. What will happen if I take part?
You will be asked to listen to a series of 60 spoken sentences and decide whether the final word in each sentence IS a real English word or IS NOT a real English word. This experiment should take no longer than 15 minutes, including an optional break of up to 2 minutes halfway through.

4. What happens when the research study stops?
If the experiment ends before we have finished the session, you will be told why. Once the data collection is completed, there will be some time spent in analysis and interpretation prior to the student's assessment. Our findings will appear in the lead researcher's dissertation and may later be shared with the academic and relevant professional communities through articles in academic journals, or presentations at conferences. You will be able to contact us after the data collection is finished if you have questions or would like to hear the outcome of the study.

5. Will our taking part in this project be kept confidential?
All information which is collected about you during the course of the research will be kept strictly confidential. Any responses/data you provide which are disseminated will be fully anonymised so that you cannot be recognised from them. All information and results are kept in a secure location.

6. What happens to the data collected after the research project is finished?
You may choose whether a) all data and your personal details are destroyed after the end of the period required by the University, or b) the data are added to a corpus of similar materials to facilitate ongoing research and teaching within the University of Leeds, for use by the student's supervisor and potential collaborators only. In this case, your details will be kept confidential and your anonymity protected. The data will not be used for research or teaching with which the student's supervisor has not been directly involved. Teaching materials will not be disseminated beyond relevant student cohorts.

7. What will happen if I change my mind about participating?
You are free to withdraw from participation at any time with no need for explanation and no penalty, up to one month after the point of data collection. If so, please contact the student identified below who will immediately withdraw your data and personal information from their project; all such information in both electronic and/or hard copy will be destroyed.

8. Who is organising and funding the research?
This research is being undertaken by ------, based at the department of Linguistics and Phonetics at Leeds University, and is supervised by Dr Gisela Tomé Lourido. This project is being conducted as part of a module that has been reviewed and approved by the Faculty Research Ethics Committee at the University of Leeds (Ethics reference: PVAR 17-128).

Contact for further information:

Department of Linguistics and Phonetics, School of Languages, Cultures and Societies, Michael Sadler Building, University of Leeds, Leeds, LS2 9JT.
Email: ------

Appendix C: Blank Copy of the Consent Form.

	Add your initials next to the statement if you agree
I confirm that I have read and understand the information sheet dated January 2019 explaining the above research project and I have had the opportunity to ask questions about the project.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, and without there being any negative consequences, up to one month after the data are recorded. In addition, should I not wish to answer any particular question or questions, I am free to decline. I understand that if I withdraw, all my data will be immediately destroyed.	
I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research.	

I agree for the data collected from me to be used in relevant future teaching or research in an anonymised form, as described in Question 6 above.	
I agree to take part in the above research project and will inform the lead researcher should my contact details change.	

Consent to take part in: Processing of Accents

Name of participant	
Participant's signature	
Date	
Name of lead researcher	
Signature*	
Date*	

*To be signed and dated in the presence of the participant.

Once this consent form has been signed by all parties, the participant should receive a copy of the signed and dated participant consent form, the information sheet and any other written information provided to the participants. A copy of the signed and dated consent form should be kept by the researcher with the project's main documents which must be kept in a secure location during data collection and handed over to the module leader by the specified date in Semester 2.

Appendix D: Blank Copy of the Language Background Questionnaire Administered to Speakers.

LANGUAGE BACKGROUND QUESTIONNAIRE

Please answer the following questions to the best of your knowledge.

If you would rather not answer some of the questions, then just leave these slots blank.

1. Please state the language(s) which you speak fluently.

2. When did you acquire the language(s) you speak and how? (e.g. from parents, at school)

3. Do your parents and/or immediate family speak a language other than English? If so, please specify which language(s) and which language(s) they use when speaking to you.

4. What is your gender?

5. What is your age?

6. In which part of the world were you living at the following stages of your life:

    a. Birth

    b. When you were attending primary school

    c. When you were attending secondary school

    d. Now

Appendix E: Blank Copy of the Language Background Questionnaire Administered to Listeners.

