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The influence of long-term exposure to dialect variation on representation specificity and word learning in toddlers.

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By

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Copyright Statement

Dedication

This thesis, in its entirety, is dedicated to the two most important people in life, my ‘best boys’, Harrison and Charlie. Throughout my thesis journey they have been my inspiration, my motivation and most importantly my favourite distraction.

Abstract

The influence of long-term exposure to dialect variation on representation specificity and word learning in toddlers.

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Until very recently language development research classified the language learner as belonging to one of two discrete groups – monolingual or bilingual. This thesis explores the hypothesis that this is an insufficient description of language input and that there are sub-groups within the monolingual category based on the phonological variability of their exposure that could be considered akin to that of bilingual toddlers. For some monolingual toddlers, classified as monodialectal, their language exposure is generally consistent, because both of their parents speak the dialect of the local area. Yet for other toddlers, classified as multidialectal, the language environment is more variable, because at least one of their parents speaks with a dialect that differs from the local area. It is considered that by testing this group of multidialectal toddlers it will be possible to explore the effect of variability on language development and how increased variability in the bilingual linguistic environment might be influencing aspects of language development. This thesis approaches the influence of variability from three areas of interest: phonetic specificity of familiar words using a mispronunciation paradigm (Experiments 1 and 2), target recognition of naturally occurring pronunciation alternatives (Experiments 3 and 4) and use of the Mutual Exclusivity strategy in novel word learning (Experiment 5). Results show that there are differences between the two dialect groups (monodialectal and multidialectal) in a mispronunciation detection task but that toddlers perform similarly with naturally occurring pronunciation alternatives and in their application of the Mutual Exclusivity strategy. This programme of work highlights that there is an influence of linguistic variability on aspects of language development, justifying the parallel between bilingualism and multidialectalism.

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Author's Declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Committee. Work submitted for this research degree at the Plymouth University has not formed part of any other degree at Plymouth University or at another establishment.

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The work reported in this thesis complies with the British Psychological Society's (2009) ethical guidelines. Ethical approval was granted for all of the methodological procedures used throughout this thesis by the Faculty of Science and Technology at Plymouth University. The author completed and passed Criminal Records Bureau checks in order to undertake this work with participants under the age of 18.

Relevant scientific seminars and conferences were regularly attended at which work was presented. Courses were attended to develop specific skills and papers were prepared for publication, submitted and accepted.

Published Papers

Delle Luche, C., **Durrant, S.,** Floccia, C., & Plunkett, K. (2014). Implicit meaning in toddlers. *Developmental Science*

Durrant, S., Delle Luche, C., Cattani, A., & Floccia, C. (2014). Monodialectal and Multidialectal infants' representations of familiar words. *Journal of Child Language*

Floccia, C., Delle Luche, C., **Durrant, S.,** Butler, J., & Goslin, J. (2012). Parent or community: Where do 20-month-olds exposed to two accents acquire their representation of words? *Cognition*, 124, 95-100

Mani, N., **Durrant, S**., & Floccia, C. (2012). Activation of phonological and semantic codes in toddlers. *Journal of Memory and Language*, 66, 612-622.

Oral Presentations

Delle Luche, C., **Durrant, S.,** Floccia, C., & Butler, J. (2012). Mum is from London, baby is born in the South West: How accent exposure shapes early word representations. *Early Language Acquisition conference*, Lyon, France, December 5-7.

Durrant, S., Delle Luche, C., & Floccia, C. (2012) Do bidialectal infants accept 'gat' for 'cat'? *Presented at the 4th Cognitive Linguistics Conference , London*

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Durrant, S., Delle Luche, C., Duffy, H., Farag, R., & Floccia, C. (2012) Can bidialectal children tell that a gat is not a cat? Mispronunciation effects in 20-month-old mono- and bidialectal toddlers. *Poster presented at the XVIII Biennial International Conference on Infants Studies, Minneapolis, Minnesota*

Durrant, S., Delle Luche, C., Duffy, H., Farag, R., & Floccia, C. (2012) Can bidialectal children tell that a gat is not a cat? Mispronunciation effects in 20-month-old mono- and bidialectal toddlers. *Poster presented at the 4th Annual University of Plymouth Department of Psychology Postgraduate and Staff Conference, Plymouth*

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Chapter 1.

Introduction

A plethora of research has explored infants and toddlers' ability to learn and recognise words from the speech they encounter on a daily basis. The majority of the studies conducted to date focus on monolingual and bilingual participants as two distinct populations. Traditionally, monolingual toddlers have been thought to constitute a homogenous group whose development would provide the benchmark to compare the development of the more variable group of bilingual (or multilingual) children. Although there appear to be similarities across these two groups of language learners (Byers-Heinlein & Fennell, 2014; de Houwer, 1995; Hoff et al., 2012; Oller, Eilers, Urbano, & Cobo-Lewis, 1997; Pearson & Fernández, 1994; Petitto et al., 2001); there are also differences in their developmental pathways (Bosch & Sebastián-Gallés, 2003; Ramon-Casas, Swingley, Sebastián-Gallés, & Bosch, 2009; see Chapter 2.3 for a full discussion); for example, bilingual toddlers appear delayed in their ability to use phonetic information to discriminate newly learned words (Fennell, Byers-Heinlein, & Werker, 2007; Werker, Fennell, Corcoran, & Stager, 2002). Recently however, some researchers (Albareda-Castellot, Pons, & Sebastián-Gallés, 2011) have started questioning the homogeneity of the monolingual population itself.

In fact, the monolingual population can be further subdivided to identify sub groups of infants and toddlers who hear variations within a single language, in the form of dialect variation. This is the case for toddlers whose parents speak the same language but one or both of them use a dialect that differs from that of the local community, e.g. they live in the South West, Dad has a local accent and Mum has a Scottish accent. In this example the child will be exposed to local pronunciations from Dad and the community, as well as Scottish pronunciations from Mum; these two pronunciations can differ considerably in their phonetic (and prosodic) realisation. Many dialects also encompass lexical variations so that different words are used to express the same meaning, e.g. 'wee' for 'little' and 'bairn' for 'baby' in Scottish English. Children raised in such multidialectal environment are required to manage this variability on a daily basis, in a similar way to bilingual toddlers who must cope with their two languages.

So far, little work has examined this unique population of monolingual, yet multidialectal, toddlers; instead many of the studies looking at the impact of accented speech and variability more generally (e.g. speaker variation, affect, and pitch) on language development introduce variability as part of the experimental procedure. These studies have found that toddlers' ability to accommodate variation is dependent on the type of variation tested, the age of the child and the context of the variation (Houston & Jusczyk, 2000; Jusczyk, Pisoni, & Mullennix, 1992; Kuhl, 1983; Rost & McMurray, 2009, 2010; Singh, Morgan, & White, 2004; van Heugten & Johnson, 2012). The few studies that have explored the impact of long-term exposure to variable input, since this thesis began, have found differences in language processing between toddlers exposed to consistent input and those whose input is variable. In some cases variable exposure is shown to have a negative influence on familiar word recognition (Van Heugten & Johnson, 2013), whereas in others benefits are observed (Kitamura, Panneton, Deihl, & Notley, 2006). This thesis seeks to add to this body of knowledge by exploring the influence of long term exposure to variable input on language development, and focusing on dialectal differences in children's linguistic background. In a series of studies toddlers identified as monodialectal or multidialectal will be examined in their ability to detect mispronunciations of familiar words, accommodate naturally occurring variation and learn new words.

Chapter 2 discusses the available literature regarding the acquisition of new words (Chapter 2.1) as well as the stored representations of those words once they have been learned by toddlers (Chapter 2.2). Both word learning and representation specificity have been found to differ in monolingual and bilingual populations (Chapter 2.3). As such these represent interesting avenues for research into the parallel suggested between bilingual and multidialectal toddlers (Albareda-Castellot et al., 2011). The overarching theme of this thesis is the impact of variability on word learning and representation specificity in toddlers, which called for a review of the impact of other types of variations on word processing, such as speaker variability, foreign accents and indexical variation (Chapter 2.4). Specifically, this thesis considers the variability generated by accents and dialects in a single language, that is, regional variation, and the impact this variation has on task performance (Chapter 2.5).

The target population of this thesis is toddlers who are raised hearing at least two regional varieties of English and have done so throughout their language development. At the time this work began very little had been done looking at the impact of long-term exposure to dialect variation, in fact in the only study available, Kitamura et al. (2006) assumed that exposure to variability could explain their results but did not measure this in any consistent way. Over the course of this PhD this topic has emerged as a growing area in the field, although there are still few published studies (Chapter 2.6).

As a first investigation into the impact of long-term variability in the language environment of toddlers, the experiments reported in Chapter 3 consider the influence of long-term variation on the specificity of representations of familiar words using a mispronunciation paradigm. The experiments in Chapter 4 consider whether the effects observed in the first experiments can be observed with tokens that are variable in the input of all toddlers, specifically allophonic variation. Finally, the influence of long-term variability on a word learning strategy, Mutual Exclusivity, is explored in Chapter 5. The last chapter of this thesis, Chapter 6, draws together the results of all of these studies, presents a synthetic explanation of the findings and makes suggestions for the continued research in this area.

Chapter 2.

Literature review

Before the novice word learners can begin the task of assigning meaning to the words they are learning they need to identify the individual words from the speech they are hearing. It has been demonstrated that infants begin to recognise familiar words at around 6 months (Bortfeld, Morgan, Golinkoff, & Rathbun, 2005; Singh, Nestor, & Bortfeld, 2008), possibly by capitalising on having heard them in isolation at this stage. Jusczyk and Aslin (1995) show that from as early as 7.5 months of age this ability extends to being able to segment newly familiarised words from continuous speech. They familiarised infants to unfamiliar isolated words and then tested them on sentences either containing the words they had previously heard or new unfamiliar words. At 7.5 months infants listened longer to sentences including the words from the familiarisation phase than to sentences containing unfamiliarised words, indicating that they had been able to segment these words from the sentences. The same effect was observed when the familiarisation phase included sentences and the test phase lists of words either included in those sentences or not. This ability to extract novel words from continuous speech has been replicated in American and Canadian English (e.g. Johnson & Jusczyk, 2001; Schmale & Seidl, 2009; Seidl & Johnson, 2006; Singh, Nestor, et al., 2008) and in French (Nazzi, Mersad, Sundara, Iakimova, & Polka, 2014).

The ability to identify words from continuous speech is a necessary pre-cursor for later word learning and language use. Until infants have successfully identified words from continuous speech these cannot be matched to the objects and concepts they represent. Swingley (2009) explains that 'knowing' a word is not as simple as recognising its sound form but also requires an understanding of its meaning – including its semantic and syntactic properties. Learning the meaning of words is one of the fundamental problems of language learning; once infants have developed the ability to identify word forms from the speech stream they must figure out what these words mean.

2.1 Word learning in infants

Language learning is considered an inductive process. In order to learn the meaning of a new word and link it to an object a listener makes an inference about what the speaker is referring to. Over time and repeated exposure these inferences are refined and, if necessary, adjusted to match the usage pattern of the surrounding language users (Quine, 1960). This process is a complex one given the number of potential referents in the world that a speaker could be referring to, yet by the end of their first year infants already understand many words that occur frequently in their input, e.g. mummy, daddy, cat, book and ball. At around 18 months of age toddlers enter a period of accelerated vocabulary growth often termed the 'vocabulary spurt' or 'naming explosion' (L. Bloom, 1973; Gopnik & Meltzoff, 1986, 1987; Nelson, 1973 although see Dahan & Brent, 1999 for an alternative description of this behaviour). At this stage toddlers begin to produce and understand a large number of words in quick succession and use them functionally, to name objects, to make requests and to communicate with others. How toddlers achieve this task has been the subject of much research over the years with the currently favoured mechanisms discussed below.

It is generally accepted that infants under the age of 12 months are less concerned with the task of word learning than with the acquisition of the phonemic categories in their language (Gervain & Mehler, 2010; Polka & Werker, 1994; Werker & Tees, 1984) and the extraction and recognition of the forms of frequent words (Jusczyk & Aslin, 1995). This assumption is supported by evidence that infants aged 13 months but not 11 months can successfully identify the referent of a familiar word (Thomas, Campos, Shucard, Ramsay, & Shucard, 1981). In this study Thomas et al. (1981) presented infants with an array of four images in an adapted Intermodal Preferential Looking (IPL) procedure. Infants' caregivers, who could not see the images, were asked to name one object that the child would be familiar with, one that was unfamiliar and one non-word. They found that infants only preferentially fixated the image matching the known words at 13 months. At 11 months infants' looking times during all trials was at chance. This was taken as evidence that before the age of 13 months infants had not yet formed associations between familiar words and their referents.

Since then, additional evidence that infants know the meanings of words around their first birthday has been presented by Mani and Plunkett (2010). Using a typical IPL procedure with 2 rather than 4 images, they presented 12 month old infants with familiar images, naming one of them at the mid-point of the trial. Infants' looking times to the target prior to it being named (pre-naming) and after naming (post-naming) were recorded. An increase in looking times in the post-naming phase, as compared to the pre-naming phase, signifies that infants have learned an association between the presented auditory label and the target image. Such an increase was found in this study, providing clear evidence that infants at 12 months have successfully learned the words presented to them.

More recently a study by Bergelson and Swingley (2012) demonstrated that younger infants, aged between 6 and 9 months, can identify the referent of a familiar noun. Using the IPL procedure infants saw pairs of images on a screen and heard a short sentence, such as 'Can you find the X' where X was the target word. Unusually for this paradigm the sentences were spoken by the infants' caregiver following prompting through headphones. Bergelson and Swingley (2013) have since followed this up with a more typical procedure where infants heard a recorded voice producing the sentences. The results of this follow up support those where the parents named the object. That is, infants at 6-9 months successfully identify a target over a distracter when it is named by either a caregiver or a recorded voice. The ability to identify the referent of a word at this very young age has limitations. Bergelson and Swingley (2013) demonstrate that although infants are successful with concrete common nouns it is not until 10 months of age that infants can do this with more abstract concepts such as 'all gone' and 'eat'. One point to note here is that it is difficult to establish whether infants are unsuccessful with abstract concepts due to a lack of understanding or because these concepts themselves are hard to present to infants using images. This new evidence suggests that infants are learning words concurrently with the sounds of their native language during the first year of life.

The evidence presented thus far clearly demonstrates that children are able to learn words but does little to explain how children acquire these words from the language environment. The language environment in which children are immersed is both rich - there is much information available - and variable - differences are found between and even within speakers. The child must learn which are relevant, in its content. Over the years there have been three directions of research attempting to explain how toddlers learn words, namely the social-pragmatic approach, the associative learning approach, and the lexical principles account.

2.1.1 The social-pragmatic approach

The central claim of the social-pragmatic approach is that the 'process of word learning is constrained by the child's general understanding of what is going on in the situation in which she hears a new word' (Tomasello & Akhtar, 2000, p.5). This approach focuses on the influence of the social environment in which language in experienced and the role social cues and pragmatics directions play in learning new words. In this way, the mechanisms that children are using are not language specific but domain general such as eye gaze and communicative intentions to infer both the object of the speakers' attention and their intention in relation to that object: for example, whether they are naming it or describing the action of a rabbit. Tomasello (2003) presented evidence suggesting that speaker's eye gaze, tone of voice and facial expression are all important cues used by children when they are learning new words. One further non-linguistic cue not yet mentioned here, that has been found to support word learning, is joint attention, that is, the shared attention of the speaker and the learner. This cue is particularly effective when the speaker focuses their attention where the child is focussed rather than attempting to redirect the child's attention to a new location or item (Tomasello & Farrar, 1986). The gestures of the caregiver during these shared interactions provide important additional cues to aid infants in early word learning, and especially the synchrony of these gestures with the auditory input (Rader & Zukow-Goldring, 2012). Within this approach the principle of contrast (Clark, 1988) is the prevailing explanation of children word learning abilities.

2.1.1.1 The Principle of Contrast

The principle of contrast states that a difference in the form of a word indicates a difference in meaning (Clark, 1988) and is largely based on the idea that within a dictionary no two words share exactly the same meaning (Bolinger, 1965). In order to acquire words infants need to assume that meanings are contrastive; once they have learned this assumption they can use it to learn new words. The primary claim in this explanation of word learning is that children are using knowledge of the pragmatics of the input and speakers intentions to guide their learning. The key advantage of this explanation over the others currently available is that it explains how children successfully learn that two words can refer to the same object: fish as the category name and 'Nemo' as the name for this particular fish.

Waxman and Senghas (1992) demonstrated this in toddlers aged 2 years, they were able to learn two names for the same object if the objects were perceptually similar. Over 4 experimental sessions toddlers were introduced to three novel objects, e.g. a toy horn, a hook and a whisk, and taught a novel name for each. In session 1 only one word and object pairing was introduced, with the final 2 objects and words presented in the second session. Over the course of the sessions toddlers' learning of the novel word-object pairing was tested and all toddlers were shown to have successfully learned the new words. Additionally, when a novel object introduced in session 2 was perceptually similar, e.g. a tong as perceptually similar to the whisk from session 1, toddlers extended the label given to the first object to the perceptually similar one. This pattern of responding was not seen when the newly introduced objects were perceptually dissimilar, e.g. the whisk from session 1 and a toy flute.

Interestingly, the application of the object label from session 1 did not prevent children from learning the new label for the new object in the subsequent session as would be expected taking a Mutual Exclusivity view. Instead, toddlers applied both labels to the same object indicating that they were able to associate multiple labels to the same object. However, one caveat to this explanation of novel word learning is that there is little advantage for rapid word learning. It is unclear how a child would differentiate whether an auditory label is intended as a label for a new item or as a second label for a name-known object. This proposal also relies on perceptual similarity being a consistent cue which is not always the case.

2.1.2 The associationist approach

A second approach to explaining word leaning in young children draws similarities with the social-pragmatic approach, in so much as, it posits that word learning is a domain-general process calling on general learning rather than language specific mechanisms. It is supposed that in cross-situational accounts of word learning, such as those proposed by the associationist approach, listeners have already acquired knowledge that the words heard relate to the immediate environment of the speaker, so that this knowledge of speakers' intended referents is integrated by the learner. The learner then uses consistent associations between words and their referents to build the lexicon (Yu & Smith, 2007). The ability to make these associations between words and their related object is supported by other general learning mechanisms including context dependency and novelty preference. The context of language experiences can guide how children interpret the meaning of novel words. Samuelson and Smith (1998) explain that children learn words most effectively when the context of learning and recalling is matched. There is also evidence (Mather and Plunkett, 2010) suggesting that novelty of objects guides word learning in infants as young as 10 months,

2.1.3 The constraints and biases approach

An alternative approach considers that the process of assigning meaning to words by the novice word learner relies on a number of principles, such as the noun bias (Gentner, 1982) and the whole object assumption (Landau, Smith, & Jones, 1988; Waxman & Markow, 1995). The noun bias assumes that infants are pre-disposed to learning nouns; when they hear a novel word they initially link it to an object rather than an action or property of the object. Similarly, the whole object assumption (Landau et al., 1988; Waxman & Markow, 1995) supposes that upon hearing a novel word (e.g. cat) infants assume that it relates to the entire object of reference and not to a specific feature of it (e.g. its colour, brown) or a smaller part of it (e.g. tail). Contrasting explanations of word learning that rely in part on these prior assumptions have been proposed, including the novel-name-nameless-category (N3C) principle (Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992; Golinkoff, Mervis, & Hirsh-Pasek, 1994) and the Mutual Exclusivity Principle (Markman, 1989).

2.1.3.1 The Novel Name Nameless Category (N3C) Principle

The N3C principle holds that infants map a novel word to an object that does not yet have a name and extend this name to other similar but unfamiliar objects (Golinkoff et al., 1992). This happens rapidly requiring as little as one instance for successful mapping to take place, although this early mapping is incomplete and needs further repetitions to develop completely. One of the key claims about this principle is that it allows word learning from the input alone without the requirement of additional cues such as pointing. Golinkoff et al. (1992) tested 28 month toddlers' ability to extend a novel name to a similar, but not identical, object. They presented toddlers with a single novel object, in the presence of other familiar objects, and used a novel word e.g. 'dax' when requesting an object; toddlers consistently chose the novel object when hearing a novel word. In a second trial with 2 new novel objects they found that toddlers reliably extended the same novel label ('dax') to the novel object differing only by colour, rather than to a second, entirely novel object. Golinkoff et al. (1992) claim that toddlers applied a category label to the object rather than assuming the novel word referred to any novel object encountered, and present this as confirmation that toddlers are mapping words to unnamed category objects rather than to specific objects. In addition to these findings, an early study by Mervis and Bertrand (1994) found that the acquisition of the N3C principle coincided with the vocabulary spurt and that it was not available to infants in the earliest stages of word learning. They tested 16-20 month old toddlers using the same procedure as Golinkoff et al. (1992) and found that some toddlers successfully extended the novel name to the new exemplars of the novel object while others didn't. Further analyses of individual toddlers' performance revealed that success in this task was determined by vocabulary size, and specifically by whether or not toddlers had entered the vocabulary spurt.

2.1.3.2 The Mutual Exclusivity Principle

The Mutual Exclusivity Principle is based on the assumption that objects have only one name. In order to avoid violating this assumption a novel word is mapped onto a novel object rather than being applied as a second label to a name-known object (Markman & Wachtel, 1988). Mutual Exclusivity is made up of a set of four biases that support word learning. The first of these is disambiguation, which is the process of excluding objects with known labels as potential referents for the novel label. That is, in the presence of a fork for which a child would have a label and a knife which currently wouldn't have any, upon hearing a novel word 'knife' the new label would be applied to the unlabelled object and the novel word ('knife') would be learned. The number of instances required to cement the mapping of novel labels and objects is unclear though it is thought to occur relatively quickly, in some cases by the second presentation (Mather & Plunkett, 2012).