LANGUAGE BACKGROUND QUESTIONNAIRE

Please answer the following questions to the best of your knowledge.

If you would rather not answer some of the questions, then just leave these slots blank.

1. Please state the language(s) that you speak fluently and at what age you started to acquire it/them.

2. What is your age?

3. What is your gender?

4. Do you have a history of any hearing problems?

5. For each accent below, please indicate whether you have experience with it or not. If you have, please describe what type of experience this is in much detail as possible.

    a. Yorkshire English

    b. Liverpool English

    c. Indian English

6. In which part of the British Isles were you living at the following stages of your life:

    a. Birth

    b. When you were attending primary school

    c. When you were attending secondary school

    d. Now

7. Please state whether you have lived elsewhere (not stated above) for at least 1 year:

8. Are you left-handed or right-handed?

Appendix F: Native Accent Condition Stimuli Sentences.

1. When she got to the bottom of the hill, Jane noticed a pole.
2. When she got to the bottom of the hill, Jane noticed a sign.
3. When she got to the bottom of the hill, Jane noticed a vaws.
4. When she got to the bottom of the hill, Jane noticed a chak.
5. Sally had produced a beautiful painting of a boat.
6. Sally had produced a beautiful painting of a deer.
7. Sally had produced a beautiful painting of a dord.
8. Sally had produced a beautiful painting of a neek.
9. Yesterday evening, all of the teenagers went to the jail.
10. Yesterday evening, all of the teenagers went to the mill.
11. Yesterday evening, all of the teenagers went to the birl.
12. Yesterday evening, all of the teenagers went to the zord.
13. When John looked in the cupboard, he found a nail.
14. When John looked in the cupboard, he found a note.
15. When John looked in the cupboard, he found a vord.
16. When John looked in the cupboard, he found a mird.
17. The girls were not surprised when they saw the rain.
18. The girls were not surprised when they saw the lies.

19. The girls were not surprised when they saw the rorn.
20. The girls were not surprised when they saw the meez.

Appendix G: Familiar Accent Condition Stimuli Sentences.

1. When she got to the bottom of the hill, Jane noticed a bike.
2. When she got to the bottom of the hill, Jane noticed a road.
3. When she got to the bottom of the hill, Jane noticed a lork.
4. When she got to the bottom of the hill, Jane noticed a teep.
5. Sally had produced a beautiful painting of a wave.
6. Sally had produced a beautiful painting of a moon.
7. Sally had produced a beautiful painting of a lird.
8. Sally had produced a beautiful painting of a tuzz.
9. Yesterday evening, all of the teenagers went to the hall.
10. Yesterday evening, all of the teenagers went to the room.
11. Yesterday evening, all of the teenagers went to the gawn.
12. Yesterday evening, all of the teenagers went to the wurn.
13. When John looked in the cupboard, he found a cake.
14. When John looked in the cupboard, he found a ball.
15. When John looked in the cupboard, he found a gork.
16. When John looked in the cupboard, he found a turs.
17. The girls were not surprised when they saw the news.
18. The girls were not surprised when they saw the bear.
19. The girls were not surprised when they saw the leck.
20. The girls were not surprised when they saw the dack.

Appendix H: Unfamiliar Accent Condition Stimuli Sentences

1. When she got to the bottom of the hill, Jane noticed a duck.
2. When she got to the bottom of the hill, Jane noticed a gate.
3. When she got to the bottom of the hill, Jane noticed a jorn.
4. When she got to the bottom of the hill, Jane noticed a nawl.
5. Sally had produced a beautiful painting of a rock.
6. Sally had produced a beautiful painting of a bird.
7. Sally had produced a beautiful painting of a poot.
8. Sally had produced a beautiful painting of a lort.

9. Yesterday evening, all of the teenagers went to the pool.
10. Yesterday evening, all of the teenagers went to the meal.
11. Yesterday evening, all of the teenagers went to the yawd.
12. Yesterday evening, all of the teenagers went to the gack.
13. When John looked in the cupboard, he found a rope.
14. When John looked in the cupboard, he found a lock.
15. When John looked in the cupboard, he found a seef.
16. When John looked in the cupboard, he found a rard.
17. The girls were not surprised when they saw the mess.
18. The girls were not surprised when they saw the tide.
19. The girls were not surprised when they saw the keek.
20. The girls were not surprised when they saw the mork.