The second of these biases is correction. This refers to the process of deciding that a novel label refers to an object that the child already thought she could name, and adjusting the mapping accordingly. For example, the infant may decide that the word ‘widget’ refers to the cup and correct the label for that object so that it is now labelled widget and not cup (Merriman & Bowman, 1989).

Rejection is the third bias and is similar to correction. In these cases the infant assumes that the speaker has made an error and thus completely ignores and rejects the novel label. It is difficult experimentally to differentiate correction and rejection, however, there is anecdotal evidence suggesting that rejection does occur separately from correction.

The final bias is restriction, which Merriman (1991) proposes to be necessary for Mutual Exclusivity to be utilised. It is the idea that a label is restricted to a single class of items. Merriman (1991) uses the example of presenting infants with a number of unfamiliar vehicles and asking them to point first to cars and then to buses. In this scenario infants should create two sets of items with each vehicle being either a car or a bus by using restriction. What is unclear with Mutual Exclusivity is how and when infants learn to violate Mutual Exclusivity in order to map two (or more) words to the same object, e.g. sofa, couch, and settee, and how they decide when to apply each of these constraints.

2.1.3 Summary

Current theories overlap in many ways in describing how children approach the task of word learning. For example, they all assume that children rely on some basic underlying assumptions in order to learn words, whether it is that different word forms imply different meaning, that objects can have only one label, or that the speaker is referring to something in the immediate environment. The principle of contrast stands apart from the other approaches as it posits a greater reliance on social interactions and social cues for word learning. In addition, this approaches places emphasis on the meanings of the words being heard rather than the objects to which these words refer. Alternatively, the two approaches most similar in their approach, in that toddlers reject a second label for an object, are Mutual Exclusivity and N3C. Underpinning both of these approaches is the assumption that objects can have only one label and thus a second unknown label must relate to a new object. However, they differ on one key point, namely the motivation for applying a novel label to a novel object (Diesendruck & Shemer, 2006). For Mutual Exclusivity infants map a novel label to a novel object in order to avoid giving a known object a second label. N3C posits a more positive motivation for the same phenomenon, namely that infants seek out a label for a novel object so that they can talk about the object with another person. M. C. Frank et al. (2009) has offered a multidimensional account of word learning through the use of a computational model, where infants use whichever cues are available to them at the time with a combination of cues providing the best environment for learning. What is clearly evident, given how quickly and successfully language is acquired, is that infants are motivated to learn new words and do so efficiently, creating representations of words that are ultimately recognised and reproduced, as demonstrated by their ability to communicate effectively with peers, caregivers and any other people they encounter.

2.2 Phonetic specificity in infants' representations of words

We have seen that young infants and toddlers are excellent word learners, possibly guided by a series of assumptions regarding sound-to-meaning mapping as well as by cues provided by social interactions. A recent area of research has focused on the identification of what toddlers know about the words they are learning, more than how they learn words. This research branch has sought to explore the specificity of the representations infants and toddlers have stored in their lexicon.

2.2.1 Specificity of familiar words

It has been reported that infants recognise familiar word forms from as young as 11 months of age. Hallé and Boysson-Bardies (1994) utilised the Head Turn Preference Procedure (HTPP) and presented French learning infants with lists of either familiar or unfamiliar disyllabic words. Recognition for one word type over the other would be apparent by longer listening times to one list as compared to the other. At 12 months this preference for familiar over unfamiliar words was clearly evident and was emerging at 11 months. This suggests that infants have stored sound sequences as familiar words and that these can be accessed in the absence of any visual referent. In a further study Hallé and Boysson-Bardies (1996) examined how specific 11-month-olds' representation of these words were They used the same procedure as Hallé and Boysson-Bardies (1994), however this time the unfamiliar words were mispronunciations of the familiar words presented, with mispronunciations created by altering the initial phoneme by a single feature. Hallé and Boysson-Bardies (1996) found that French-learning infants did not identify the mispronunciations of these words, behaving similarly to unaltered and altered versions. From these results Hallé and Boysson-Bardies (1996) concluded that infants' initial representations of words are global and not specified enough that these differences are detected.

However, it has additionally been demonstrated that as young as 7.5 months of age infants are storing phonetic information alongside the words they are hearing. Jusczyk and Aslin (1995) demonstrate, using the Head Turn Preference Procedure (HTPP), that words segmented from speech contain enough detail that single feature mispronunciations do not elicit recognition responses. Jusczyk and Aslin (1995) familiarised American English infants to mispronunciations of isolated words, later included in their correctly pronounced form in sentences heard during the test phase. The mispronunciations of words were all created by manipulating the onset consonant of monosyllabic words by a single phonetic feature, e.g. 'cup' to 'tup'. If infants' representations lack phonetic detail then during the test phase they should listen longer to the sentences containing the correctly pronounced versions of the familiarisation words rather than untrained words such as 'zeet', a mispronunciation of feet. This was not the case: infants showed no preference for either set of sentences indicating that even at this young age their representations contain sufficient detail that a single-feature mispronunciation was insufficient for later recognition.

The findings of Hallé and Boysson-Bardies (1994, 1996) conflict with the results reported by Jusczyk and Aslin (1995): whereas the former showed no evidence of fine-grained phonetic representation in familiar words at 11 months, the latter found so at 7.5 months. Hallé and Boysson-Bardies (1996) propose two explanations for these disparate findings. Firstly there might be a general shift in infants' representations of words. Specifically, early representations would be well specified, as in Jusczyk and Aslin (1995), but as the infant begins to understand more words in the second half of the first year of life the stored representations would change to become more global and therefore less specified as in Hallé and Boysson-Bardies (1994, 1996).

The second explanation they propose is that language differences are influencing the performance of these toddlers. In French the typical stress pattern of words is iambic, that is, stress is placed on the second syllable of disyllabic words, whereas in English the typical word pattern is trochaic, with stress placed on the first syllable. This difference in exposure to language specific stress patterns during language learning could affect the specification of word initial consonants. English-learning infants might focus more on the initial consonant as this is the stressed segment of the word whereas the iambic nature of French may draw French-learning infants' attention away from the initial syllable and lead to less specified representations of word onsets. In both of these studies the word onsets are the site of the mispronunciations of the target words and thus the amount of attention paid to this segment of words would explain the difference in the reported results, with English infants succeeding earlier than French infants.

In a series of similar experiments, Vihman, Nakai, DePaolis, and Hallé (2004) explored the representation specificity in English-learning infants aged 9 and 11 months. They used an identical procedure to Hallé and Boysson-Bardies (1996), presenting infants with lists of familiar and unfamiliar English words using the HTPP, and found that at 11 months infants discriminated the lists of familiar and unfamiliar words but not at 9 months. In subsequent experiments Vihman et al. (2004) manipulated the stress pattern of familiar words or created mispronunciations of the word onset consonant or onset consonant of the second syllable in disyllabic words. In these experiments they found that toddlers ignored manipulations where the stress was altered, finding no discrimination when mis-stressed words were compared to either unfamiliar or typically stressed words. However, when mispronounced tokens were compared to unfamiliar or correctly pronounced tokens infants' recognition reflected their language experience. English learners did not discriminate familiar words from those that were mispronounced at the onset of the second unstressed syllable but did discriminate when the mispronunciation was in the word onset position. This finding offers support for the explanation of Hallé and Boysson-Bardies (1996) that stressed syllables are well specified but that unstressed syllables lack specification at the early stages of word learning.

Swingley (2005) reports similar findings with Dutch infants at 11 months of age, also using the HTPP. In this study infants heard lists of correctly produced familiar words alternated with lists of the same familiar words mispronounced on either the onset or coda consonant. Swingley (2005) found that infants listened longer to correctly pronounced words over incorrectly pronounced words only when mispronunciations were on the onset consonant, ignoring coda mispronunciations; listening times to both lists of words were similar. This suggests that toddlers' representations contain sufficient phonetic detail that onset mispronunciations on the stressed syllable are detected but that changes to the coda of the word are accepted as possible pronunciations of familiar words. The explanation offered by Swingley (2005), following that of Hallé and Boysson-Bardies (1996) and Vihman et al. (2004), is that infants' representations are initially specified on the stressed syllable with the unstressed syllable receiving less attention in these early stages, resulting in no preference for correct over coda mispronounced lists. A second, linked, suggestion is that representations are more generally less robust at this stage for word endings and as such mispronunciations are not reliably detected.

Currently the earliest age at which infants have been shown to detect mispronunciations in familiar words is 11 months (Swingley, 2005; Vihman et al., 2004) although this has limitations and does not include target recognition: these studies consider only word-form recognition in the absence of any visual referents. In order to specifically explore form-meaning mappings researchers have utilised the IPL paradigm. In typical IPL studies infants are presented with pairs of images on screen and hear a word at the mid-point of each trial. To test phonetic specificity the auditory stimulus presented is manipulated; the words that infants hear are produced correctly for the intended target image or incorrectly with one phoneme substituted for another. Longer looking times towards the target image following the auditory stimulus as compared to a baseline measure taken prior to the word onset are indicative of a naming effect, suggesting that toddlers have successfully associated the label with the image. For mispronunciation trials this increase in target looking time is reduced and in some cases, not found at all. Using this IPL paradigm the earliest age where mispronunciation detection has been found is at 12 months (Mani & Plunkett, 2010). Earlier than this there is no evidence of specification; actually Bergelson and Swingley (2013) report a lack of specification at 6-8 months in monosyllabic words, with infants looking longer at an image of an apple regardless of whether it was pronounced 'apple' or 'opal'.

In a seminal paper investigating sensitivity to mispronunciations, Swingley and Aslin (2000) used familiar words and tested toddlers aged 18-23 months. They were presented with pairs of familiar images and at the mid-point of the trial the target was named, either correctly or mispronounced by a single feature on the onset consonant. Although toddlers demonstrated recognition of the words regardless of whether they were correctly produced or not, the correct words were recognised significantly better than the mispronounced words. These differences were taken as evidence that from the age of 18 months toddlers' representations of familiar words are sufficiently well specified that single feature deviations are not accepted as suitable labels for the target image. These results were supported by Swingley and Aslin (2002) who demonstrated the same effect in toddlers aged 14 months and extended this further to show that both 1 feature and 2 feature mispronunciations yielded the same negative impact on target recognition. This follow-up study by Swingley and Aslin (2002) sought to identify whether the specificity of the representations of toddlers was related to the neighbourhood density of the words being mispronounced. The absence of a neighbourhood effect led to the conclusion that infants' representations are not specified as a result of necessity - they have successfully learned many similar sounding words - but are well specified from the early stages of word learning.

To confirm this suggestion that words are well specified from the early stages of acquisition Bailey and Plunkett (2002) tested target recognition of well-known as well as newly learned words. Using the same IPL paradigm as Swingley and Aslin (2000, 2002) they presented 18 and 24 month toddlers with pairs of familiar pictures where the target was correctly and incorrectly named. In addition Bailey and Plunkett (2002) controlled when target word were acquired by toddlers using a parental report measure, separating trials into well- known and newly-learned words. By doing this it was possible to identify whether specificity was related to experience with the test words, as newly learned words may incorporate a lesser degree of specification until toddlers have amassed sufficient experience with the items. Toddlers successfully identified the target when it was correctly pronounced for both well-known and newly acquired words. When mispronounced token were heard recognition of both newly learned and well known words was negatively affected, as indicated by no preference for the target image over the distracter. From these results it was concluded that, as suggested by Swingley and Aslin (2002), toddlers' lexical representations are well specified from the early encounters with a word.

Further research has sought to identify whether mispronunciations in positions other than word onset lead to the same effects. Mani and Plunkett (2007) used the IPL paradigm to examine whether toddlers are equally sensitive to both word onset and word medial mispronunciations. They found that infants aged 15, 18 and 24 months failed to demonstrate target recognition for any of the mispronunciation trials and proposed that toddlers' representations are well specified for both these positions. Specification of words beyond the onset consonant can be seen in Mani and Plunkett (2010) who found that infants at 12 months were overall equally sensitive to onset consonant and medial vowel mispronunciations of familiar words. It has also been demonstrated that word medial consonants on the onset of the second syllable of disyllabic words are as well specified as word onsets in Dutch (Swingley, 2003), as reduced recognition of the target image following mispronunciations in both positions is found in Dutch toddlers.

The last position investigated in the mispronunciation literature is the word final syllable coda position. This position could be more difficult for toddlers to process, particularly in English and other trochaic languages, as this is typically the unstressed portion of the word; mispronunciations in this position are usually more difficult for adults to identify (Redford & Diehl, 1999). Additionally many more minimal pair words differ on the onset consonant e.g. 'big'-'pig'-'dig', than the later segments e.g. 'cat'-'cap'-'car' (Swingley, 2009) requiring infants to learn to discriminate words differing on the onset sooner than those differing on the coda (Swingley, 2009). A final explanation for the difficulty associated with coda mispronunciation detection is that in an IPL task toddlers may fixate the target before the word is completely articulated prior to detecting a coda mismatch. Indeed accumulated evidence suggests that toddlers, like adults, interpret speech incrementally (e.g. Swingley, Pinto, & Fernald, 1999) and as such may have discarded the distracter image as a contender for the auditory stimulus before the coda mispronunciation occurs. Indeed, in a further IPL study with toddlers aged from 14-22 months Swingley (2009) demonstrated that coda mispronunciations are as well specified as onset mispronunciations when provided with the opportunity to demonstrate this specificity. Toddlers' recognition of the target was negatively affected when words were mispronounced in both the onset and the coda position. Similarly, Ren and Morgan (2011) present evidence that coda mispronunciations impact recognition of a target in 14 and 22 month infants using an IPL task. Taken together these studies demonstrate that familiar words are well specified in the lexicon of infants as English or Dutch learning toddlers are able to detect mispronunciations in all word positions.

In addition to single feature mispronunciations, research has explored the types of mispronunciations tested in terms of phonetic features. Mani and Plunkett (2010) introduced mispronunciations to the medial vowel of familiar words and included different types of feature change. They found that toddlers aged 12 months were sensitive to all medial vowel mispronunciations, height, backness, and roundedness. In contrast, for onset consonant mispronunciations only place and manner changes affected target recognition, whereas changes to the voicing of the onset consonant were followed by increased target fixation. In contrast, White and Morgan (2008) identified graded sensitivity to the number of feature changes used to create onset mispronunciations of familiar words using an IPL task when pairing familiar targets with unfamiliar distracters. They found that recognition deteriorated relative to the degree of mismatch between the word and its intended target.

The disparity between the results of these studies could be explained by the different ages tested or by the use of unfamiliar distracters. The toddlers tested by White and Morgan (2008) are older than those tested by Mani and Plunkett (2010), this points to a developmental trend with sensitivity to consonant voicing changes developing later. Additionally, there were procedural differences: White and Morgan (2008) presented toddlers with unfamiliar distracters whereas Mani and Plunkett (2010) used familiar objects as distracters. White and Morgan (2008) claim that the use of unfamiliar distracters allowed children to demonstrate graded sensitivity as toddlers could not use the name of the distracter to guide their looking behaviour. For example, , when 'ball' is mispronounced as 'gall' in the presence of the images of a 'ball' and a 'bus', toddlers interpret 'gall' as 'ball' because of its dissimilarity to bus whose label is known to them. If they are presented with a picture of a ball and an unknown object such as a garlic press, they might attach 'gall' to the garlic press for which they have no name yet, discarding the ball as a candidate. Therefore this experiment provided more opportunities for toddlers to display a graded sensitivity to mispronunciations than the typical IPL studies.

Furthermore, Ren and Morgan (2011) used the White and Morgan (2008) unfamiliar distracters paradigm to test 14 and 22 month olds' sensitivity to mispronunciations of the coda consonant. They also observed a graded sensitivity to mispronunciations based on the number of feature changes suggesting that infants are differentially sensitive to mispronunciations as a function of the number of feature changes in the coda position, similarly to word onsets. Taken together the results from White and Morgan (2008) and Ren and Morgan (2011) suggest that the degree of specification of toddlers' representations is consistent across word positions, with all positions equally well specified by the middle of the second year. It is also apparent from these findings that toddlers detect the difference across the number of feature changes but the typical familiar target and distracter pairs used in with IPL do not allow for this ability to be demonstrated.

One interesting point to consider is that although a mispronunciation in the coda position has a negative effect on word recognition, complete omission of the coda does not (Fernald, Swingley, & Pinto, 2001). In this study infants were presented with the complete word-form or only the first 300ms in a typical IPL task. Toddlers aged 18 months showed no negative impact in the accuracy and speed of recognition of the intended target when the coda of the word was omitted. Considering these studies together there seems to be some disparity in the use of information in the coda position during word recognition. The findings presented by Fernald et al. (2001) suggest that this information is not necessary for recognition of familiar words whilst the findings from Ren and Morgan (2011) and (Swingley, 2009) suggest that the coda position is as well specified in the lexicon as any other position in the word.

In summary, from the age of 12 months infants' representations of familiar words are stored with enough detail that they are sensitive to even single feature mispronunciations in all word positions, even for newly acquired words. This sensitivity to deviations from the canonical form of words is consistent across differing degrees of mispronunciation in the presence of a target image and a familiar distracter. However, when adding an unfamiliar distracter evidence of graded sensitivity to mispronunciations is identified. A follow-up question is whether the same precise phonological representation abilities apply during the process of learning new words.

2.2.2 Specificity of novel words

The evidence presented thus far demonstrates clearly that once infants have acquired a word, even newly learned words (Bailey & Plunkett, 2002); they are able to detect mispronunciations across a range of situations. In order to evaluate whether the representations of words in the infant lexicon are well specified from the onset of word learning studies have turned to novel word learning paradigms. In these studies toddlers are taught new form-meaning mappings during the course of the experiment and subsequently tested on their ability to detect mispronunciations or deviations from this novel word-form.

Werker, Cohen, Lloyd, Casasola, and Stager (1998) demonstrated that toddlers have the ability to learn novel words and link them to a referent during the experimental procedure as young as 14 months. Using a Switch task 14 month toddlers were taught the novel word-object pairings 'lif' and 'neem'. Following this learning phase toddlers were tested on 'same' and 'switch' trials. In 'same' trials the object and word matched those presented during the training phase, whereas for 'switch' trials the object and word mismatched, e.g. the word 'lif' was paired with the object previously named 'neem'. If toddlers successfully learned the word object pairings they should look longer during the switch trials as these violate their expectations. This is exactly what was observed by Werker et al. (1998): toddlers looked longer during switch trials than they did during same trials, indicating that they had noticed the violation. This pattern of behaviour clearly shows that toddlers had successfully learned the word-object pairings from the learning phase. Whilst this study demonstrates toddlers' ability to learn form-meaning mappings rapidly during the experimental procedure, it doesn't explore the nature of the specificity of the representations formed during learning.

The first study to investigate the specificity of novel words was carried out by Stager and Werker (1997). They demonstrated that at 14 months toddlers did not store sufficient phonetic detail about novel words and failed to detect a switch during the test phase. Stager and Werker (1997) trained toddlers on the novel word-object pairings 'bih' and 'dih' and then tested them with 'switch' and 'same' trials. Whether toddlers were trained on both word-objects pairings or with a simpler version of this task where only one pairing was taught and testing was made with the violation of this pair, they did not look longer during switch trials. This absence of a difference between switch and same trials was taken as evidence that toddlers had not detected the change to the word. The change presented to infants was a single feature change of the type successfully discriminated at 12 months in familiar words (Mani & Plunkett, 2010). In order to confirm that infants were able to successfully discriminate the 'b'/'d' contrast Stager and Werker (1997) tested toddlers at 14 months without a visual referent. This led Stager and Werker (1997) to propose that it is not the contrast per se but an inability to discriminate this contrast during a word learning task that led to a lack of specificity for novel words during switch trials. The cognitive demands of the word learning tasks were such that the resulting representations lacked specificity.

The proposal that task demands are the driving force behind toddlers' failure is supported by evidence from Werker et al. (2002). They presented the same task to toddlers at 14, 17, and 20 months, training them on two novel word-object pairings. As expected the 20 month old toddlers detected the violation in the switch trials and looked longer than during the same trials; in this group the toddlers have increased cognitive abilities allowing them to manage the task. Toddlers succeeded at 17 months although task performance was moderated by their comprehensive vocabulary: toddlers with 200 or more words succeeded in detecting the switch. This study suggests that there is a developmental process influencing task performance, the cognitive demands of the task presenting less of a challenge for more experienced word learners.

In the studies discussed so far the same single feature change was used to distinguish the stimuli, however toddlers at 14 months may respond differently to different types of change (Mani & Plunkett, 2010) and to multiple feature changes (White & Morgan, 2008). Pater, Stager, and Werker (2004) tested infants on a different pairing and the inclusion of a coda consonant ('bih' to 'bin') to make the stimuli more naturalistic. They presented infants with the same place change used in the earlier studies ('bin'/'din'), and additionally added a voicing change ('bin'/'pin') and a combination of both voicing and place changes ('din'/'pin') equivalent to a two feature mispronunciation. They found that toddlers at 14 months failed to detect the violation in the switch trials across any of the manipulations suggesting that it is not a feature of the selected auditory stimuli that explained the failure of infants in this task. In particular, for the voicing and two feature change conditions, toddlers were tested in the simpler procedure, with only a single word-object pairing during the training phase. When considering the findings of these studies it would seem that toddlers fail to encode newly learned words with enough specificity that they can detect a mispronunciation of this word affecting the onset consonant.

Evidence from IPL studies presents a slightly different picture of toddlers' abilities to detect changes in the pronunciation of novel words first encountered during the experiment. Ballem and Plunkett (2005) found that 14 month old toddlers taught two novel words prior to testing in the IPL task demonstrated recognition only for the correctly produced tokens, similarly to familiar words. Following correct pronunciations of both newly learned and familiar words toddlers successfully identified the target. Specifically, performance on correctly pronounced and mispronounced familiar trials was significantly different. In contrast, when hearing mispronunciations of newly learned words toddlers showed no target preference; however, performance on correctly pronounced and mispronounced newly learned word trials did not differ significantly. This suggests that although target recognition was not found in the mispronounced trials, performance was similar to correct trials for newly learned words. This study demonstrates that mispronunciations of newly learned words are detected less well than those of familiar words, but that they are detected nonetheless.

Mani, Coleman, and Plunkett (2008) report a similar finding extending this to vowels in a word medial position of a novel word. Once again toddlers displayed a preference for the target when the word was produced correctly and not when mispronounced. This is evidence that toddlers have sufficiently encoded the phonetic details of novel words in the training phase that they do not accept the mispronunciation for the object. The fact that the mispronunciation effect is stronger for familiar word trials, as compared to the newly learned word trials, (as evidenced by the significant difference between correct and mispronounced trials) in Ballem and Plunkett (2005) suggests that representations are refined over time with greater exposure leading to a more robust encoding once words are well-known.

An alternative finding comes from a study with 18 month old Dutch learning toddlers who fixated the target image even when hearing a mispronunciation (Swingley, 2007). During a pre-exposure phase toddlers watched an animated story where a novel word was heard but not attached to any object. Following this there was a training phase where toddlers were explicitly taught a novel word–object pairing. There were two groups of toddlers, those who had previously heard the word in the pre-exposure phase and those who heard a completely new word paired with the object. After this word learning phase they were tested on correct and incorrect pronunciations of this word in an IPL task. For those toddlers who encountered the novel word for the first time during the testing there was no difference in performance between correct and mispronounced trials: toddlers treated the mispronounced variant as an acceptable exemplar for the target word. In contrast, toddlers who heard the new word during the pre-exposure phase better recognised the mispronunciations and did not look towards the target.

At first glance the findings of Swingley (2007) and Ballem and Plunkett (2005) seem contradictory: Swingley (2007) found that toddlers' newly learned word representations were poorly specified unless they had prior exposure with a word, whereas Ballem and Plunkett (2005) showed that representations of novel words were well specified. However, under closer inspection they present a similar picture; no difference is observed between correct and incorrect pronunciations of newly learned words in either case when compared to performance with correct pronunciations, although no naming effect for mispronunciations is found in Ballem and Plunkett (2005). The key difference between these studies was that toddlers' success in Swingley (2007) was determined by the pre-exposure phase, which was missing in Ballem and Plunkett (2005). It was only when toddlers had brief prior experience with the word encountered during the test phase that they succeeded in this task in Swingley (2007).

The combined results of these studies show that toddlers' newly learned words are less well represented than familiar words but that explicit pairing with an object is not necessary, simple exposure to the word form is sufficient for infants to build a specified representation.

In addition to the extra exposure the toddlers in Swingley (2007) had with the novel words, they were also 4 months older than those in Ballem and Plunkett (2005). Intuitively this should lead to a prediction of better mispronunciation detection in older toddlers, however, the reverse was found, with the younger toddlers in Ballem and Plunkett (2005) showing better mispronunciation detection than the older infants of Swingley (2007). This age difference suggests, unexpectedly, that as toddlers learn more words their newly learned representations are less well specified than when they know fewer words. One explanation for the improved detection of the mispronunciations by the younger toddlers relates to the developmental stage they are at in their word learning journey. At 14 months of age toddlers have not yet entered the vocabulary spurt and so may focus primarily on the specific features of the words whereas 18 month old toddlers are at a stage where they are acquiring many words rapidly, potentially at the expense of phonological encoding.

There is some disparity between the results from the Switch and the IPL tasks with toddlers demonstrating at least a rudimentary ability to identify mispronunciations of newly learned words in the simpler IPL task. Recall that in the Switch task Stager and Werker (1997) found that toddlers were unable to identify a single feature switch to a newly learned word-object pairing until 17 months. However, Fennell, Waxman, and Weisleder (2007) present evidence suggesting that it is not as clear cut as a task specific explanation. They added a familiar object training phase to the Switch task to familiarise toddlers with the fact that a single word could act as the name of the object. Following this brief training, infants were able to detect a minimal change in a single novel word-object pairing. Further support for the claim that task demands influence toddlers' ability to utilise phonetic information is seen in the Switch task when a carrier sentence, e.g. 'Look at the *X*', is added during the training phase (Fennell & Waxman, 2010). When all other aspects of the procedure remain the same but this additional referential cue, toddlers demonstrate successful discrimination of the single feature change to the newly learned word at 14 months. This same success is not found when the additional information is non-referential, e.g. 'Wow'.

Finally, Fennell (2012) presents evidence that it is not only familiarity with the word form that improves performance in identifying pronunciation changes in novel words; object familiarity can also improve discrimination. In this study, toddlers aged 14 months were either pre-exposed to an object regularly before the study or encountered the object for the first time on the day of testing. The toddlers were taught the name for the object during the experimental session and tested using the Switch task to identify whether they were able to identify the altered label for the object. The group of toddlers who had been pre-exposed to the object succeeded in this task suggesting that the effects of familiarity are not exclusive to the word-form but extend to the object itself.

Studies showing improvements when the task is simplified either by reducing the amount of novelty the toddler is required to contend with or by reducing the demands of the task itself demonstrate that toddlers' representations of newly learned words can be phonetically well-specified. In all of these cases the additional cues provided are likely to be those toddlers experience naturalistically when learning new words; parents will likely use referential phrases rather than present words in isolation - indeed only 9% of child directed speech is made up of isolated words (Brent & Siskind, 2001). It is also likely that toddler would hear word forms before linking them to a referent and observe objects before learning their label.

2.2.3 Summary

Upon hearing an auditory label infants as young as 6 months old fixate the correct image providing they have some experience with the word. A number of studies have demonstrated that performance can be negatively influenced simply by changing one of the sounds in the word and creating a mispronunciation. The age at which mispronunciations affect toddlers is not yet determined definitively; at 6-9 months mispronunciations are accepted as exemplars of the target in an IPL task (Bergelson & Swingley, 2013) but not at 12 months in the same task (Mani & Plunkett, 2010). In a different task, the HTPP, mispronunciations affect 7.5-month-old toddlers' recognition of words learnt during the experiment (Jusczyk & Aslin, 1995). However, with the same HTPP task, discrimination of mispronunciations from correct pronunciations and unfamiliar words is not reported until 11 months (Hallé & Boysson-Bardies, 1994, 1996). Once mispronunciations are detected, performance is moderated by a number of other factors, including the number of feature changes used to create the mispronunciation (Mani & Plunkett, 2007, 2010; White & Morgan, 2008), the demands of the task (e.g. Fennell & Waxman, 2010; Werker et al., 1998) and the position of the mispronunciation in the word (e.g. Ren & Morgan, 2011; Swingley, 2005, 2009), with stressed syllables initially more specified than unstressed syllables (Swingley, 2005; Vihman et al., 2004)

Representation specificity is refined over time with well-known familiar words sufficiently encoded that mispronunciations are readily identified, whereas words encountered for the first time during the experimental situation are not afforded the same level of specificity (Ballem & Plunkett, 2005). More specifically, experience with the word forms or the objects themselves rather than the referential context dictates successful performance (e.g. Fennell, 2012; Fennell & Waxman, 2010; Swingley, 2007).

The evidence presented thus far demonstrates that monolingual toddlers are learning the meaning of words and representing them precisely in the lexicon. However, monolingual infants are only a subset of language learners and many learners grow up multilingually, learning 2 of more languages concurrently. To gain a complete picture of word learning in infancy the development of bilinguals must be considered, as for these toddlers the task of learning language is considerably different.

2.3 Bilingual infants

Bilingual language learners face a different set of challenges as compared to their monolingual counterparts. Monolingual infants need to learn a single set of phonemes, morphology and grammatical rules, whereas, in stark contrast, the bilingual infant is faced with two sets of each to learn, with commonalities and differences across them. In addition to this they need to identify the language being spoken at any given time and learn to violate the assumption that each object has a single label (Markman & Wachtel, 1988); indeed for the bilingual learner all objects have two names – one for each of their languages. Yet despite these differences in task complexity bilingual children succeed in acquiring both languages to which they are exposed, often reaching native proficiency in both.

2.3.1 Developmental trajectory: similarities and differences between monolingual and bilingual populations

The existence of differences between the developmental trajectories of monolingual and bilingual language acquisition is a hotly debated topic. In many ways the general pattern of language development between these two groups of infants is comparable, they pass critical milestones at similar ages (de Houwer, 1995; Oller et al., 1997; Pearson & Fernández, 1994; Petitto et al., 2001) and when the vocabulary scores of both languages are combined for bilingual infants, they are found to be comparable to those of monolingual peers (Hoff et al., 2012). In a word-object association task, when the words are distinct from each other, performance in monolingual and bilingual infants is equivalent (Byers-Heinlein, Fennell, & Werker, 2013). Using a Switch task toddlers were familiarised to the novel word-object pairings ('lif' and 'neem'). At 12 months of age both groups of infants, monolingual and bilingual, looked equally to switch and same trials, suggesting they had not formed word-object associations at this age. However, by 14 months both monolingual and bilingual infants demonstrated successful and comparable performance in this task, with longer looking times during switch trials. This result suggests that, when tested with dissimilar sounding words, the ability to form word-object associations is equivalent irrespective of the number of languages being learned and that the general task of word learning is not adversely affected by growing up bilingually.

2.3.1.1 Differences in phonetic specificity

This comparable performance with phonologically distinct words does not carry over when minimal pair words are examined. When investigating the degree of specificity in the representation of novel words across monolingual and bilingual populations, differences are apparent, with bilingual toddlers detecting minimal changes between words later than their monolingual peers (Fennell, Waxman, et al., 2007; Werker et al., 2002). Using the Switch task with minimal pair words 'bih' and 'dih', that differ only on the initial phoneme, monolingual and bilingual children successfully identify the switch at different ages: 17 months for monolinguals (Werker et al., 2002) and 20 months for bilinguals (Fennell, Byers-Heinlein, et al., 2007). This suggests that the phonological specification of the lexicon when learning word-object associations occurs later in bilingual toddlers despite there being no difference in the performance of monolingual and bilingual populations when the words are sufficiently dissimilar (Byers-Heinlein & Fennell, 2014).

Further evidence for differences in phonetic encoding between monolingual and bilingual populations is identified in Spanish and Catalan infants (Bosch & Sebastián-Gallés, 2003). Monolingual Catalan and Spanish infants were tested alongside Spanish-Catalan bilinguals on a contrast that is found only in Catalan, /e/ - /ɛ/. Using a typical head-turn preference procedure, infants were habituated to one of the vowel sounds and then presented with the unheard vowel in the test phase. Looking longer when the change occurs is taken as evidence that they have noticed the difference between the two stimulus types. At 4 months of age all infants successfully discriminated the two forms, as expected due to a general ability to discriminate all possible phonemes at this age, an ability which disappears as infants begin to fine tune their phonetic repertoire, beginning with vowels at around 6 months of age (Kuhl, Williams, Lacerda, Stevens, & Lindblom, 1992), to the consonants required for their native language by the end of the first year of life (Werker & Tees, 1984).

The same procedure and contrast was also tested at 8 months, with Catalan monolingual infants, for whom the contrast is relevant, being successful whereas Spanish monolingual infants failed. This is precisely what is expected for monolinguals as by this age, infants typically start to retain the vocalic sounds of the native language (Kuhl et al., 1992). Interestingly, the Catalan-Spanish bilinguals also failed to discriminate this contrast at 8 months, despite it being relevant to one of the languages they were learning. Further testing at 12 months identified that the ability to discriminate these two vowels had reappeared in bilingual infants, creating a U-shaped pattern of development. The authors suggest that this decline in performance at 8 months is evidence that bilinguals lag behind monolinguals in the process of attuning to vowel contrasts relevant for only one of the languages they are learning. This U shaped pattern of development demonstrates clear differences in the specificity of the representations these infants have for their native language(s) when growing up bilingual.

The discrimination of the /e/ - /ɛ/ contrast in bilingual Catalan-Spanish learners has been explored further with 22 month old infants using an IPL task (Ramon-Casas et al., 2009). Recognition of familiar words was tested following either correct pronunciations or mispronunciations created by substituting /e/ - /ɛ/ or the reverse. All of the words tested were cognate words in the two languages: they shared some phonology and meaning, e.g. Catalan [gə'lɛtə] and Spanish [ga'λeta] both meaning cookie. In the monolingual groups from each language, toddlers fixated the target above chance when hearing both correct and incorrect pronunciations of familiar words. However, Catalan monolingual toddlers' performance across the two trial types, correct and mispronounced, differed. Ramon-Casas et al. (2009) suggest that this is indicative of the identification of the mispronunciation although this is not sufficient for these toddlers to reject the target entirely. In bilingual toddlers target recognition was found for both pronunciations and like the Spanish monolingual toddlers there was no difference identified in performance between the two trial types. What was identified in the bilingual toddlers was a correlation between performance and the amount of exposure to each language, with Catalan dominant toddlers demonstrating performance most like Catalan monolingual toddlers and Spanish dominant bilinguals responding most like Spanish monolinguals. The explanation put forward for these results by Ramon-Casas et al. (2009) is that bilingual toddlers exposed to variation in this vowel distribution have learned to use it when differentiating two words in Catalan where this is the only distinction, but have additionally learnt to overcome this variation in other situations.

To further explore infants' performance with this contrast, Albareda-Castellot et al. (2011) re-tested Catalan-Spanish infants' discrimination of the /e/ - /ɛ/ distinction with a simpler procedure. They found that all toddlers were successful when task demands were reduced. In this study 8 month old infants were not required to discriminate directly between the two variants; instead they were required to anticipate the location of the emergence of a visual stimulus from behind an occlusion on the screen. Using this Anticipatory Eye Movement (AEM) paradigm, infants were presented with a visual stimulus that appeared at one of two locations contingent with an accompanying auditory stimulus, in this case the /e/ or /ɛ/. If infants looked to the location where the visual stimulus would appear prior to its emergence upon hearing the auditory stimulus, this would suggest that they have learned the contingency and are able to discriminate the contrast. Alternatively, no evidence of anticipatory looking would indicate that infants are treating both auditory stimuli similarly. Using this simplified task Catalan-Spanish bilingual infants demonstrated an ability to discriminate the contrast, which was previously demonstrated only by their monolingual Catalan counterparts. This suggests that reduced task demands, in comparison with the Bosch and Sebastián-Gallés (2003) methodology, allowed bilingual infants to demonstrate performance akin to their monolingual peers.

These results are comparable to those of Sundara, Polka, and Molnar (2008) where equal discrimination abilities were found between monolingual and bilingual toddlers. Looking at a different language pairing, French and English, Sundara et al. (2008) present evidence that French-English bilingual infants aged 6-8 and 10-12 months successfully discriminated two highly frequent phones, despite overlap in their distribution across the two languages. They tested infants on French and English versions of /dæ/ which is dental in French and alveolar in English (manner of production). Based on the results presented by Bosch and Sebastián-Gallés (2003), a delay in the discrimination of this contrast would be expected in bilingual toddlers and not monolingual toddlers. They used an infant controlled habituation procedure where infants engaged in a series of habituation and test sequences. During the habituation phase infants heard tokens of either the French or English /dæ/ syllables and then at test heard both variants. If infants are able to discriminate the English and French variants then listening times should increase during the test phase for only the novel stimulus, namely the one not heard during habituation. At 6-8 months, monolingual English and French groups and French-English bilingual infants demonstrated successful discrimination of these variants of /d/. At 10-12 months, only monolingual English infants and bilingual French-English infants discriminated the contrast, as expected based on adult findings (Sundara & Polka, 2008). This demonstrates that the developmental time course of phonetic perception in bilingual infants, rather than being slowed down in a general way, is moderated by the properties of their input. This explanation would also account for the results of the Catalan-Spanish studies where the input of each language mediated the mispronunciation effects (Ramon-Casas et al., 2009).

2.3.1.2 Differences in word learning

Other differences in the performance of monolingual and bilingual infants are found when examining the use of the Mutual Exclusivity constraint. It has been demonstrated that monolingual infants aged 17 months employ this strategy as a means of learning new words (Halberda, 2003). However, in a methodologically similar study it has been demonstrated that bilingual infants do not demonstrate the use of this strategy (Byers-Heinlein & Werker, 2009; Houston-Price, Caloghiris, & Raviglione, 2010). These studies presented toddlers, in an IPL paradigm, with three types of trials: either the target and distracter objects were known (KK trials), only the target object was known (KU trials), or the target object was unknown and the distracter familiar (UK trials). The critical trials were the UK trials where the unknown target was labelled ‘dax’; if toddlers use the Mutual Exclusivity bias they should look longer at the novel object in this condition. Houston-Price et al. (2010) found exactly this pattern of looking in a group of 17-22 month old monolingual toddlers; however, bilingual infants did not demonstrate the use of this strategy at the same age. This is an unsurprising result when considering the language environment of the bilingual infant. For these infants the Mutual Exclusivity principle is frequently violated as all of the objects they encounter have at least two labels, one for each of the languages they are learning.

This result is further supported by findings from Byers-Heinlein and Werker (2009) who used the same procedure and reported that the more languages toddlers are learning the less likely they are to use this strategy. They demonstrated clear evidence of monolingual toddlers using this strategy reliably at 17-18 months, whereas bilingual toddlers showed some inconsistent use. A final trilingual group of toddlers showed no use of this strategy at all. This suggests two possible explanations, firstly that multilingual children have learned, based on their language exposure, that Mutual Exclusivity is not a useful strategy for them to use to learn words or second, that this strategy is learned by monolinguals and not by bilinguals.

2.3.2 Explaining the performance differences between monolingual and bilingual populations

The evidence presented above demonstrates that despite there being a number of similarities between the developmental trajectories of monolingual and bilingual children's language development, there are also a number of divergent findings. A number of proposals attempting to explain the underlying reasons for these apparent delays in some areas of the bilingual toddlers' development have been put forward. These focus on the difficulty of the task faced by the bilingual toddler, the commonalities between languages as creating ambiguity and the influence of the variability to which bilingual language learners are exposed across both of their languages.

2.3.2.1 Cognitive limitations hypothesis

Fennell, Byers-Heinlein, et al. (2007) suggest that the differences between monolingual and bilingual populations can be attributed to resource limitations as a result of the increased cognitive demands faced by bilingual infants. It has been reported that bilingual toddlers can demonstrate success in some domains when task demands are reduced (Albareda-Castellot et al., 2011; Byers-Heinlein & Werker, 2009; Werker et al., 1998). Even before considering task demands specific to the experimental design the bilingual language learners are required to, simultaneously, acquire the two lexicons of the languages they are learning, establish a phonetic/phonological repertoire for each and identify which is relevant at any given time. In order to succeed in, for example, the Switch task, they must access the relevant phonemic units of the word, recognise them, hold both of these in memory and link the phonemic string to the correct object. This high cognitive demand, added to the resource load needed by virtue of being bilingual, may lead to the differences in performance that are observed. This hypothesis, termed the cognitive limitations hypothesis (Werker & Fennell, 2004), is supported by findings that 14 month old monolingual infants can identify a minimal pair change (e.g. /bih/ versus /dih/) associated to a novel object only when the task is simplified so that toddlers are required to learn only a single novel word-object pairing (Werker et al., 2002).

It should be reminded that further support for cognitive limitations affecting the performance of bilingual toddlers comes from Albareda-Castellot et al. (2011) who used an AEM paradigm to test for the discrimination of the same Catalan specific vowel contrast (/e/-/ɛ/) that bilingual infants failed to discriminate at 8 months (Bosch & Sebastián-Gallés, 2003). Using this simplified task Catalan-Spanish bilingual infants demonstrated an ability to discriminate the contrast, showing similar performance to that previously observed in their monolingual Catalan counterparts. This lends support to a resource limitations explanation for the earlier results of Bosch and Sebastián-Gallés (2003), as reduced task demands allowed bilingual infants to demonstrate performance akin to their monolingual peers.

2.3.2.2 Shared cognates explanation

A second explanation for the bilingual findings that has been proposed relates to the number of shared cognates between the two languages of the bilingual infant. Cognate words are those words that share their meaning and most of their phonetic information, e. g. the English word 'apple' and the German 'Apfel'. It has been suggested that phonetic discrimination is more difficult for bilingual infants whose languages have a high number of cognate words (Ramon-Casas & Bosch, 2010). Using a traditional IPL procedure Ramon-Casas et al. (2009) presented monolingual Spanish or Catalan and bilingual Spanish-Catalan toddlers with mispronunciations of cognate words, using the /e/ - /ɛ/ contrast that has proved problematic for this population in previous studies (Bosch & Sebastián-Gallés, 2003). As expected all infants looked longer at the target following the correct pronunciations of the words. However, only the monolingual Catalan toddlers rejected the incorrect pronunciations, while both the bilingual infants and the Spanish monolingual infants looked longer at the target, even when hearing mispronunciations. This performance was mediated in the bilingual group by the amount of exposure to each language, with Catalan dominant toddlers showing performance in the same direction as Catalan monolinguals.