Appendix I: Training Condition Stimuli Sentences.

1. Last weekend the policeman discovered a yain.
2. After she had eaten her breakfast, Holly picked up a sarz.
3. All of the animals ran towards the beel.
4. When he put his glasses on, Henry was able to see the door.
5. Despite searching for weeks, the young man could not find his suit.

Appendix J: Raw Mean Reaction Times (milliseconds) and Standard Deviations for Non-Words in each Accent Condition.

Accent	**Raw mean (milliseconds)**	**Standard Deviation**
Native	929.8	0.55
Familiar	882.7	0.55
Unfamiliar	870.6	0.53

Appendix K: mean accuracy rates (%) and standard deviations for both word types in each accent condition.

Accent	Word Type	Mean Accuracy Rate (%)	Standard Deviation
Native	Real	91.67	7.1
Native	Non	88.77	9
Familiar	Real	97.16	4.7
Familiar	Non	96.11	5.0
Unfamiliar	Real	97.16	4.7
Unfamiliar	Non	80.56	15.1

Appendix L: Participant Averages for Reaction Times (RT) for each Accent Condition and Word Type.

Participant	Native Mean RT (milliseconds)	Familiar Mean RT (milliseconds)	Unfamiliar Mean RT (milliseconds)	Real Words Mean RT (milliseconds)	Non-words Mean RT (milliseconds)
LG1	846.1	816.8	747.1	675.7	941.8
MG2	993.7	779	632.8	546.7	1167.2
RW3	1345.5	1237.7	1310.2	960.9	1653.5
LW4	1351.1	1202.6	979.8	1101.1	1251
NS5	725.2	687.7	907.8	684.4	861.3
CS6	420.7	297.6	417	373	388.4
JW7	332.4	211.4	232.7	263.5	247.1
JT8	866.8	719.3	826.4	908.1	689.7
CP9	1728.66	1507.3	1387.6	1379.5	1714.3
RC10	757.5	835.2	845.5	690	944.1
LS11	1143	999.3	1187.5	919.5	1337.2
NA12	995.9	857.3	811	854	923.6
WM13	890.7	1000.2	921.2	886.7	1001.8
NR14	604.8	489.1	594.6	556.4	565
EM15	302	196.4	254.1	244.7	254.9
CC16	572.7	381.8	546	442.4	552.2
FL17	897.2	776	973.1	668	1105.6
JK18	726.6	652	778.4	715.2	718.5
Mean	**797.1**	**640.1**	**720.5**	**717.5**	**894**

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Appendix M: Participant Average Accuracy Rates for each Accent Condition and Word Type.

Participant ID	**Native Mean Accuracy Rate (%)**	**Familiar Mean Accuracy Rate (%)**	**Unfamiliar Mean Accuracy Rate (%)**	**Real Mean Accuracy Rate (%)**	**Non Mean Accuracy Rate (%)**
LG1	95	95	85	96.7	86.7
MG2	80	85	70	93.3	70
RW3	75	80	90	90	83.3
LW4	100	100	100	100	100
NS5	90	100	90	96.7	90
CS6	95	95	100	96.7	96.7
JW7	84.5	94.5	94.5	85.9	96.3
JT8	95	100	95	100	93.3
CP9	95	90	85	93.3	86.7
RC10	90	100	85	96.7	86.7
LS11	90	95	80	100	76.7
NA12	90	95	85	93.3	86.7
WM13	90	95	95	96.7	90
NR14	90	95	85	93.3	86.7
EM15	89.5	100	95	96.7	92.3
CC16	95	100	100	96.7	100
FL17	90	100	85	96.7	86.7
JK18	90	95	80	93.3	83.3
Mean	**90.2**	**96.7**	**88.9**	**95.3**	**88.5**