The fact that the mispronunciations were created using a contrast that is not lexically contrastive for the Spanish learning infants would explain the pattern of results observed in this group, that is, no target recognition. However, for the Spanish-Catalan bilingual infants the change is contrastive in one of their languages so it would be expected that they should identify the mispronunciation. Interestingly, when tested with non-cognate Catalan words with the same mispronunciation, Spanish-Catalan bilinguals responded as expected, looking longer at the target only when hearing correct pronunciations (Ramon-Casas & Bosch, 2010). Following this it would seem that the failure to detect mispronunciations is specifically related to the cognate words: when words are not cognates the performance of all infants is comparable. In fact the mispronunciation effect for these cognate words is not observed in Catalan dominant toddlers until 3-4 years and never in Spanish dominant bilingual (Ramon-Casas et al., 2009), yet all infants show a discrimination effect for /e/-/a/ and /e/-/i/ mispronunciations. This further supports the claim that cognate words are problematic for bilingual infants' discrimination of a lexically relevant vowel contrast.

2.3.2.3 Variable input hypothesis

As a final explanation for the performance differences, it has been proposed that bilingual learners are challenged by the high amount of acoustic variability they have to process, more than by the fact that they have to learn two language systems. The bilingual listener hears a wider range of phonemes from their input, natural variation due to the differing phoneme inventories of each of the languages they are learning but also variation in the realisation of these phonemes within each of the languages. For example a child with a French speaking mother and an English speaking father is likely to hear, in addition to the two languages, French accented English from the mother and English accented French from the father. Bosch (2010) suggests that this variation may negatively affect the stabilisation of phonetic boundaries in the early lexicon and that variability be considered systematically as a factor contributing to the later successes observed in bilinguals. Currently the bilingual literature considers only how much of each language the infant is exposed to and which parent speaks which language without systematically calculating the variability within each language (but see Cattani et al., accepted).

To date there is only one study exploring the influence of variable pronunciations of words in bilingual toddlers. Mattock, Polka, Rvachew, and Krehm (2010) tested 17 months French and English monolinguals and French-English bilinguals using a Switch task with the novel words 'bowce' and 'gowce'. This minimal pair /b/-/g/ was chosen as it is phonemic in both French and English. During training 6 tokens of each word were presented, three were French pronunciations and 3 were English. Interestingly, when presented with these variable tokens, monolingual toddlers did not detect the switch whereas bilingual toddlers did. This finding is surprising given the previous literature that demonstrates that bilingual toddlers have difficulties in tasks with minimal pairs at this age whereas monolingual children succeed (Fennell, Byers-Heinlein, et al., 2007; Werker et al., 2002). Any predicted difference would have been in the opposite direction: monolingual toddlers would succeed and bilingual toddlers would fail in discriminating this contrast.

In order to explain this unusual finding Mattock et al. (2010) presented monolingual French and English learning toddlers with language matched tokens in the same task, that is, monolingual French toddlers heard 6 French tokens and monolingual English toddlers heard 6 English tokens. Given this manipulation monolingual toddlers identified the violation in the switch trials demonstrating discrimination of the /b/-/g/ contrast, suggesting that the lack of discrimination previously observed was related to the variability of the test tokens and not to a lack of discrimination in the monolingual population. A third study ruled out the possibility that this was simply a frequency driven effect, due to hearing 6 similar tokens, by presenting French monolingual toddlers with English pronounced tokens. In this final condition the French toddlers failed to notice the violation, suggesting that the non-native pronunciations of the words were problematic. This study clearly demonstrates the influence of variability on the performance of both monolingual and bilingual toddlers. A facilitative effect was observed for all toddlers when the stimuli in the training phase reflected the conditions of the language exposure: monolinguals did better with a single language, and bilinguals did better with a mix of two languages.

2.3.3 Summary

The overall pattern of development in monolingual and bilingual toddlers is generally comparable; however differences emerge when considering the specific skills of the language learners. In bilingual toddlers the ability to discriminate minimal pair words occurs later than for monolinguals (e.g. Fennell, Byers-Heinlein, et al., 2007; Werker et al., 2002) as does the ability to discriminate some linguistically relevant phonological contrasts (Bosch & Sebastián-Gallés, 2003; Ramon-Casas & Bosch, 2010; Ramon-Casas et al., 2009). Although this performance is moderated by a range of factors including the task used and the properties of the input (Albareda-Castellot et al., 2011; Mattock et al., 2010), this suggests that learning two languages initially presents challenges in some areas. In order to explain these differences three proposals have been offered, the first relates to the demands of the task facing bilingual toddlers learning two languages concurrently (Fennell, Byers-Heinlein, et al., 2007). The second focuses on the commonalities between the two languages being learned and suggests that the number of shared cognates between the languages influences performance (Ramon-Casas & Bosch, 2010; Ramon-Casas et al., 2009). Finally, increased exposure to variable input could be responsible for a delay in bilingual toddlers as compared to monolingual toddlers who hear consistent input from speech (Bosch, 2010).

Currently none of these explanations are able to entirely account for the performance differences identified in monolingual and bilingual populations. This thesis seeks to explore in detail the third proposal suggested here, exposure to increased variability, by investigating the impact of exposure to multiple accents or dialects.

2.4 Impact of variability on speech perception and word learning

Exposure to variability in speech is not restricted to bilingual learners; both mono- and bilinguals are confronted with a high amount of variability in the speech signal. Variability here refers to the acoustic, phonetic or phonological information present in human speech that does not signal linguistic distinctions between words. Potential sources of variability include speaker identity, vocal emotion (affect), prosody and accents or dialects (which will be discussed specifically in section 2.5). In order to successfully acquire language infants need to learn which differences are not lexically relevant and ignore them. The effects of including variability during discrimination tasks, segmentation tasks, and when learning new words have so far yielded mixed results that thus far seem to be dependent on the type of variability under scrutiny.

2.4.1 Influence of variability on phonetic discrimination

In one of the first studies to examine how infants cope with variability in vowels, Kuhl (1983) tested the discrimination of the vowels /ɒ/ and /ɔ/, which do show a high level of acoustic overlap when produced by a single speaker, and even more when produced by multiple speakers. Kuhl (1983) tested 6 month old infants using a conditioned head turn procedure, in which looks to a specified location contingent with an auditory stimulus change are rewarded by the presentation of a visual stimulus, while incorrect looks when there is no auditory change are not. For some trials there was no change in the auditory stimulus and for others /ɒ/ changed to /ɔ/ or the reverse. If infants discriminated the contrast they would look towards the visual reinforcement only after hearing the change. The changes made to the vowels involved altering the pitch contour (rising or falling), the gender of the speaker (male or female) and the age of the speaker (adult or child). Infants only successfully identified the auditory stimulus change when this affected the phoneme and did not react to any other changes, suggesting that they could accommodate phonetically irrelevant variability within the same vowel at 6 months. This finding was extended to an easier contrast /ɒ/ - /i/ with the same task (Kuhl, 1979), suggesting that infants are likely able to accommodate acoustic variation across all the vowels of English when presented in isolation.

With even younger infants, Jusczyk et al. (1992) tested discrimination of a phonetic contrast, in addition to speaker changes. They used the High Amplitude Sucking (HAS) procedure, in which infants are played a stimulus until sucking on an artificial nipple decreases to a set criteria. They are then presented with a new stimulus in the test phase. If infants notice and discriminate the change, they will increase the number of sucks, whereas if the change is not detected there will be no increase in sucking rate. Jusczyk et al. (1992) habituated infants to tokens of the word 'bug' from a single speaker or from 3 different speakers. In the test phase they heard a new single speaker or a new set of 3 speakers producing the same word. At 2 months of age infants detected the change in the single speaker condition but were unsuccessful when hearing multiple speakers. This success was observed in the single speaker condition even after a two minute delay, suggesting that infants had encoded some of the speaker information when hearing the sequences during habituation.

In addition to a speaker change, (Jusczyk et al., 1992) tested discrimination of a phonetic change, from 'bug' to 'dug', following habituation with one or multiple speakers. Surprisingly, infants were successful following both habituation types suggesting that they were able to extract the relevant phonetic units even in the presence of speaker variability. However this effect disappeared following a two minute delay before testing in the multiple speaker condition, indicating that the stored representation following multiple speaker exposure is fragile and decays over time. In order to determine whether this effect was related to the variability across tokens in the multiple speaker condition, infants were presented with multiple tokens from a single speaker to increase the intra-speaker variation. In this task infants were still able to discriminate the phonetic change, leading the authors to conclude that variability across tokens from a single speaker is less disruptive than across speakers, and therefore that disruption is caused by between-speaker variation.

2.4.2 Influence of variability during segmentation

As previously reported, infants successfully extract words from the speech stream at 7.5 months (Jusczyk & Aslin, 1995). However, a number of studies have found that some conditions introducing variability negatively affect performance in this task. One of the major sources of variability likely to be encountered in the infants' environment is speaker gender; they need to learn that a word said by Mum is the same as one said by Dad. Houston and Jusczyk (2000) used the HTPP to examine infants' abilities to recognise words across genders. They familiarised infants to isolated words spoken by a female and then tested them on sentences spoken by a male. At 7.5 months infants successfully identified the target words in the sentences when the gender between familiarisation and test was matched, but not when gender differed. However they were successful with a different speaker of the same gender, allowing for the conclusion that it was gender changes that influence performance and not mere speaker change. It was not until 10.5 months that infants were able to identify the sentences containing the familiarised words when the gender of the speaker differed between familiarisation and test. This finding suggests that gender variability but not speaker variability presents a challenge to segmentation before 10.5 months.

Contradictory evidence on this topic has been reported recently by van Heugten and Johnson (2012) who have demonstrated successful cross-gender segmentation in 7.5 month infants. In their task the stimuli were recorded by parents of the infants, with a group of control infants who heard the stimuli recorded by the parents of a different infant yet still succeeded in segmenting words across speaker gender. One other difference in this task was that infants were familiarised to the passages and tested on the novel words, whereas Houston and Jusczyk (2000) used the word-passage order. This success is explained by van Heugten and Johnson (2012) as due to the additional exposure to the idiosyncrasies of the individual speakers during the familiarisation phase. This information allowed infants to adapt to the individual speaker and identify the irrelevant non-linguistic cues that could be ignored, resulting in a better representation of the stored word. It was also noted that the use of parents of infants from the target age allowed stimuli to be more naturalistic than the stimuli in other studies where unrelated speakers are asked to imagine speaking to an infant. These disparate findings suggest that under the right conditions, the variability encountered as a result of gender can be overcome. Additionally, the fact that the testing conditions in van Heugten and Johnson (2012) are more naturalistic than those in Houston and Jusczyk (2000) suggests that infants are typically succeeding in segmenting speech outside of the experimental setting.

In addition to gender differences, infants are also presented with mood-related variability in speech. These affective cues are useful in determining many features in the discourse situation but are not lexically relevant. Singh et al. (2004) tested 7.5 and 10.5 month infants in the word-passage variant of the segmentation task, adding affective variation. The speakers either spoke with a happy or neutral tone and infants were tested with the same affect or the one not heard during familiarisation. The younger 7.5 month infants successfully segmented only when the affect at familiarisation and test matched, whereas older children succeeded with both the matched and mismatched affect conditions. These findings were extended in a study by Singh (2008) who found that increasing the amount of variability from 2 types of affect to 5 (happy, sad, neutral, angry, and fearful) improved performance. Using the HTPP with infants aged 7.5 months, those who heard only the happy and neutral affect during familiarisation were unsuccessful in the segmentation task, whereas those who heard tokens in all 5 affect types succeeded. These studies suggest that infants' representations are influenced by experience with the specific exemplars they have encountered, containing even the irrelevant details. However, when presented with a wider range of variation, performance is better than with less variable tokens.

One further type of variation whose influence has been examined in the segmentation literature is pitch, which is not lexically contrastive in English, although stress in English influences pitch, amplitude, and duration. Singh, White, and Morgan (2008) used the HTPP with the word-passage order and found that differences in pitch cannot be accommodated in the representations of 7.5 month American English learning infants. At this age infants only succeeded when pitch was matched in the familiarisation and test phases but not when there was a mismatch. By 9 months these difficulties had been overcome and infants successfully identified the passages containing the familiarised words even when there was a pitch mismatch. In addition to varying pitch, some infants were tested with variation in amplitude. When amplitude varied, all infants, including those at 7.5 months, were successful, suggesting that pitch but not amplitude is used by young infants to identify words despite neither being lexically relevant in English.

The final type of variation that has been identified as problematic in young infants is emphatic stress, that is, the stress placed on a word to call attention to it when embedded in a sentence. Bortfeld and Morgan (2010) identified that mothers alternate in their use of emphatic stress, when speaking to their infants: They typically stress the word for the first occurrence and then again for later instances of the word but not consistently for all tokens. Based on these observations, Bortfeld and Morgan (2010) examined the use of emphatic stress experimentally using the HTPP and familiarising infants with words stressed in a number of ways. When emphatic stress was alternated during the familiarisation phase infants could successfully identify the target words embedded in the passages during the test phase. In addition, children were also successful when emphatic stress was matched half of the time, that is, when the familiarisation words were either emphatically stressed or non-emphatically stressed and the test passages contained both versions. However, if there was no overlap between familiarisation and testing, then performance was negatively impacted. This demonstrates that 7.5 month old infants can accommodate some variability in emphatic stress between familiarisation and test but that they still need some degree of overlap.

The evidence presented here suggests that the novice word learners are affected by a range of variation that is not lexically relevant, but that they quickly learn which details they need to attend to in order to extract words from continuous speech. However, in all of these studies infants were presented with unfamiliar words, increasing the task demands considerably. Not only were infants contending with variation in the signal, they also encountered unfamiliar words. To address this caveat, Singh, Nestor, et al. (2008) presented infants with familiar and unfamiliar words that contained surface variability in the form of pitch differences. At 7.5 months the unfamiliar words were only segmented when there was an exact match between familiarisation and test exemplars, whereas familiar words were segmented more robustly. This finding suggests that exposure to a word-form is necessary for representation specificity to develop sufficiently to incorporate and accommodate variation.

2.4.3 Influence of variability on novel word learning

Having clearly established that variability influences performance in segmentation tasks in infants, it is important for the purpose of this thesis to address how variability may impact older toddlers, encountering variability in a novel word learning situation. At these ages the most common source of variability infants will encounter is that found between speakers. Rost and McMurray (2009) tested 14 month old infants in a Switch task with the single feature distinction 'b'/'p'. As is typical of toddlers' performance in this task using a single speaker, they were unsuccessful in identifying the switch. However, a second group of toddlers heard multiple speakers during the familiarisation phase exposing them to variability along indexical (such as speaker and emotion differences that are not lexically relevant), prosodic and phonetic dimensions. Toddlers in this multiple speaker condition successfully detected the mismatches in the switch trials. This indicates that variability along non-lexical dimensions provides toddlers with sufficient information that they can focus on the stable aspects of the words, resulting in a better stored representation.

In a follow-up to this study, Rost and McMurray (2010) used the same stimuli but manipulated Voice Onset Time (VOT: the continuous contrastive cue distinguishing the voicing of two sounds such as /p/ and /b/) as this may have been the cue the toddlers in Rost and McMurray (2010) were using to identify the switch from /b/ to /p/ as this is the dominant cue differentiating these sounds. In order to explore the effects of VOT differences, Rost and McMurray (2010) manipulated either VOT alone, which is a phonetically contrastive cue, or other non-contrastive cues, such as prosodic and indexical information. In this condition toddlers did not detect the switch from /b/ to /p/ when the only cue available for discrimination was VOT. To clarify whether it was the combination of VOT and speaker variation, or whether speaker variation alone was sufficient for success in this task, a final version of the experiment retained the non-contrastive cues but eliminated the variation in VOT across speakers. In this version of the experiment toddlers were successful at identifying switch trials, suggesting that variability along non-contrastive cues - prosody and indexical information, is supportive of learning and that this effect is the result of exposure to irrelevant speaker information rather than lexically relevant distinctions. These findings lead to an explanation in which variability along dimensions that are not lexically relevant strengthens orthogonal phonetic representations; variation draws toddlers' attention to the similarities between words, allowing them to better identify differences in the Switch task.

In addition to speaker variation it has been demonstrated that variation in the context in which the words are presented during familiarisation can improve identification of a switch between /b/ and /p/. Thiessen (2011) added a familiarisation prior to the training phase in the Switch task so that the 15 month old toddlers heard either similar words /'dagu'/ and /'tagu'/, or distinct words /'dabo'/ and /'tagu'/, presented with no visual referent. They were then exposed to the syllable /'da'/ paired with a novel object and then tested on their discrimination of 'd'/'t' in a typical Switch procedure. They found that those infants who heard the distinct words in the familiarisation phase identified the switch but those infants familiarised with similar words did not. The contextual variability of the words presented in the familiarisation phase improved performance so that a change to the newly learned word-object pairing could be identified. It is proposed by Thiessen (2011) that this improved performance is the result of the demonstration immediately prior to the learning situation that the 'd'/'t' contrast is linguistically relevant. This study presents another case where exposure to variability enhances the performance of toddlers.

Contrastingly, with older toddlers, aged 23 months, Hollich (2006) found that speaker variability in a word learning and recognition situation resulted in poorer task performance. In this study using HTPP, toddlers heard two new words produced either by the same speaker or by a different speaker for each word. They were then taught word-object pairings for these new words and tested on their recognition of these form-meaning mappings in a typical IPL task. When the speaker matched during the training and teaching phase, infants succeeded in correctly identifying the target in the test phase. However, when the speaker for the training and teaching phases did not match, toddlers did not preferentially fixate the target, suggesting that speaker variation negatively impacted performance.

The task used by Hollich (2006) differs from the Switch task in that toddlers were required to identify the target referred to by an auditory label in the presence of a distracter, rather than identify whether the auditory stimulus matched the stored representation for that object. These methodological differences may recruit different resources, explaining why variability plays a different role in these studies. It may also be the case that the variability due to two speakers is insufficient for the successful abstraction of the novel words; in previous studies looking at the influence of multiple speakers there were at least 3 different voices heard by participants. This additional third speaker in previous studies may have provided sufficient variability to enhance performance. Too few speakers may not provide enough phonetically variable information to prove beneficial to discrimination abilities.

2.4.4 Summary

As a general rule it seems that speech variability has beneficial effects for early language learning, allowing infants and toddlers to develop strong and robust representations of the words they are learning across a number of tasks. This benefit seems to be emphasised when there is more variability present (e.g. Rost & McMurray, 2009; Thiessen, 2011), whereas minimal variability reverses the effect with a reduction in performance observed (e.g. Hollich, 2006). Indeed, Apfelbaum and McMurray (2011) suggest that high variability along non-contrastive dimensions is most effective, especially when contrastive dimensions are kept consistent. It seems that the introduction of non-contrastive variability leads to variable dimensions receiving less attention than those which are consistent, resulting in the consistent variability being encoded reliably. However, to date, with the notable exception of Jusczyk et al. (1992), nobody has looked at whether these effects are long lasting or a short term effect observed only during the experiment.

Considering the influence of variability it would then seem reasonable to suggest that the variable exposure experienced by a bilingual child may be beneficial for their encoding of the words they are learning. However, this is not typically the case (see section 2.3) as it is often reported that bilingual toddlers' performance in language tasks or achievements is delayed in comparison to their monolingual peers (Fennell, Byers-Heinlein, et al., 2007; Werker et al., 2002). One key difference between the variability faced by bilingual toddlers and that imposed during the experimental situation is that bilingual toddlers have experienced continual variability from the onset of their language learning journey. Currently, no research has looked into the influence of variable input in bilingual populations, leaving this question unanswered as yet.

2.5 Accents and dialects

One specific source of variability not considered in the above section is that of naturally occurring accent and dialect differences between speakers. This type of variability poses significant challenges as pronunciations can differ considerably from those with which the listener is familiar. This variability commonly occurs when someone is speaking a language that is not their native tongue, and throughout this thesis this will be referred to as a foreign accent. In addition, within a language there are often differences in accents and dialects based on the specific region, country or social group to which the person belongs; these will be referred to as regional accents.

At this point it might be useful to operationally define the terms accent and dialect. According to Hughes, Trudgill, and Watt (2013), accent refers to the pronunciation differences occurring exclusively at the phonological and prosodic levels and relating to differing pronunciations of the same words by different speakers. Dialect refers, in addition to the pronunciation differences, to the differences that occur in grammar (e.g. 'You were doing X' is the most common grammatical form, yet in the Midlands it is not uncommon to hear 'You was doing X'), morphology, syntax and in some cases vocabulary (e.g. 'aye' for yes in Scotland and 'bairn' for child in Yorkshire). In the literature these terms are often used interchangeably however, throughout this thesis they will be used as defined above.

Accent and dialect-related differences can cause comprehension difficulties for listeners unfamiliar with them. Anecdotally, in a conference for example, it is common to initially experience difficulties recognising words produced in an unfamiliar foreign or regional accent. Yet after a few sentences this initial difficulty is minimised and the speech becomes easier to understand. Of interest for this thesis is how infants and toddlers cope with accented speech.

It is very likely that toddlers encounter both foreign and regional variation in their maternal language during the course of their language learning journey. These two forms of accented speech are considered separately here as there are fundamental differences between them. Regional accents contain variation that constitutes a coherent and unique phonology, whereas foreign accents contain a mix between two phonologies: that of the non-native speaker, and that of the target language. As a result, Clarke and Garrett (2004) suggest that accents can be ranked perceptually based on their acoustic difference from native speech, with foreign accents being the furthest away on the scale and regional accents somewhere in between the two extremes on this continuum. Evidence from Floccia, Goslin, Girard, and Konopczynski (2006) demonstrates that accented speech is indeed processed differently by adults depending on whether it is regional or foreign. In a lexical decision task, where listeners were asked to indicate whether a word they are hearing is a real word or not, spoken words were identified as real words fastest in the local accent of listeners, with words produced in a regional accent incurring a delay of around 30ms and those produced in a foreign accent being identified with a the greatest delay of around 100ms.

2.5.1 Foreign accents

A foreign accent manifests itself in the second language of a speaker and, according to Adank, Evans, Stuart-Smith, and Scott (2009), is the product of the segmental and suprasegmental characteristics of the speakers' first language and the target language interacting. As a result of this the observed differences are not uniform: speakers of the same native language are likely to make the same pronunciation errors but these will differ depending on the combination of languages being spoken. In addition, the properties of the foreign accent reflect not only the native language but the proficiency of the speaker in the target language and may include variation along phonetic, phonological and prosodic dimensions.

2.5.1.1 Characteristics of foreign accents

According to Flege (1981) there are a range of cues that manifest at the suprasegmental, subsegmental, and subphonemic levels of non-native accented speakers.

The suprasegmental cues have been identified as differences between the average speaking fundamental frequency (Majewski, Hollein, & Zalewski, 1972) and variation in the fundamental frequencies of intonation contours (Willems, 1978). With regards to the subsegmental properties, differences are found in speech timing that affect the rhythmic properties of speech and the influences of consonant co-articulation on vowel lengthening (Chen, 1970). Finally the subphonemic cues primarily concern the VOT which is particularly evident for stop consonants, and also include differences that are found in the first and second formants and duration of vowels. Additionally, non-native speakers will often recruit phonemes from their native language in place of those in the target language when these are similar, with more distinct phonemes rarely being mispronounced (Flege, 1995).

It is clear that the speaker's native language plays a large part in the pronunciation of the non-native language. For example, speakers of Japanese where /l/ and /r/ are not contrastive often fail to differentiate these sounds when speaking English (Adank & Janse, 2010). A similar effect is identified in German accented English where the vowel sounds /ɛ/ and /æ/ are not lexically distinctive and so the German accented English pronunciations of 'bat' and 'bet' sound similar (Bohn & Flege, 1992). One final example comes from French where the 'h' sound is not present, as such this sound is rarely pronounced in French accented English words. These differences allow listeners to identify the origins of the foreign accent of their interlocutor.

2.5.1.2 Impact of foreign accent on recognition in infants

As previously mentioned, infants aged 7.5 months successfully segment new words from the speech stream (Jusczyk & Aslin, 1995), however this ability is diminished following the introduction of a foreign accent (Schmale & Seidl, 2009). Using the HTPP Schmale and Seidl (2009) familiarised 9 and 13 month American English learning infants to novel isolated words and then tested them on the recognition of those words when embedded in sentences across a range of conditions manipulating variability in speaker and accent. In the simplest task, recognition across two different speakers of the same local accent, infants, as expected, succeeded at 9 months. This was not the case when a foreign accented speaker was introduced. In a second experiment infants either heard the local accented speaker at familiarisation followed by the foreign (Spanish) accented speaker at test, or the reverse. In this condition infants only succeeded in the segmentation task at 13 months and not at 9 months.

Similarly, although 9-month-olds successfully segmented words when speaker and accent matched during familiarisation and test, when different foreign accented speakers were used in each phase they were unsuccessful until 13 months. This suggests that the presence of a foreign accent hinders speech processing in early language learners, and that accommodating variation is a gradual process, with cumulative effects. Indeed when there is only speaker variability to contend with, infants are successful; yet when accent variability is introduced, performance is negatively impacted. This suggests a developmental improvement in accommodating accent variability. As infants become more practiced in segmenting words from running speech they are able to do so even when the segmentation and recognition phases are not perfectly matched. This seems to be an ability that improves with age and is not specific to exposure to the particular accents used during the experiment.

2.5.1.3 Impact of foreign accent on word learning in infants

Foreign accent variability introduces sufficient challenges that performance in word learning tasks can also be adversely affected. Schmale, Hollich, and Seidl (2011) trained American children on two novel word-object combinations using either a foreign accented speaker, in this case Spanish, or a local American English accented speaker. They then tested toddlers' recognition of these words using an IPL procedure, with the auditory targets presented in the opposite accent to the training phase. At 2 years of age toddlers showed no recognition of the target object when trained with the local accent, but did recognise the target when trained with the Spanish accented speaker, whereas toddlers aged 2;6 demonstrated a target preference in both conditions. This suggests that younger toddlers are vulnerable to the influence of irrelevant non-contrastive information during the early stages of lexical development but that this is overcome at older ages. It could be that by 2;6 these infants have simply had more exposure to variable speech so can better accommodate accent-related variation, or have learnt to ignore accent specific variation.

Interestingly, as little as two minutes of exposure to a foreign accent improves younger toddlers' performance on subsequent tasks of word recognition (Schmale, Cristia, & Seidl, 2012). Toddlers aged 2 years listened to a short story read by a single or multiple speakers in either a local accent or a foreign Spanish accent. There were no accompanying visual referents during the story phase so any facilitative effects are due solely to exposure to this speech style. Toddlers were subsequently trained and tested on novel word recognition following the same procedure as Schmale et al. (2011). Only when the pre-exposure story period included the foreign accent did toddlers demonstrate successful word learning and recognition in the test phase. This was the case following exposure to both single and multiple speakers as well as when a new previously unheard speaker was presented in the test phase.

Surprisingly, when the local accent speaker produced the items of the familiarisation and word learning phases, there was no benefit to recognition at test. That is, even when exposed to greater variability in the local accent, there was no facilitative effect demonstrated for word recognition in an unfamiliar accent. Schmale et al. (2012) suggest that exposure to the foreign accent results in a general expansion of phonemic categories, facilitating accommodation of the novel accent and allowing subsequent target recognition.

2.5.2 Regional accents and dialects

The accents and dialects of native English speakers are many and varied, although not all originate from the United Kingdom. There are of course other areas of the world where English is a native language, for example, Australia, North America and South Africa.

However the accent and dialect differences discussed here are those that have been identified in regions of the United Kingdom.

2.5.2.1 Characteristics of regional accents

Broadly speaking accents and dialects of British English, according to Trudgill (1999), can be classified in two main categories: those from the North and those from the South. This is then further specified with the South of England separated into only three sub-areas: South West, East Anglia and South East (Altendorf & Watt, 2004). The variants of English spoken in these three areas, although distinct from one another, share many common features and it can often be difficult for an unfamiliar listener to determine where exactly in the South of England the speaker is from. Yet local speakers from within these areas have no trouble achieving this. In the North of England and Scotland the accents and dialects of many cities have remained distinct from one another, for example, the geographically close cities of Manchester and Liverpool have distinct accents and dialects that are discernibly different to even a novice native English listener.

There are numerous documented phonological differences between accents; the most common are discussed below (Hughes et al., 2013; Wells, 1982). These differences do not discriminate between two accents in particular but different combinations of these features are found to make up the many dialects of the UK.

The first of these regional differences is the 'foot-strut' distinction in relation to the pronunciation of words such as 'cup'. In the Midlands and the North of England 'cup' is pronounced with the same vowel as 'foot' whereas elsewhere in the UK 'cup' contains the same vowel as 'strut'. A further difference is apparent in words such as 'bath', 'dance', 'last' and 'path'. In the North and Wales these words are pronounced with the same vowel sound as in 'trap', whereas in the South of England they typically contain the same vowel as 'palm' or 'father'. Additionally, the words 'goat' and 'face' are pronounced with monophthongs (steady state vowels) in the North and Scotland but with diphthongs in the South. In the South West and Scotland post-vocalic /r/ is pronounced in words such as ‘car’, ‘arm’ and ‘tiger’ but is absent in the South East and Northern accents. The use of a glottal stop [?] for /t/ at the end and in the middle of words has become widespread in recent years appearing in most regional accents and dialects even becoming a more accepted part of Standard English. Another feature of phonology that is spreading across the UK having previously been prevalent only in London accent is the replacement of ‘th’ with ‘f’ or ‘v’, such that the word ‘thin’ sounds like ‘fin’ and ‘brother’ would rhyme with ‘lover’.

In addition to phonological differences, dialects can be differentiated by grammatical characteristics. In the North and the Midlands there are differences in pronoun use with the word ‘tha’ being used for ‘you’ and ‘hissen’ for ‘himself’. These differences extend beyond pronouns to verbs so that in Scotland ‘fall’ is ‘fa’ and ‘go’ is ‘gang’. And additionally the forms for ‘I am’ differ between regions, being ‘I is’ in the Northwest, ‘I are’ in the Midlands, and ‘I be’ in the South West. Finally, in the mid-South and South West of England, the present tense has the addition of –s in the whole word paradigm, e.g. ‘I likes’. This range of differences between dialects and accents can make understanding accented speech challenging even for native British English speakers travelling around the country (Kerswill, 2002).

2.5.2.2 Discrimination of regional accents

Despite the differences highlighted between accents, adults are usually able to rapidly accommodate this variation and communicate effectively with speakers from other regions of the UK. It has been demonstrated that as young as 5 months of age infants can discriminate their own accent from another regional variety (Butler, Floccia, Goslin, & Panneton, 2011; Nazzi, Jusczyk, & Johnson, 2000). Using a variant of the HTPP infants heard either a speaker with a familiar or an unfamiliar accent producing short passages, followed speakers from both accents producing new passages during the test phase. Butler et al. (2011) found that in the test phase, infants listened longer to the passages spoken in the accent that matched the familiarisation phase, suggesting that they could differentiate their own accent (South West accented English) from another regional variety (Welsh accented English). Similarly, Nazzi et al. (2000) found that infants aged 5 months who were familiar with American English successfully discriminated American accented English and British accented English. To establish whether this was a general ability to discriminate between variants of their native language or a more accent-specific ability, Butler et al. (2011) tested 5 month old infants raised in the South West of England for the discrimination of Welsh and Scottish accented English, both accents being unfamiliar to the participants. In this case infants failed to discriminate the two accents. Taken together these findings suggest that young infants are able to discriminate between two varieties of their own native language only when familiar with one of them.

The course of development of within-language accent discrimination has also been explored. Phan and Houston (2006) propose a U-shaped pattern of development for discrimination of the local accent (North Midland American English) and an unfamiliar variety (Southern American English). They used a visual habituation procedure with infants and toddlers aged 7, 11, 18, 24, and 30 months. During a habituation phase one accent was presented, followed by a test phase in which the child heard both accents. At 7 months infants discriminated the two accents as they looked longer during the test trials towards the accent they were not familiarised with. By 11 months this discrimination was no longer found. However, at 18, 24 and 30 months the amount of time spent looking to the novel accent increased with age. This is strongly reminiscent of the U-shaped pattern of development seen in bilingual infants' vowel discrimination (Bosch & Sebastián-Gallés, 2003). Together, the evidence for a U-shaped trajectory in the perception of within (Phan & Houston, 2006) and between-language variations (Bosch & Sebastián-Gallés, 2003) suggests that this might be a general developmental stage that all toddlers pass through rather than a direct result of the input exposure. Indeed, the effect of the specific language environment of the child can be seen in the age at which toddlers pass through this stage, with delays apparent in some groups (Bosch & Sebastián-Gallés, 2003).

2.5.2.3 Impact of regional accent on word segmentation in infants

It has been identified that infants can discriminate foreign accents at a young age but that inclusion of accented speech in the experimental design results in a delay in the ability to segment words from the speech stream (Schmale et al., 2012; Schmale et al., 2011; Schmale & Seidl, 2009). What remains to be seen is whether these effects extend to regional dialects of the same language.

Polka and Sundara (2012) present evidence that 8 month old Canadian-French learning infants can recognise words in European French equally as well as in Canadian French. Using the HTPP infants were presented with isolated words during the familiarisation phase, followed by sentences containing the familiarised words produced by a European French speaker during the test phase. Infants listened longer to sentences containing the familiarised words even when produced in an unfamiliar dialect. However, contrasting results were found by Nazzi et al. (2014) who tested European French learning infants with the Canadian French stimuli. Firstly, Nazzi et al. (2014) reported, with the same procedure as Polka and Sundara (2012), that European French learning toddlers were only segmenting words produced in a European French dialect at 8 months when presented with the passages during the familiarisation phase and the isolated words at test. In order for the European French infants to successfully segment the Canadian French stimuli, a longer familiarisation with the passages was necessary. Recall that the Canadian French infants segmented successfully in both the word-passage and passage-word orders, and with a shorter familiarisation time in the familiar and unfamiliar dialect. This suggests that the Canadian French learning infants were better at accommodating dialect variation at the early stages of word learning than their European French learning peers. Three explanations are proposed by Nazzi et al. (2014) for these differences; first, the better performance of Canadian infants may reflect some differences in exposure, with Canadian French infants more likely to hear European French than the reverse. Second, increased prosodic variation at the sentence level in Canadian French might make segmentation easier when presented with European French whereas the reduced variation in European French makes segmenting Canadian French difficult. Third and finally, infants learning each of these dialects might be using different cues from the same stimuli, however, the authors acknowledge that at this time there in insufficient evidence available to determine what these cues are.

Schmale, Cristia, Seidl, and Johnson (2010) used the HTPP to test 9 and 12 month infants' ability to recognise words when familiarised and tested across regional accents of English. They familiarised infants with isolated words produced in a familiar American accent or an unfamiliar Canadian accent and tested them with passages containing the target words in the opposite accent. They found that only 12-month-old infants listened longer to the passages containing the familiarised words. This is a month earlier than for foreign accented speech (Schmale & Seidl, 2009) but at least 3 months later than when tested with speakers of the local dialect. This study suggests that regional accent variation presents a challenge to infants, impeding recognition and delaying success in a segmentation task. Perhaps infants' representations of newly learned words cannot accommodate variation in the early stages of word learning. With greater language processing experience, representations are more robust and able to accommodate regionally accented variations.

2.4.2.4 Word-form recognition across accents

In the studies discussed above children recognise words from recently encountered forms rather than accessing word-forms stored in their lexicon and matching these to accented pronunciations. It could be that newly learned forms are relatively easy to recognise despite accent variation because these are less well represented in the lexicon; the variable pronunciation would be a "good enough" match to elicit a target fixation response. If this is the case it would be expected that toddlers would struggle to recognise familiar words across accents.

Best, Tyler, Gooding, Orlando, and Quann (2009) presented 15 and 19 month toddlers with lists of familiar and unfamiliar words in a familiar, local accent (Connecticut American English) or an unfamiliar accent (a Jamaican Mesolect dialect). They used a visual preference fixation procedure where the duration of toddlers' looks to a central fixation point, contingent with an auditory stimulus, is recorded. With a similar procedure it had been demonstrated (Hallé & Boysson-Bardies, 1994, 1996) that infants look longer at a visual stimulus following familiar but not unfamiliar words. Best et al. (2009) report the same effect in toddlers aged 15 and 19 months when the words are produced in the local, familiar accent. In contrast, when the words are presented in the unfamiliar accent, only toddlers at 19 months demonstrated a preference for familiar words. According to Best et al. (2009), toddlers have developed "phonological constancy" by this older age, that is, they recognise that the phonetic realisation of a word does not affect its phonological structure which remains constant despite surface variation. This suggests that before phonological constancy fully develops, toddlers' performance is affected by the surface variation of accented pronunciations which makes them unable to recognise familiar words in an unfamiliar accent.

This finding that accented pronunciations are problematic for recognition of familiar words in young toddlers is supported by a study with Canadian learning toddlers. Using the same methodology as Best et al. (2009) with Canadian accented English (familiar) and Australian accented English (unfamiliar), van Heugten and Johnson (2013) found that toddlers did not recognise familiar words in an unfamiliar accent until 22 months of age. This is slightly later than demonstrated by Best et al. (2009) which van Heugten and Johnson (2013) suggest could be the result of the different accents being used in their version of the study. In a second experiment van Heugten and Johnson (2013) presented toddlers a story read by the same speaker prior to testing, which provided children with some exposure to the speaker but not to the test words. In this condition, they found that toddlers aged 15 months were able to recognise familiar words spoken by the speaker whom they had heard reading the story. However, this facilitative effect was only present when the story was familiar to the child; if the child did not already know the story, the benefits of speaker exposure were no longer present. This suggests that toddlers' familiarity with the words heard in an unfamiliar accent is crucial in determining their subsequent success or failure at adapting to that accent; mapping the unfamiliar pronunciations onto familiar pronunciations allows them to identify the similarities and differences between accents. Once these differences have been identified, toddlers are then able to generalise this information to other words they have not yet heard produced by that particular speaker in that particular accent.

The benefits of hearing known words produced in a non-canonical way is also seen when the deviant pronunciations are created in the lab and not from accented speech. White and Aslin (2011) exposed 19 month old toddlers to standard pronunciations of words or mispronunciations, where one phoneme was consistently replaced by another - 'dog' was produced as 'dag'. They found that when tested in a typical IPL study with familiar words containing the shifted pronunciation, only toddlers who had heard the shifted pronunciations in the exposure phase recognised the mispronounced target. Additionally, they investigated whether exposure to the shifted pronunciation resulted in a specific or general adaptation to mispronunciations from that speaker. They found no target recognition for words that were mispronounced by the same number of features but that toddlers had not had experience with during the exposure phase e.g. /ɒ/ as in 'dog' to either /ɛ/ as in 'deg' or /ɪ/ as in 'dig'. This suggests that toddlers were not simply accepting any mispronunciations from this speaker, but had adapted to the specific characteristics of the speakers' productions and were able to generalise this information to words they had not heard him say. The findings of White and Aslin (2011) show that toddlers can accommodate some forms of accent variability, although in their paradigm only one phoneme deviated from the local accent. In reality accented speech differs across a number of phonemes simultaneously and contains additional sources of variability.

Mulak, Best, Tyler, Kitamura, and Irwin (2013) demonstrate with an IPL task that toddlers are able to accommodate the multi-faceted variability of accents in a target identification task at 19 months. They presented toddlers with pairs of images and a target word heard in either a familiar (Australian English) or an unfamiliar (Jamaican English) accent. They found that at 15 months toddlers demonstrate target recognition in the familiar accent; however, when hearing the unfamiliar accent they were only able to identify the target at 19 months. This further suggests that until 19 months of age coping with accent variability remains problematic. One final point to note is that Mulak et al. (2013) reported that the performance of the 15 month old toddlers was predicted by their vocabulary size rather than age; those toddlers who knew more words were better able to accommodate the accent variability and identify the target.

Vocabulary size was also shown to predict performance in a similar study by van Heugten, Krieger, and Johnson (2014). They tested 20 and 25 month old Canadian English learning toddlers with Australian English and Canadian English accented target words in an IPL study, with a preceding exposure phase during which toddlers heard the Australian English accented speaker read a story (as in van Heugten & Johnson, 2013). At 20 months toddlers demonstrated recognition only when hearing the familiar accent, failing to recognise accented pronunciations even when they had encountered the test words during the story. This finding is in direct contrast with the findings of van Heugten and Johnson (2013) where recognition of familiar words in an unfamiliar accent was identified after familiarisation with the accent through a story. In the van Heugten et al. (2014) task toddlers were required to assign an auditory label to an image rather than simply identifying whether the words are familiar (van Heugten & Johnson, 2013), these additional task requirements could explain the performance differences observed. Additionally, performance in younger toddlers was moderated by their expressive vocabulary score and not by age. However, at 25 months toddlers reliably recognised words in an unfamiliar accent even without hearing the accent during the exposure phase.

2.5.3 Summary

At the earliest stages of word learning, exposure to accented pronunciations has a negative effect on performance in a number of tasks, with foreign accented pronunciations having a greater and more prolonged influence (Schmale et al., 2010; Schmale & Seidl, 2009). However, the interference effects of both foreign and regional accent variation can be overcome with as little as two minutes of exposure to accented speech (Schmale et al., 2012). The evidence also suggests that once toddlers have been exposed to some accented speech, they are able to use this experience and generalise to instances of words that they have not yet encountered (Van Heugten & Johnson, 2013; White & Aslin, 2011).

2.6 Multidialectalism

The evidence discussed in the preceding section highlights the challenges that understanding and recognising both foreign and regional accents pose for the listener. However for some listeners regional accent variation is the everyday norm. Specifically, multidialectal infants are raised in an environment where the linguistic input is variable due to dialectal differences within their native language.

2.6.1 Defining Multidialectalism

For the multidialectal listener there is continuous and consistent variation in their input from the dialects they are hearing, accent variation and dialect variation. A child being raised in the South West of England by a father who is from the local area and a mother who is from Scotland will hear variable pronunciations of the same words, much like cognates between languages. In addition, she will also be exposed from the earliest stages of language learning to dialectal differences such as /bæθ/ or /baːθ/ contrast and very likely to many other phonetic and lexical variants, e.g. ‘aye’ for ‘yes’. Albareda-Castellot et al. (2011) suggest that multidialectal infants be seen as a unique group of bilinguals, acquiring a single set of morphological and syntactic rules but two distinct phonologies (to varying degrees) with a large proportion of cognates in their lexicon. To date there have been very few studies that consider the background of monolingual listeners, instead studies expose participants to variability as part of the experimental procedure (Schmale et al., 2010; White & Aslin, 2011). These studies only tell us how listeners respond to and accommodate variability following brief exposure; the effects of long-term exposure could be very different.

2.6.2 Multidialectalism research in infants

Exposure to a second accent is acknowledged as having an influence on the discrimination of an infant's native and non-native accent (Kitamura et al., 2006). In this study American and Australian infants were presented with sentences in both accents using a visual preference fixation procedure, similar to the HTTP, where infants' listening times to each of the accents whilst fixating on a coloured bulls-eye are measured. A difference in the amount of time infants fixate on the bulls-eye indicates preference for one of the two accents. It was found that only 5 month old American infants showed reliable preference response, listening longer to the novel Australian speaker, whereas the Australian infants showed no preference for either accent. These infants did not prefer Australian English over American English pronunciations, treating them as equivalent. However, at 3 months of age Australian infants demonstrated similar performance to the 5 month American infants and preferred their native accent over the American one. Kitamura et al. (2006) suggest that this early ability seen in the Australian infants diminishes as a result of exposure to the American accent through exposure to American TV shows. This indirect exposure serves to accelerate attunement to the non-native accent. Although no attempt was made to quantify the relative amount of accent infants heard on a day to day basis, these children were in many ways multidialectal due to regular exposure to an additional accent via other sources (i.e. the media). The fact that this exposure resulted in different performance is a first indication that variability in the input influences performance with dialectally variable stimuli, allowing for example Australian infants to accommodate the American English speech style. Due to the lack of exposure to

Australian English in the American population, the same ability could not be found in this population.

At present, the only study to directly examine the effects of long-term exposure to dialectally variable pronunciations was conducted by van Heugten and Johnson (2013). They tested 12.5 and 14.5 month old English learning toddlers' discrimination of familiar and unfamiliar words using the HTPP. Toddlers were exposed at home either to Canadian accented English only (native accent group), or Canadian accented English plus at least one other accented variant of English (mixed accent group). During testing, toddlers heard lists of familiar and unfamiliar words presented in the local, familiar, Canadian accent. Looking times towards a contingent visual stimulus were recorded. Only the native accent group successfully discriminated the two lists of words at 12.5 months, and it was not until 14.5 months that the mixed accent group was successful in this task. This delayed success for the mixed accent group is explained by van Heugten and Johnson (2013) as the result of reduced exposure to the regionally dominant accent. However, it could be the case that the lack of discrimination in the mixed accent group was not a failure to recognise the familiar words but instead demonstrates recognition of the unfamiliar words as lexical candidates, which would point to an early ability to accommodate variation.

2.6.3 Summary

Little work has been conducted exploring the influence of long term exposure to dialectally variable speech in young language learners. The evidence that is currently available suggests that variable exposure does influence the performance of infants and toddlers (Kitamura et al., 2006; Van Heugten & Johnson, 2013); however the extent of this influence is currently unclear. For example, it is difficult to determine whether the lack of discrimination between Australian and American accented speech found by Kitamura et al. (2006) when infants are routinely exposed to both accents would later lead to a greater acceptance of variability in pronunciations, or, as van Heugten and Johnson (2013) suggest, whether this would have a negative impact on performance. The precise effects of long term variable input in toddlers have yet to be explored, which this thesis begins to address.

Throughout this thesis we capitalise on the long term naturalistic variation experienced by toddlers whose parents either speak with a different accent from each other, or both speak with a different accent from that of the local community. This is used to create two separate groups of toddlers, those who have variable accent input and those who have consistent accent input. In many cases parallels will be made between the performance of bilingual toddlers and those exposed to accent variation within a single language, based on the suggestion of Albareda-Castellot et al. (2011) that multidialectal toddlers could be considered as a subtype of bilingual. The experiments presented throughout this thesis seek to explore the impact of accent variation across a number of situations including the specificity of toddlers' representations of familiar words (Experiments 1 and 2), their ability to accommodate naturally occurring pronunciation deviations (Experiments 3 and 4) and finally the use of a word learning strategy, the Mutual Exclusivity constraint, for acquiring new words (Experiment 5).

Chapter 3.

The influence of Multidialectalism on the specificity of word-form representations.

Language development research has traditionally compared two distinct populations, monolinguals and multilinguals (e.g. Bosch & Sebastián-Gallés, 2003; Fennell, Byers-Heinlein, et al., 2007; Ramon-Casas & Bosch, 2010). However, these broad categories cannot provide a fully accurate description of toddlers' language input. Monolingual toddlers actually fall into one of two sub-groups: monodialectal or multidialectal. Multidialectal toddlers hear multiple dialects of a single native language if one or both of their parents speak with a dialect that differs from that of the surrounding locality. Albareda-Castellot et al. (2011) suggest that multidialectal toddlers be seen as a unique group of bilinguals, acquiring a single set of morphological and syntactic rules but two distinct phonologies (to varying degrees) with a large proportion of cognates in their lexicon. Of interest in the current study is how life-long exposure to dialectal variation affects toddlers' representations of familiar words.

In many ways the general pattern of language development in bilingual and monolingual toddlers is comparable, with all toddlers passing critical milestones at similar ages (Pearson, Fernández, & Oller, 1993). However, when looking at vocabulary scores differences have been identified between monolingual and bilingual populations (Bialystok, Luk, Peets, & Yang, 2009). Typically bilingual toddlers have fewer words in their vocabulary than monolingual peers when considering each of their languages; however, when collapsing all words across both languages, bilingual toddlers' scores are comparable to those of monolinguals (Poulin-Dubois, Bialystok, Blaye, Polonia, & Yott, 2013).

Differences also arise between these two populations when exploring the specificity of their word representations. Bilingual toddlers seem to detect minimal changes between words later than their monolingual peers. Using a Switch task, Fennell, Waxman, et al. (2007) taught toddlers the novel word-object pairings 'bih' and 'dih' and then tested them on trials where these pairings were congruent with training or where there was a mismatch or 'switch' between the label and the object. Monolingual toddlers succeed at noticing the switch at 17 months whereas bilingual toddlers are successful only at 20 months. This suggests that bilingual toddlers have less specific representations of words than their monolingual counterparts (see also Bosch & Sebastián-Gallés, 2003). Following the suggestion from Albareda-Castellot et al. (2011) that multidialectalism is a unique form of bilingualism, it is proposed that multidialectal toddlers might behave more similarly to bilingual toddlers than monolingual, monodialectal toddlers. The studies presented in this chapter compare mono- and multidialectal toddlers' ability to detect mispronunciations of familiar words using an IPL task. If there are performance differences between these two groups of toddlers this suggests that, like bilingual toddlers, multidialectal toddlers' lexical development is influenced by the variability found in their linguistic input.

3.1 Experiment 1 – Mispronunciation detection in monodialectal and multidialectal toddlers

Experiment 1 is an adaptation of a paper in press: Durrant, S., Delle Luche, C., Cattani, A., and Floccia, C. (in press). Monodialectal and Multidialectal Infants' Representation of Familiar Words. Journal of Child Language.

It has been shown that increased variability in speech can affect performance in monolingual toddlers. For example, Rost and McMurray (2009) trained 14-month-olds in a Switch task with minimal pair words /buk/ and /puk/ with training sequences produced by either single or multiple speakers. Toddlers only looked longer during switch trials following the multiple speaker training phase, suggesting that speaker-related variability leads toddlers to focus on the stable or invariant aspects of the input and develop more robust representations of words. In a follow-up study, Rost and McMurray (2010) manipulated phonetic variability more closely in the same task with the same stimuli. When varying cues that are either phonetically contrastive (Voice Onset Time; VOT) or non-contrastive (prosodic and indexical), they found that toddlers only noticed the switch when the non-contrastive cues were present, failing to look longer to switch trials with contrastive cues alone. In contrast, when phonetic information remained consistent but non-contrastive cues varied, toddlers once again succeeded. This suggests that phonetically contrastive variability can be problematic for creating phonologically specific representations of new words. However non-contrastive variability, such as speaker differences that are usually not used to discriminate words, can support learning. Multidialectal toddlers are exposed regularly to phonetically contrastive cues that are not phonologically relevant (such as rhotic versus non-rhotic pronunciations of final tense vowels as in 'car'). Following Rost and McMurray (2010) it would be predicted that multidialectal toddlers' exposure to phonetically variable tokens of words may result in less well defined representations being incorporated into their lexicon.

However, the study of the impact of dialectal variations on toddlers' word representations has led to mixed conclusions so far. Best et al. (2009) played American toddlers familiar words in either a Jamaican (unfamiliar) or American-English (familiar) accent in a Head turn Preference Procedure (HPP). At 15 months toddlers listened longer to familiar words in a familiar accent over an unfamiliar one, whereas at 19 months listening times were comparable for both accents. That is, until 19 months of age toddlers failed to recognise familiar words produced with unfamiliar pronunciations due to accent differences. This indicates that unfamiliar within-language variation can negatively affect word recognition (see also Schmale et al., 2010).

Alternatively, Schmale et al. (2011) present evidence that accent-related variability can aid the creation of robust representations of words. Toddlers aged 24 months were trained on novel words in either a foreign or local accent and tested in the reverse accent using a variant of the Intermodal Preferential Looking procedure (IPL). Toddlers looked longer at the target only when training was in the foreign accent; training in the local accent resulted in no preference for the target. Schmale et al. (2011) suggest that 'exposure to phonetic variability leads to more robust representations by promoting broader lexical categories' (p10). In the foreign accent training condition word representations better accommodated variation, whereas training in a familiar local accent made abstraction across similar instances more difficult in young toddlers.

In an attempt to explore this further White and Aslin (2011) trained toddlers with mispronunciations of familiar words containing the shifted vowel [ɒ] to [æ] e.g. dog to dag, prior to testing. Toddlers were tested with both correct and incorrect pronunciations of familiar words in a typical IPL task, with incorrect pronunciations using the trained vowel shift. They found that following brief exposure to a novel accent 20-month-olds could accommodate this shift and recognise incorrect pronunciations of familiar words, as only toddlers who were trained looked longer at the target following the mispronunciation. Additionally, the successful toddlers recognised mispronunciation words they had not previously heard, showing generalisation of the shift to other exemplars. So, with relevant exposure to accent variations (in this case an artificial novel accent), toddlers are able to accommodate incorrect pronunciations of familiar words.

The above studies demonstrate toddlers' ability to adapt rapidly at the time of testing to deviant pronunciations of words, both familiar and novel. However, multidialectal toddlers are faced with within-language variation on a daily basis due to the nature of their input and so present an interesting case for study and for comparison with the traditional bilingual/monolingual contrast. Here the impact of continuous naturalistic dialect-related variability on toddlers' phonological representations of familiar words is examined, rather than an introduced and artificially designed variability as in (as in Best et al., 2009; Schmale et al., 2011; White & Aslin, 2011). Using a standard IPL procedure monodialectal and multidialectal toddlers were tested on correct and incorrect pronunciations of familiar words produced in the local British South West English dialect.

It was predicted that the monodialectal group of toddlers would behave as expected from the previous literature when monolinguals are presented with mispronunciations of familiar words (Mani & Plunkett, 2010; Swingley & Aslin, 2000): they should only look longer at the target following correct pronunciations. However, multidialectal toddlers could respond in one of two ways. First, they could detect mispronunciations similarly to or better than monodialectals, looking longer to the target following correct but not incorrect pronunciations. This would suggest that they have representations that are sufficiently specified that deviant pronunciations are successfully identified. It could also suggest that any relaxation or broadening of phonetic boundaries is input specific, and does not apply to any presented phonetic or phonemic contrast as expected from studies by Schmale et al. (2011) and White and Aslin (2011). Due to the design of this experiment these two explanations would be difficult to disentangle at this stage.

Secondly, toddlers could treat all pronunciations as acceptable exemplars of the target and look longer at its picture regardless of pronunciation, suggesting a general relaxation or broadening of phonetic boundaries or poorer use of phonological information in word recognition, as a result of daily exposure to variable pronunciations, as suggested by results from Best et al. (2009) and Rost and McMurray (2010).

3.1.1 Method

English-learning toddlers aged 20 months were presented with pairs of images accompanied by correct or incorrect pronunciations of a target. Sensitivity to mispronunciations of familiar words should result in longer looks to the target image following correctly but not incorrectly pronounced trials as compared to the pre-naming phase (e.g. Mani & Plunkett, 2007).

Participants

Thirty-two monolingual English toddlers born and raised in the South West of England successfully completed this experiment. There were two groups of toddlers: monodialectals (N=16, 5 boys, mean age = 19 months, 25 days) and multidialectals (N=16, 12 boys, mean age = 20 months, 2 days). Additional toddlers were tested but excluded due to inattention (3) and fussiness (2). All toddlers had no known hearing problems, developmental delays, were no more than 6 weeks premature, and were recruited from the Babylab database. All parents completed the Oxford Communicative Development Inventory (OCDI, Hamilton, Plunkett, & Schafer, 2000) with no significant difference found between the two groups, (mean understanding scores – monodialectals = 235 words, range 33-348, $t(30)=-.15$, $p=.88$ and multidialectals = 231 words, range 140-354; mean production scores – monodialectals = 79 words, range = 12-180 and multidialectals = 91 words, range = 7-240, $t(30)=.57$, $p=.57$). Toddlers were classified as mono- or multidialectal prior to testing.

Parents reported their dialect background and were recorded reading an elicitation passage (Weinberger, 2003; Appendix A) in addition to some natural speech describing a typical day with their child. Expert listeners, familiar with the English South West dialect, assessed these recordings in order to determine whether the speaker spoke with a South West accent or not. Given the suggestion from Trudgill (1999) that the major dialect boundary of British English lies between the North and South and the specification from Altendorf and Watt (2004) that the South of England is further separated into three dialect areas: South West, East Anglia and South East, toddlers whose parents both spoke with a South West dialect were classified as monodialectal. All other toddlers were considered multidialectal (See Table 3.1 for a full list, including percentage of exposure to the South West dialect).

A dialect exposure questionnaire was completed, derived from a language exposure questionnaire (Cattani et al., accepted; Appendix B) calculating the amount of exposure to the South West dialect. Multidialectal toddlers' exposure scores were required to be between 25 and 75% to be included in this group, following the bilingual literature (Pearson, Fernández, Lewedeg, & Oller, 1997). On average, multidialectals heard the local dialect 42% of the time (range 26% to 69%). Dialect status was obtained prior to testing to ensure that each group contained all of the possible trial combinations; coders were naive to this information.

Table 3.1- *List of dialects heard by each of the multidialectal infants included in the experiment. Both parents of monodialectal infants spoke with a British South West dialect. Infants 14 and 15 heard the local dialect only from their childcare provider; however, the behaviour of these infants followed the same pattern as the others in the multidialectal group. These two infants were still familiar with the local pronunciations of words hearing the local dialect 35 and 26% of the time respectively.*

Child	Multidialectal		% Exposure to South West
	Mother	Father	
1	South West	Midlands	53
2	South West	London	57
3	South West	Coventry	51
4	South East	South West	52
5	South West	Liverpool	62
6	South West	Yorkshire	31
7	South West	Birmingham	53
8	South West	Buckinghamshire	33
9	South West	Liverpool	65
10	South West	Hampshire	44
11	South West	Yorkshire	31
12	South West	London	33
13	Staffordshire	South West	46
14	Wales	Reading	35
15	Leicester	Leicester	26
16	Northampton	South West	33

Stimuli

Thirty-two monosyllabic consonant initial nouns were selected from the OCDI as understood by children at this age (see Table 3.2). These were divided into 16 target (mean understanding score = 88%) and distracter (84%) pairs. Each toddler saw all 16 pairs once, with one image acting as the target for all toddlers, e.g. target dog and distracter duck. The images were all colour photographs, controlled for size, and appeared on a white background. They were deemed good exemplars by the authors and an independent observer. Toddlers saw 16 trials including 8 correct pronunciations and 8 mispronunciations, created by changing either the onset consonant or medial vowel by a single feature, where possible (Table 3.2). The auditory stimuli were produced in a local dialect by a native female speaker of British English in a child directed manner and heard in the carrier phrase 'Look! Target.'

Table 3.2 - *Summary of stimuli and phonetic transcriptions used for correct and incorrect trials. Percentages represent the number of 20 month old infants who know the target and distracter words based on OCDI norms (Hamilton et al., 2000).*

Target	Consonant mispronunciation	Vowel mispronunciation	Distracter
Ball (100%) /bɔ:l/	/gɔ:l/	/bu:l/	Bear (86%)
Bath (93%) /bɑ:θ/	/dɑ:θ/	/bɛθ/	Boat (64%)
Bed (100%) /bɛd/	/pɛd/	/bʌd/	Book (93%)
Bib (79%) /bɪb/	/dɪb/	/bæb/	Boot (79%)
Bread (86%) /brɛd/	/grɛd/	/brɔ:d/	Brush (100%)
Bus (79%) /bʌs/	/pʌs/	/bæs/	Bike (93%)
Cat (100%) /kæt/	/gæt/	/kɑ:t/	Cow (93%)
Cot (100%) /kɒt/	/tɒt/	/kɛt/	Car (100%)
Cup (71%) /kʌp/	/gʌp/	/kɛp /	Clock (86%)
Dog (100%) /dɒg/	/bɒg/	/dʊg/	Duck (100%)
Foot (71%) /fʊt/	/sʊt/	/fɔ:t/	Fish (71%)
Hat (86%) /hæt/	/ʃæt/	/hɛt/	Horse (93%)
Keys (86%) /ki:z/	/ti:z/	/kæz/	Coat (79%)
Shoe (100%) /ʃu:/	/fu:/	/ʃi:/	Shop (71%)
Sock (100%) /sɒk/	/zɒk/	/sʊk/	Spoon (79%)
Tree (64%) /tri:/	/pri:/	/tru:/	Train (71%)

Procedure

Toddlers sat in a highchair approximately 180cm away from a projection screen; eye movements were recorded by two cameras positioned directly above the visual stimuli. Auditory stimuli were delivered via a centrally located speaker. The experiment was presented, coded and analysed using the 'Look' software package (Meints & Woodford, 2008). See Appendix C for diagrams of the setup from an aerial and front view perspective.

Initially toddlers saw two training trials (hand-chair, bird-pig), always with correctly pronounced targets, to familiarise them with the procedure and improve engagement during test trials. During the test phase toddlers were presented with 16 5s trials consisting of one pair of images, measuring 52cm diagonally from corner to corner and 43cm apart. The onset of the target word occurred at 2500ms, splitting the trial into pre- and post-naming phases. Between trials a smiley face was presented to re-centre toddlers' attention.

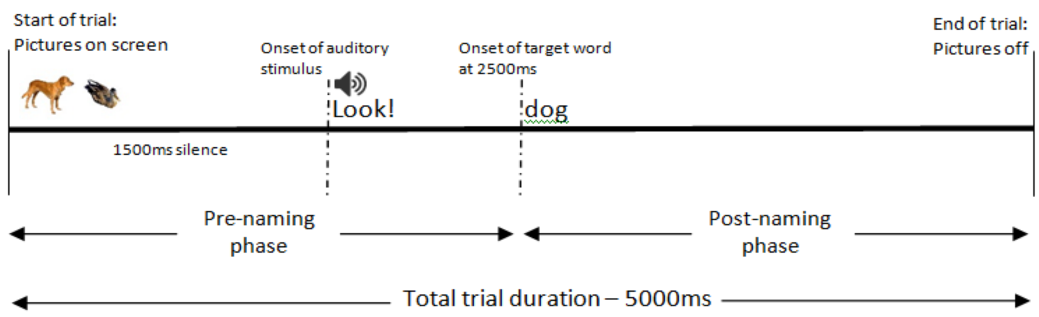

Figure 3.1– *Time line of experimental procedure starting from the left with a total duration of 5 seconds*

Throughout the experiment targets were presented equally often on the left and right of the screen. This was counterbalanced across children and the order in which trials were presented was randomised with no more than two consecutive pronunciations of the same type.

Scoring

Videos were scored to determine the toddlers' gaze direction and fixations on a frame-by-frame basis (every 40ms). A second skilled coder independently scored 10% of the videos with an inter-experimenter agreement Intraclass Correlation Coefficient of 0.978 (Shrout & Fleiss, 1979).

Codings were used to calculate the amount of time toddlers spent looking at the target and distracter in both the pre and post naming phases of each trial. Only looking times that occurred between 367ms and 2000ms after the onset of the word were analysed following previous research (e.g. Swingley & Aslin, 2000).

3.1.2 Results

Analyses were conducted only on trials where toddlers looked at both images during the trial and caregivers reported the target word was known; these criteria retained 86% of all trials. The Proportion of Target Looking (PTL) measure was used, calculated as the time spent looking to the target divided by the total time spent looking at both target and distracter (t/t+d). A significant increase in PTL in the post-naming phase compared to the pre-naming phase is taken as evidence that the child has recognised the word and is aware of the relationship between the target image and the target label, corresponding to a naming effect (Mani et al., 2008; Mani & Plunkett, 2007, 2010; Swingley & Aslin, 2000, 2002). Data were analysed using a mixed model ANOVA with the within-participant factors Naming (pre and post) and Pronunciation (correct and incorrect), and the between-participant factor Dialect (monodialectal and multidialectal). There was a main effect of Naming ($F(1,30)=11.72$, $p=.002$, $\eta_p^2=.281$), an interaction between Naming and Pronunciation, ($F(1,30)=10.71$, $p=.003$, $\eta_p^2=.263$) and a significant 3-way interaction between Naming, Pronunciation and Dialect ($F(1,30)=10.62$), $p=.003$, $\eta_p^2=.261$). Figure 3.2 illustrates this interaction and shows that the dialect groups are responding differently across the pronunciation types. Further exploration examines the dialect groups independently.

Monodialectal toddlers

In the monodialectal group a marginal main effect of Naming was found ($F(1,15)=3.95$, $p=.065$, $\eta_p^2=.209$) but no overall main effect of Pronunciation type ($F(1,15)=1.88$, $p=.19$, $\eta_p^2=.112$). A significant interaction between Naming and Pronunciation ($F(1,15)=14.17$, $p=.002$, $\eta_p^2=.486$) was also found, indicative of the toddlers treating correct and incorrect pronunciations differently. Looks to the target increased from the pre-naming to the post naming phase following correct pronunciations (t(15)=-4.26, p=.001, d=1.80; pre-naming - mean = .43, SD = .10 and post-naming – mean =.60, SD = .09) but not incorrect pronunciations (t(15)=.72, p=.481, d=.27; pre-naming - mean = .50, SD = .07 and post-naming – mean =.46, SD = .17). This supports previous work in this area showing that monolingual toddlers from 12 months identify a familiar target when its label is correctly, but not incorrectly, pronounced (e.g. Mani et al., 2008; Mani & Plunkett, 2007, 2010; Swingley & Aslin, 2000, 2002), indicating that they are sensitive to phonemic or phonetic changes in familiar words. No differences between mispronunciation types was found for monodialectal toddlers (all t's <1).

Multidialectal toddlers

In multidialectal toddlers, a main effect of Naming was found (F(1,15)=10.10, p=.006, η_p^2=.402), together with no main effect of Pronunciation (F(1,15)=1.56, p=.231, η_p^2=.094) and no interaction between Naming and Pronunciation (F(1,15) < 1, η_p^2<.001), suggesting toddlers were looking longer at the target in the post-naming phase regardless of pronunciation. For correct pronunciations there were significantly longer looks to the target following naming (t(15)=-2.78, p=.014, d=.98; pre-naming - mean = .50, SD = .07 and post-naming – mean =.57, SD = .08) as with monodialectal toddlers. What differed between the two dialect groups was the response when the target was incorrectly named: here a significant increase in PTL during the post-naming phase (t(15)=-2.50 p=.024, d=.60; pre-naming - mean = .45, SD = .11 and post-naming – mean =.53, SD = .13) was observed, similar to what was found for correct pronunciations. There was no correlation between the amount of exposure to the local accent and performance in mispronounced trials (r=.336, n=16, p=.204).

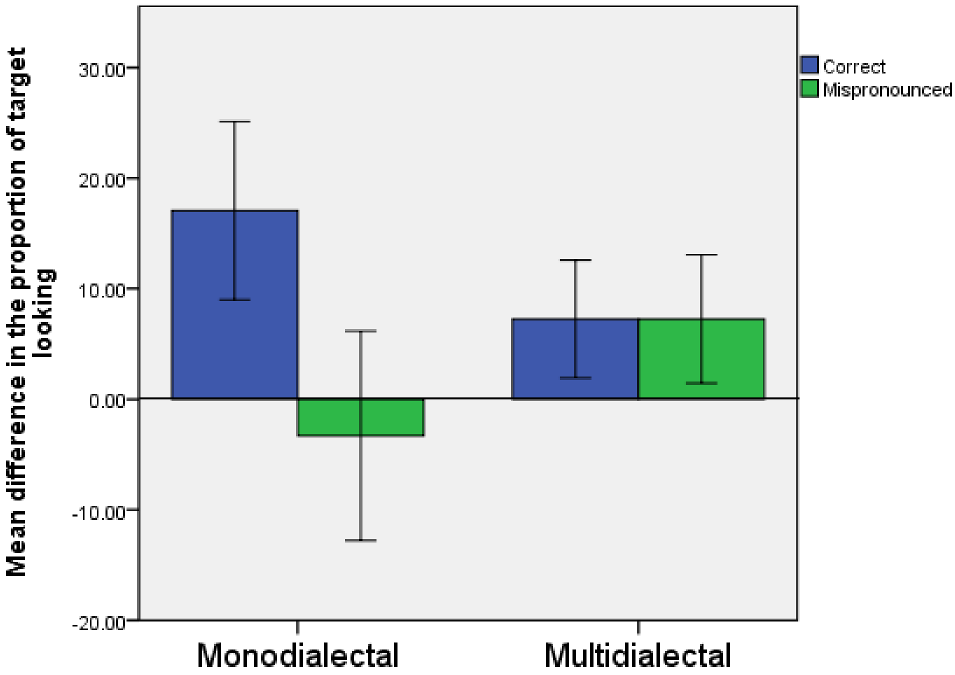

Figure 3-2 - *Mean difference in the proportion of looking times to the target over the distracter (post-naming phase – pre-naming phase) for the multidialectal (left) and monodialectal groups (right). Error bars represent +/- 1.5 SE.*

Due to the nature of accents differing mainly on vocalic details (Wells, 1982), performance on vowel and consonant mispronunciations was compared (see Figure 3.3). Results indicated that in multidialectal toddlers, correct pronunciations yielded a significance increase in target looking in the post-naming phase compared to the pre-naming phase ($t(15)=2.78$, $p=.04$, adjusted for multiple comparisons; pre-naming - mean = .50, SD = .08 and post-naming – mean =.57, SD = .08) whilst consonant mispronunciations showed only a marginally significant increase ($t(15)=-2.59$, $p=.06$, $d=.80$, adjusted for multiple comparisons, pre-naming - mean = .45, SD = .12 and post-naming – mean =.55, SD = .12) and there was no difference following vowel mispronunciations ($t(14) < 1$; pre-naming - mean = .46, SD = .16 and post-naming – mean =.50, SD = .21). This could suggest that multidialectal toddlers are more sensitive to vowel mispronunciations than consonants, or that following an initial consonant mispronunciation the remaining overlap with the correct pronunciation is enough to identify the target. In contrast, in the monodialectal group only the correct pronunciations evoked longer looking times to the target following naming ($t(15)=-4.26$, $p=.003$, $d=1.80$, adjusted for multiple comparisons; pre-naming - mean = .43, SD =10 . and post-naming – mean =.60, SD =.09) with no increase observed for either vowel or consonant mispronunciations ($t(15)<1$; consonant pre-naming - mean = .50, SD = .15, consonant post-naming – mean =.51, SD = .15, vowel pre-naming - mean = .49, SD = .15 and vowel post-naming – mean =.42, SD = .23).

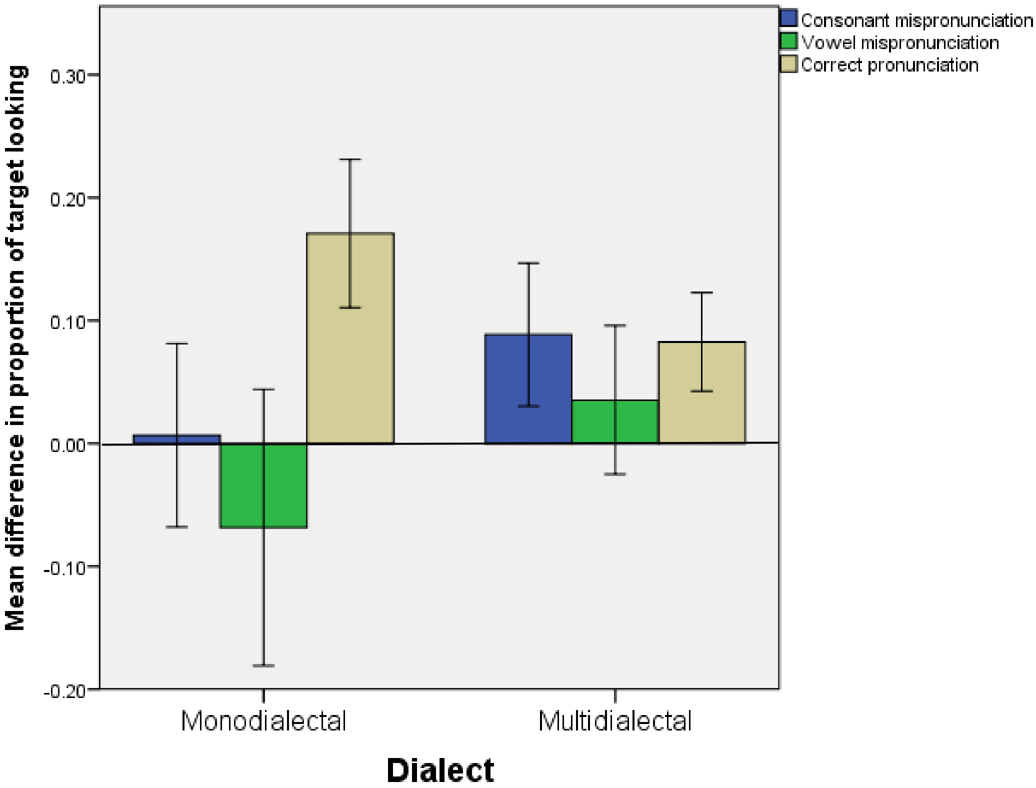

Figure 3-3 - *Mean difference in the proportion of looking times to the target over the distracter (post-naming phase – pre-naming phase) for consonant mispronunciations (left), vowel mispronunciations (centre) and correct pronunciations (right) shown for each dialect group – monodialectal (left three bars) and multidialectal (right three bars). Error bars represent +/- 1.5 SE.*

3.1.3 Discussion

The present experiment sought to add to the growing body of work looking at the effects of variability on young toddlers' word learning abilities. However, in contrast with previous work, where variability was introduced during the experimental procedure, this experiment utilised instead the continuous and natural variability characteristic of the input to multidialectal toddlers. These toddlers hear variable pronunciations as a result of at least one of their parents speaking with a dialect that differs from that of the local area, whereas monodialectal toddlers hear mostly consistent phonological input from both parents and the ambient environment. The monodialectal group of toddlers, who hear little input variation, behaved consistently with previous findings with monolinguals (Mani et al., 2008; Mani & Plunkett, 2007; Ramon-Casas et al., 2009; Swingley & Aslin, 2000): these toddlers did not accept mispronunciations as adequate exemplars of familiar words, as demonstrated by a significant interaction between Naming and Pronunciation. Contrastingly, the multidialectal toddlers looked at the target more often after naming regardless of how the word was pronounced. The difference in performance between the two groups suggests that long-term exposure to dialectal variability does indeed have an impact on toddlers' representations of familiar words.

One interpretation of these results would be that multidialectal toddlers experience a delay in the creation of detailed word representations as compared to monodialectals, similarly to the interpretation of monolingual and bilingual performance differences. According to another perspective, the pattern of results could indicate that multidialectals are more able than monodialectals to accommodate variations in speech, due to more relaxed phonetic boundaries. In what follows both of these interpretations are discussed.

The first explanation is that phonological specificity of early lexical representations is affected by variable input, as suggested by results from Best et al. (2009) and Rost and McMurray (2010). Monodialectal toddlers' lexical entries contain sufficient phonological detail that mispronunciations of a single phoneme interfere with the identification of a target referent as has been shown as early as 12 months of age (Mani & Plunkett, 2010). That multidialectal toddlers behave differently suggests that their representations may be phonologically less well specified as a result of exposure to dialectally variable pronunciations. The development of representations that are robust enough to deal with phonological deviations in the form of mispronunciations may be hindered by inconsistencies in the pronunciations they are hearing as a result of dialectal variation.

A second interpretation of these results could relate to the broadening of phonetic categories suggested by studies such as White and Aslin (2011). White and Aslin propose that toddlers accept the trained vowel-shifted pronunciation due to a relaxation of a particular vowel boundary encountered in training, that is, an input-specific boundary relaxation. Although the current results differ from those found by White and Aslin (2011), where toddlers were able to detect mispronunciations that differed from the vowel shift they experienced, boundary relaxation could still be a factor here. In the current experiment multidialectal toddlers treat mispronunciations similarly to correct pronunciations, despite the fact that they have not encountered them previously nor had any experience with the changes tested (more specifically, the changes were phonemically valid in their dialects, but did not correspond to any current dialect variations). Perhaps long term exposure to variability results in a more general relaxation of boundaries, rather than an input-specific relaxation, which then leads to less well specified representations of individual words in their lexicon.

In a similar vein Schmale et al. (2011) found that even relatively brief exposure to variable pronunciations relaxes phonetic boundaries in a more general way to accommodate variation and the results presented here indeed seem to suggest a similar effect. One key difference between Schmale et al. (2011) and the current paper is the duration of exposure to variability. For the toddlers in the Schmale et al. (2011) paper the variability is brief and heard only during the study whereas the toddlers in this paper hear continuously variable pronunciations. It would be of interest to further explore the effects of exposure duration in relation to any lasting effects of broadened categories. That is, the effects observed by Schmale et al. (2011) could be short–lived whereas long-term exposure to variability could result in persistent boundary broadening. This could be problematic for toddlers learning new words as there are likely to be instances where natural dialect variation crosses phonetic boundaries. This could lead toddlers to consider two words pronounced differently as the same word when actually they are minimal pair words, e.g. 'cot' and 'cat'. The reverse could also be expected, an accented word could be considered a different word and not related to the target.

Returning to the parallel between multilingual and multidialectal children, Ramon-Casas and Bosch (2010) suggest that cognate words are less well represented than non-cognates in the lexicon of the bilingual child. Indeed, Ramon-Casas et al. (2009) found that Spanish-Catalan bilingual toddlers failed to discriminate a Catalan specific contrast (/e/ and /ɛ/) when tested with familiar cognate words ([gə'lɛtə] to [gə'letə] 'cookie'). However, the same contrast in non-cognate words ([pi'tɛt] 'bib' to [bu'lɛt] 'mushroom') was successfully discriminated (Ramon-Casas & Bosch, 2010). As mentioned previously, for multidialectal toddlers nearly all words are cognates: often they hear two pronunciations of each word due to the dialect differences they are exposed to. Cognate effects could be affecting the representations of multidialectal toddlers in much the same way as they are problematic for bilingual toddlers, leading to them having less well represented lexical entries.

A further, task-demand based, explanation could be that the greater phonological overlap between the spoken target and the intended target image than between the spoken target and the distracter image is leading multidialectal toddlers to use a 'best fit' strategy for target recognition and distracter exclusion. That is, the lack of phonological overlap between 'gat' and 'cow' allows them to reject the distracter 'cow' , whereas the shared phonological content of 'gat' and 'cat' causes them to look longer at the picture of the 'cat' while ignoring the elements of the word that are mismatched. This would, in fact, be a sensible strategy for multidialectal toddlers to adopt given the variability of the phonological information they hear. In this way they focus on those elements of the words and images that are complementary and use these to guide their looking behaviour. This explanation is addressed in Experiment 2 where unfamiliar distracter items are used; in this scenario multidialectal toddlers may be able to demonstrate sensitivity to mispronunciations not previously seen when both images are familiar.

The key finding of the current experiment is that multidialectal infants process mispronunciations of familiar words differently to their monodialectal peers, showing for the first time that long-term exposure to within-language variation affects the specificity of early representations of words.

3.2 Experiment 2 – Mispronunciation detection in monodialectal and multidialectal toddlers – Coda consonants and unfamiliar distracters

The results of Experiment 1 suggest that multidialectal toddlers' representations of words differ from those of their monodialectal counterparts. It was found that multidialectal toddlers accept single feature mispronunciations occurring in the onset consonant and medial vowel positions of familiar words, whereas monodialectal toddlers reject the same mispronunciations. However, these results do not indicate the origins of multidialectal toddlers' performance in this task. Two possibilities can be offered: either word representations in multidialectals are impoverished, leading to an acceptance of the mispronunciations as exemplars of the target word; or the variability in their input allow them to be flexible in the degree to which the heard word and the representation match. The introduction of unfamiliar distracters (e.g. an image of a dog paired with a shuttlecock and accompanied by the label 'dog' or mispronunciations 'tog', 'dag' or 'dod') in the following experiment will allow for these alternative explanations to be tested by providing an opportunity for toddlers to demonstrate the specificity of their representations. In this experimental situation the child cannot use the distracter image to guide their looking behaviour as it has no stored label in their lexicon (no name of the image of the shuttlecock for example).

It has been shown by White and Morgan (2008) that the use of unfamiliar distracters allows to observe graded sensitivity to the number of features changes in mispronunciation tasks. Using an IPL procedure they presented 19 month old toddlers with pairs of images where one depicted a familiar object and the other an object that toddlers would not know at this age (e.g. a shuttlecock). Part way through the trial toddlers heard the familiar word that was either correctly pronounced or mispronounced on the onset consonant by one, two, or three features. White and Morgan (2008) found that toddlers' sensitivity to mispronunciations was influenced by the number of features changed between the original phoneme and the mispronunciation. The more features changed in the mispronunciation from the canonical production, the less time toddlers spent looking at the target image. Importantly, when the distracter image was a familiar object graded sensitivity was not observed in toddlers of the same age using the same paradigm with vowel mispronunciations of different sizes (Mani & Plunkett, 2007). White and Morgan (2008) explain these performance differences as directly related to the presence of the unfamiliar objects. Because the child has no name for the novel object, it constitutes a viable contender for the referent of the mispronounced word, should there be a mismatch between the word representation for the familiar word and its auditory label. In studies where both objects are familiar, the norm in this area of research (Mani & Plunkett, 2007; Swingley & Aslin, 2000, 2002), the distracter image can be ruled out as the intended target due its lack of similarity with the auditory stimulus. In the context of an unfamiliar distracter, multidialectal toddlers might demonstrate well specified representations by rejecting the mispronunciation as a 'good enough' pronunciation of the target.

Experiment 1 also demonstrated a marginally significant effect for the onset consonant mispronunciation, and not for the medial vowel change in multidialectal toddlers; this could suggest that toddlers were sensitive to vowel but not consonant mispronunciations. However, it must be noted that there were only 4 trials per toddler for each of these pronunciation types and so the data on which this conclusion is based is limited. Nevertheless this finding is surprising for two reasons. First it has been established that English toddlers are equally sensitive overall to vowel and consonant changes in familiar words (Floccia, Nazzi, Delle Luche, Poltrock, & Goslin, 2013; Mani &

Plunkett, 2007, 2010); second dialectal pronunciations are more likely to differ across vowels than consonants (Wells, 1982) and so vowels would be where multidialectal toddlers would hear a greater range of variability, yet the results of Experiment 1 suggest that multidialectal toddlers may have stronger representations of the vocalic segments. From the results of Experiment 1 it is not possible to conclude whether this effect is due to the phonemic change (vowel or consonant) or the position of the mispronunciation in the word (onset or medial). To disentangle the role of phonemic and positional changes in word recognition, the next experiment will include changes to the coda position in addition to the onset and medial in Experiment 1. If toddlers represent vowels and consonants to differing degrees of specificity with vowels better represented than consonants, mispronunciations of coda consonants should have less impact on target recognition in multidialectal toddlers, similarly to onset consonant changes in Experiment 1. In contrast, if children are more sensitive to the position of mispronunciations, with late segments mismatches being detected better than early ones, then coda mispronunciations would be most disruptive to target recognition in multidialectal toddlers.

Previous research investigating the specificity of the coda position in word recognition has found mixed results. It has been shown by Zamuner (2006), with Dutch toddlers and using a modified HTPP, that the coda is not well specified in newly learned words. In this study infants aged 10 months and 16 months were habituated to a novel word and then were tested on that word and a mispronunciation of the same word in alternating trials. At 10 months, with word onset mispronunciations infants successfully discriminated the correct and mispronounced variants, but the same mispronunciation in the coda position was not discriminated. This finding suggests that in newly learned words onsets are sufficiently encoded that a change can be identified but this is not the case for the coda position. The same stimuli were played to 16 month toddlers who successfully discriminated both onset and coda mispronunciations from correct pronunciations. These results show that the ability to detect changes in the coda position follows a developmental trajectory. At 16 months, but not at 10 months, toddlers' representations of newly learned words contain detail of phonemes in both onset and coda positions.

In contrast, further evidence with Dutch infants suggests that they are sensitive to mispronunciations in the coda position, in some instances, from as early as 11 months. Swingley (2005) contrasted lists of familiar words, e.g. 'pus' [cat], with lists of unfamiliar non-words, e.g. 'vaarnt', using a HTPP, finding that toddlers listened longer to lists containing familiar words. He also found that toddlers listened longer to familiar words when contrasted with onset mispronounced words e.g. 'tus' for 'pus'. This suggests that their representations are well specified for this position in the word so that onset mispronunciations are rejected as familiar tokens. In addition, when the onset mispronounced words were contrasted with the unfamiliar words, no preference for either list was found. This suggests that infants did not recognise the onset mispronunciations as familiar words, treating them similarly to the unfamiliar tokens.

When presenting toddlers with mispronunciations in the coda position, e.g. 'puf', pitted against the unfamiliar words, the same effect was observed; infants did not recognise the coda mispronounced words as familiar, suggesting they identified the mispronunciation. However, when coda mispronounced words were tested against correctly pronounced familiar words, infants did not show a preference for either list. This lack of preference suggests that when compared with familiar words those mispronounced in the coda position are not differentiated, and treated as equal to the correct pronunciations.

To sum up, performance differences were observed between onset mispronounced words, clearly discriminated from correctly pronounced familiar words, and coda mispronunciations, treated similarly to correctly pronounced familiar words. Whilst this suggests that mispronunciations of the coda position are less well specified than those of onsets, it remains that toddlers must have some knowledge of the coda information, since that did not treat the coda mispronunciations as familiar when directly contrasted with unfamiliar words. Swingley (2005) argues that the representations of the familiar words were activated by the initial overlap and that the coda mispronunciation effect was not robust enough to override this activation when faced with correct pronunciations for comparison. This interpretation draws on parallels with the Cohort Model typically used to describe adult spoken word recognition (Marslen-Wilson & Welsh, 1978).

This model proposes that upon hearing a word all potential candidates for recognition that share the initial phonemes of that word are activated. For example, upon hearing /butterfly/, the words /bug/, /butter/, /ball/ etc. are activated following identification of the initial phoneme /b/. As more of the word is heard those lexical entries that no longer match are discarded as potential candidates (e.g. Cole & Jakimik, 1980; Marslen-Wilson, 1987; Marslen-Wilson & Tyler, 1980; Marslen-Wilson & Welsh, 1978; Tyler, 1984). In the above example the word butterfly would be recognised once the 'f' has been heard; prior to this point the speaker could be saying another word, e.g. 'buttercup'. The 'f' is the first point in this word at which these two words become distinct from one another and the decision can be made (Taft & Hambly, 1986); this is often referred to as the uniqueness point of the word. If toddlers are using a similar process of online word recognition then it seems reasonable to assume that an onset mispronunciation would be more damaging to word recognition than one in the coda position, as is found by Swingley (2005). The differing influence of onset mispronunciations compared to those later in the word has been well documented in adults. It has been shown that mispronunciations occurring after the uniqueness point are detected faster (e.g. Cole & Jakimik, 1980). Swingley et al. (1999) showed that toddlers also interpret words incrementally, taking longer to switch from looking at a picture of a doll to a picture of a dog when hearing 'dog' than to switch from a picture of a tree to that of a dog. . The phonological overlap at the onset of 'doll' and 'dog' led to a delay in switching from the picture of the doll as a potential candidate for the word being heard. Alternatively, when there is no phonological overlap, as with dog and tree, tree is not considered as the referent of the label and is rejected faster.

The findings from Swingley (2005) have been extended to word learning tasks with Dutch learning toddlers. Levelt (2012) used the single word variant of the Switch task (Stager & Werker, 1997) to train 14 and 18 month toddlers on a novel word object pairing. In this version of the Switch task toddlers are taught a single novel word object pairing and then tested on trials where there is no change to the target word or where a change is made. This change creates a mispronounciation of the word by altering a single phoneme, e.g. training with 'bih' and testing with 'dih' (Stager & Werker, 1997), or adding or omitting a coda, e.g. trained with 'pat' and tested with 'pa' or the reverse (Levelt, 2012). With the added coda all toddlers noticed the switch and looked longer at trials where this additional information was present. However, Levelt (2012) found that a coda that was present during training but omitted at test was not detected by toddlers at 14 months but was detected at 18 months. This suggests that toddlers' representations are increasingly specified with age, initially coda differences are not readily identified but this ability improves as the lexicon develops. Levelt (2012) highlights the similarity between the performance of toddlers in this task and their productive language abilities. At 14 months, the youngest age tested in this task, toddlers regularly omit the codas of words they are saying, whereas older toddlers are beginning to produce these. The argument therefore is that in order to produce codas these have to be represented in the lexicon and as long as they are not, the Switch task can help detect the incomplete representations.

Using a different task Fernald et al. (2001) show that English learning toddlers link a word with a missing coda consonant to its intended target in an IPL task. They presented 18 and 21 month toddlers with pairs of images accompanied by an auditory stimulus naming one of them. The auditory stimulus was either a whole word or just the first portion of the word, missing off entirely the coda consonant. In both coda present and coda absent conditions all toddlers successfully identified the target, suggesting that the presence of the coda is not necessary and that partial phonetic information is sufficient for recognition.

The difference in the findings of this study and those of Levelt (2012) is unsurprising when differences between the methodologies are considered. In Fernald et al. (2001) toddlers were required to choose between two images, whereas in Levelt (2012) the object was presented alone with either the full pronunciation or the coda omitted one. The reduced task demands in the variant of the Switch task used by Levelt (2012) could explain the earlier success observed (see also Stager & Werker, 1997). An alternative explanation of Fernald et al. (2001) is that toddlers are identifying the target early into the trial and as such the omission of the coda is not identified once the decision has been made about the intended target. These combined findings suggest that coda information is retained but is not necessary for recognition of familiar words from 18 months of age.

Additional evidence from French learning toddlers supports the claim that by 20 months toddlers' representations include the coda consonant. Nazzi and Bertoncini (2009) tested toddlers' abilities to learn two words differing only by the coda information using a name based categorisation task. This task began with a training phase where the toddler was shown two objects, with each one repeatedly named. After a number of presentations a third object was introduced for the test phase, and given the same name as one of the objects presented in the training phase. The toddler was then asked to pass the experimenter the other one with the same name. If toddlers have encoded all aspects of the words from the training phase they should be able to select the correct object from the original pair; if not they should choose at chance. This has been demonstrated as a successful technique with French toddlers reliably choosing the correct object when the change occurred on the onset consonant (Nazzi, 2005). In this follow-up study Nazzi and Bertoncini (2009) changed the coda consonant of the words presented to 20 month toddlers. The toddlers succeeded in the task even when the changes occurred in the coda position, suggesting that their representations of newly learned words at this age retain the coda information with enough detail that this can be used to differentiate two words.

Further evidence using the IPL task with English population of 14 and 22 month toddlers found reliably target recognition only following correct pronunciations. Swingley

(2009) tested target recognition following onset and coda mispronunciation of familiar words; when presented with mispronunciations in both the onset and coda positions none of the toddlers looked towards the target. This further supports the idea that toddlers represent all word positions with enough specificity that any modification impairs recognition of a target word. Swingley (2009) further reports that toddlers' looking behaviour is mediated by the position of the mispronunciation in the word. For all mispronunciations the latency of the switch away from the target coincided with the point at which the mispronunciation occurred, that is, if the mispronunciation was 500ms into the word, the shift was delayed by that duration with no performance differences observed between the mispronunciation types. This indicates that toddlers were responding directly to the mispronunciation as they heard it and supports the claim that phonemes in the coda position are well specified.

Finally, graded sensitivity to the number of feature changes between a correct pronunciation and a mispronunciation has also been demonstrated when the changes occur in the coda position. Ren and Morgan (2011) used an identical procedure to White and Morgan (2008) pairing familiar targets with unfamiliar distracters and creating mispronunciations using one, two, or three feature changes. The difference between Ren and Morgan's design and the original White and Morgan (2008) version was that the changes occurred in the coda position instead of the onset. Ren and Morgan (2011) report a similar result as White and Morgan (2008): 19 month old toddlers showed a graded sensitivity to the number of feature differences between a correct and incorrect pronunciation of the coda. It is therefore suggested that toddlers' representations of phonemes in the onset and coda positions are similarly specified.

The evidence presented here suggests that toddlers' representations of words initially lack detail for the coda position (Levelt, 2012; Swingley, 2005, 2009) but that specificity develops over time, with robust representations of the coda present in the lexicon of toddlers as young as 14 months (Fernald et al., 2001; Nazzi & Bertoncini, 2009; Swingley, 2009). The current experiment seeks to further explore the findings of

Experiment 1, where performance differences in a mispronunciation task were identified in monodialectal and multidialectal population, by adding coda mispronunciations to test trials. As in Experiment 1 two groups of toddlers will be tested, monodialectal and multidialectal. Using an IPL paradigm target recognition following correct pronunciations and mispronunciations of familiar words will be tested. Mispronunciations will affect the onset consonant, medial vowel and coda consonant of the words to allow for a comparison of all pronunciation types and phoneme location. In order to accommodate the coda mispronunciations additional trials will be needed; due to this toddlers at the slightly older age of 21 months will be tested as there are more words typically known at this age. Based on the current evidence (Fernald et al., 2001; Nazzi & Bertoncini, 2009; Swingley, 2009), by this age the coda should be clearly represented in the familiar words of their lexicon, which will allow any differences in specification between the dialect groups to be observed.

Crucially, in addition to the inclusion of coda mispronunciations, Experiment 2 presents unfamiliar objects as the distracter images, which will hopefully provide toddlers with an opportunity to demonstrate sensitivity to mispronunciations as in White and Morgan (2008) and Ren and Morgan (2011). Following the results of Experiment 1 and the evidence from coda mispronunciation studies, it is expected that monodialectal and multidialectal toddlers will respond differently to mispronounced trials. Specifically, monodialectal toddlers are expected to fixate the target only after hearing correct pronunciations whereas multidialectal toddlers could respond in several ways. First, if variable exposure leads to flexible representations of familiar words then multidialectal toddlers will look to the target in all conditions regardless of the word position affected by the mispronunciation.

Second, if toddlers' performance is moderated by the type of phoneme changed differences could be observed between mispronunciations affecting the consonant (onset and coda), and the vowel (medial). Specifically, if the differences observed between vowels and consonants in Experiment 1 (vowels seemed to be better represented than consonants in multidialectal toddlers) are related to the phonemic change rather than the positional change, then vowel mispronunciations will be better detected than consonant ones.

Finally, toddlers' performance could be influenced by the position of the mispronunciation in the word. The direction of this effect is difficult to predict: Experiment 1 showed that toddlers identify the target following onset mispronunciations better than medial vowel mispronunciations. From this it would be expected that the coda mispronunciation would show the least target recognition. However, previous research with the perception of coda consonants (Levelt, 2012; Swingley, 2005, 2009) suggests that these are less well represented; as such an increase in target recognition would be expected for coda mispronunciations.

3.2.1 Method

Toddlers aged 21 months were presented with pairs of images, one familiar and one unfamiliar, accompanied by either a correctly or an incorrectly pronounced label for the target image. Mispronunciations were created by modifying the onset consonant, medial vowel or coda consonant of familiar words by a single feature, in order to assess toddlers' sensitivity to mispronunciations of familiar words as a function of their location (onset, medial, and coda) and/or phonemic status (consonant/vowel). As in Experiment 1, toddlers belonged to one of two groups based on their linguistic exposure and were classified as monodialectal or multidialectal accordingly.

Participants

There were 37 monolingual English toddlers successfully tested for this experiment, all raised in the South West of England. Toddlers were classified as belonging to one of two groups: monodialectals (N= 21, 10 boys, mean age = 20 months, 30 days) and multidialectals (N= 16, 8 boys, mean age = 21 months, 2 days). An additional 21 toddlers were tested but excluded due to fussiness (10), technology failure (3), too old (1) and not enough exposure to either the local accent or the additional accent (7). No toddlers were reported to have any developmental delays, hearing problems or were born more than six weeks prematurely.

Table 3.3 - *List of dialects heard by each of the multidialectal toddlers included in the study. Both parents of monodialectal toddlers spoke with a British South West dialect. Toddlers 7, 14 and 15 heard the local dialect only from their childcare provider; however, the behaviour of these infants followed the same pattern as the others in the multidialectal group.*

Child	Multidialectal		% Exposure to South West
	Mother	Father	
1	South East	South East	29%
2	Birmingham	South West	39%
3	South West	South East	57%
4	Plymouth	Liverpool	56%
5	Plymouth	Hampshire	62%
6	Oxford	Scottish	74%
7	South East	South East	43%
8	Northamptonshire	South West	46%
9	Birmingham	South West	26%
10	South West	South Africa	38%
11	South East	South West	40%
12	South West	Manchester	74%
13	South West	South East	31%
14	South West	South East	75%
15	American	South West	32%
16	South East	South East	25%

Parents were asked to complete the OCDI; data is missing from 3 multidialectal toddlers due to parental non-completion. No significant difference was found between the two groups (mean understanding scores – monodialectals = 261 words, range 60-401 and multidialectals = 267 words, range 129-366, $t(32)=-.24$, $p = .82$; mean production scores – monodialectal = 132 words, range = 8-334 and multidialectal = 138 words, range = 32-357, $t(32) < 1$). Toddlers were classified as mono or multidialectal exactly as described for Experiment 1. See Table 3.3 for a full list of the dialects spoken by the parents of multidialectal toddlers. Multidialectal toddlers heard the local South West dialect on average around 47% of the time (range – 25 – 75%).

Stimuli

Twenty-four monosyllabic CVC target words commonly understood by toddlers at this age were taken from the OCDI (mean understanding score = 87%). These words were paired with a distracter object deemed unfamiliar to toddlers of this age and taken from a list of unfamiliar objects used by White and Morgan (2008). A full list of the object pairings can be found in Table 3.4. All 24 pairs were seen once by each toddler, each measuring 36cm diagonally from corner to corner and presented 31cm apart. Images were colour photographs, controlled for size and presented on a white background. Images were deemed good exemplars of the target by the experimenter and independent observers.

Of the 24 test trials, there were 6 each of the 4 pronunciation types: correct, mispronounced on the onset consonant, mispronounced on the medial vowel or mispronounced on the coda consonant, by a single feature whenever possible (Table 3.4 contains a full list of the mispronunciations). A female native British English speaker of the local dialect produced the stimuli in a child directed manner. All auditory stimuli were presented in the carrier phrase 'Look! *Target'*

Procedure

Toddlers were seated in a highchair approximately 86cm from a widescreen television viewing pictures that measured 36cm across the diagonal and were 31cm apart. Cameras positioned directly above the visual stimuli recorded their eye movements. The auditory stimuli were presented by a centrally positioned speaker, see Appendix D for diagrams of the setup from an aerial and front view perspective. All other procedural details for this experiment were identical to Experiment 1.

Table 3.4 - *Summary of stimuli and phonetic transcriptions used for correct and incorrect trials. Percentages represent the number of 20 month infants who know the target words based on OCDI norms. For each mispronunciation the timing of the onset of the change is added.*

Target	Onset change	Vowel change	Coda change	Distracter
Ball (100%) /bɔ:l/	/gɔ:l/ 0ms	/ba:l/ 25ms	/bɔ:n/ 375ms	Doorknocker
Bath (93%) /bɑ:θ/	/dɑ:θ/ 0ms	/bɔ:θ/ 45ms	/bɑ:s/ 280ms	Pickle
Bed (100%) /bɛd/	/pɛd/ 0ms	/bʌd/ 26ms	/bɛg/ 205ms	Fan
Bib (79%) /bɪb/	/dɪb/ 0ms	/bɛb/ 26ms	/bɪp/ 161ms	Lantern
Bin (71%) /bɪn/	/dɪn/ 0ms	/bɛn/ 29ms	/bɪm/ 220ms	Padlock
Boat (64%) /bəʊt/	/pəʊt/ 0ms	/baʊt/ 30ms	/bəʊk/ 200ms	Avocado
Book (93) /bʊk/	/pʊk/ 0ms	/bɪk/ 26ms	/bʊt/ 190ms	Paint roller
Bus (79%) /bʌs/	/pʌs/ 0ms	/bæs/ 15ms	/bʌθ/ 169ms	Abacus
Cat (100%) /kæt/	/gæt/ 0ms	/kɛt/ 120ms	/kæd/ 332ms	Bee hive
Coat (79%) /kəʊt/	/təʊt/ 0ms	/kaʊt/ 100ms	/kəʊp/ 297ms	Bullhorn
Cot (100%) /kɒt/	/tɒt/ 0ms	/kɔ:t/ 116ms	/kɒp/ 272ms	Trophy
Cup (71%) /kʌp/	/tʌp/ 0ms	/kɛp/ 125ms	/kʌb/ 257ms	Artichoke
Dog (100%) /dɒg/	/bɒg/ 0ms	/dʊg/ 25ms	/dɒd/ 245ms	Hourglass
Doll (79%) /dɒl/	/gɒl/ 0ms	/dɔ:l/ 30ms	/dɒn/ 270ms	Accordion
Duck (100%) /dʌk/	/gʌk/ 0ms	/dæk/ 24ms	/dʌt/ 141ms	Waffle maker
Fish (86%) /fɪʃ/	/vɪʃ/ 0ms	/fɛʃ/ 96ms	/fɪʒ/ 250ms	Shuttlecock
Foot (71%) /fʊt/	/θʊt/ 0ms	/fɪt/ 99ms	/fʊp/ 241ms	Bottle opener
Hat (86%) /hæt/	/ʃæt/ 0ms	/hɛt/ 130ms	/hæp/ 244ms	Pliers
Keys (86%) /ki:z/	/ti:z/ 0ms	/ku:z/ 102ms	/ki:v/ 500ms	Garlic
Leg (79%) /lɛg/	/nɛg/ 0ms	/lɪg/ 110ms	/lɛk/ 230ms	Tin opener
Pen (64%) /pɛn/	/bɛn/ 0ms	/pæn/ 125ms	/pɛm/ 230ms	Horseshoe
Pig (93%) /pɪg/	/tɪg/ 0ms	/pɛg/ 90ms	/pɪd/ 240ms	Pump
Sheep (86%) /ʃi:p/	/ʒi:p/ 0ms	/ʃu:p/ 196ms	/ʃi:b/ 244ms	French Horn
Sock (100%) /sɒk/	/zɒk/ 0ms	/sɔ:k/ 193ms	/sɒt/ 293ms	Barrel

Scoring

Toddlers' gaze direction and fixations were determined on a frame-by-frame basis (every 40ms). A second skilled coder independently scored a random sample of 10% of the videos with an Intraclass Correlation Coefficient of .998 (Shrout & Fleiss, 1979).

These codings were used to calculate the amount of time toddlers spent looking at the target and distracter in each of the pre and post naming phases for each trial. Looking times occurring between 367ms and 2000ms after the onset of the mispronunciation in the word (exact timings are included in Table 3.4) were analysed. The time window used here reflects that used in Experiment 1 and previous studies (e.g. Swingley & Aslin, 2000) combined with the information about the onset of the mispronunciation for each word: this allows to account for the delay in latency reported by Swingley (2009) with coda mispronunciations.

3.2.2 Results

Trial inclusion criteria are the same as for Experiment 1 and the PTL measure used for all analyses. Data were entered into a mixed model ANOVA with the within-participant factors Naming (pre and post) and Pronunciation (correct, incorrect onset, incorrect vowel and incorrect coda), and the between-participant factor Dialect (monodialectal and multidialectal). A main effect of Naming was identified ($F(1,35) = 18.66$, $p<.001$, $\eta_p^2 = .35$) together with interactions between Naming and Dialect ($F(1,35) = 11.56$, $p=.002$, $\eta_p^2 = .25$) and Naming and Pronunciation ($F(3,105) = 2.77$, $p=.046$, $\eta_p^2 = .07$). These interactions suggest that overall toddlers respond in different ways to each of the pronunciations and that target looking differs between the two dialect groups (see Figure 3.4). Further analyses examine the dialect groups independently.

Monodialectal toddlers

When considering monodialectal toddlers a mixed model ANOVA with the factors Naming (pre and post) and Pronunciation (correct, incorrect onset, incorrect vowel and incorrect coda) revealed no significant main effects (all *p*'s >.05). However, the interaction between Naming and Pronunciation is approaching significance ($F(3,60) = 2.31$, p=.09, η_p^2 = .10), suggesting that there might be some difference across the pronunciation conditions. It is expected that all toddlers would recognise at least the correct pronunciations: if toddlers were looking more at the target in all naming conditions there would be a main effect of naming. The absence of this main effect and the nature of the design of this experiment could mean that any naming effect in the correct condition is not strong enough when pitted against the other 3 conditions for the interaction to be significant. To confirm, t-tests were conducted comparing each of the mispronunciation conditions to the correct condition to identify any performance differences. One-tailed tests were carried out as performance in the mispronunciation conditions should be equal to or significantly reduced when compared to correct pronunciations. For monodialectal toddlers performance differs significantly from correct trials (mean = .09, SD = .20) when the mispronunciation occurs on the onset (t(21) =1.79, p=.04, d=.64, one-tailed; mean = -.04, SD = .21) and medial vowel (t(21)=1.97, p=.03, d=.67, one-tailed; mean = -.04, SD = .20), but not in the coda position (t(21)<1; mean = .06, SD =.19).

In order to make direct comparisons with toddlers' performance in Experiment 1 additional t-tests were conducted comparing looking times between the pre and post-naming phases. As expected target looking increased in the post-naming phase as compared to the pre-naming phase following correct pronunciations (t(20) = -2.09, p=.05, d=.57; pre-naming - mean = .55, SD = .17 and post-naming – mean =.64, SD = .14) but there was no difference for any of the mispronunciation conditions, (onset – t(20) =-.87, p=.40, d=.30, pre-naming - mean = .59, SD = .13 and post-naming – mean =.55, SD = .14; vowel - t(20)=1.01, p=.32, d=.31, pre-naming - mean = .59, SD = .13 and post-naming – mean =.54, SD = .15; and coda - t(20) = -1.42, p= .17, d=.42, pre-naming - mean = .59, SD = .14 and post-naming – mean =.65, SD = .15). These results suggest that, regardless of word position, mispronunciations of familiar words impair recognition of a target image in monodialectal toddlers and this is supported when comparing conditions directly. What these results demonstrate is that performance in the coda position is similar to correct pronunciations. Interestingly, this is not reflected in the results comparing looking times from the pre and post-naming phases suggesting that rejection of a coda mispronunciation is intermediate and emerging at this stage.

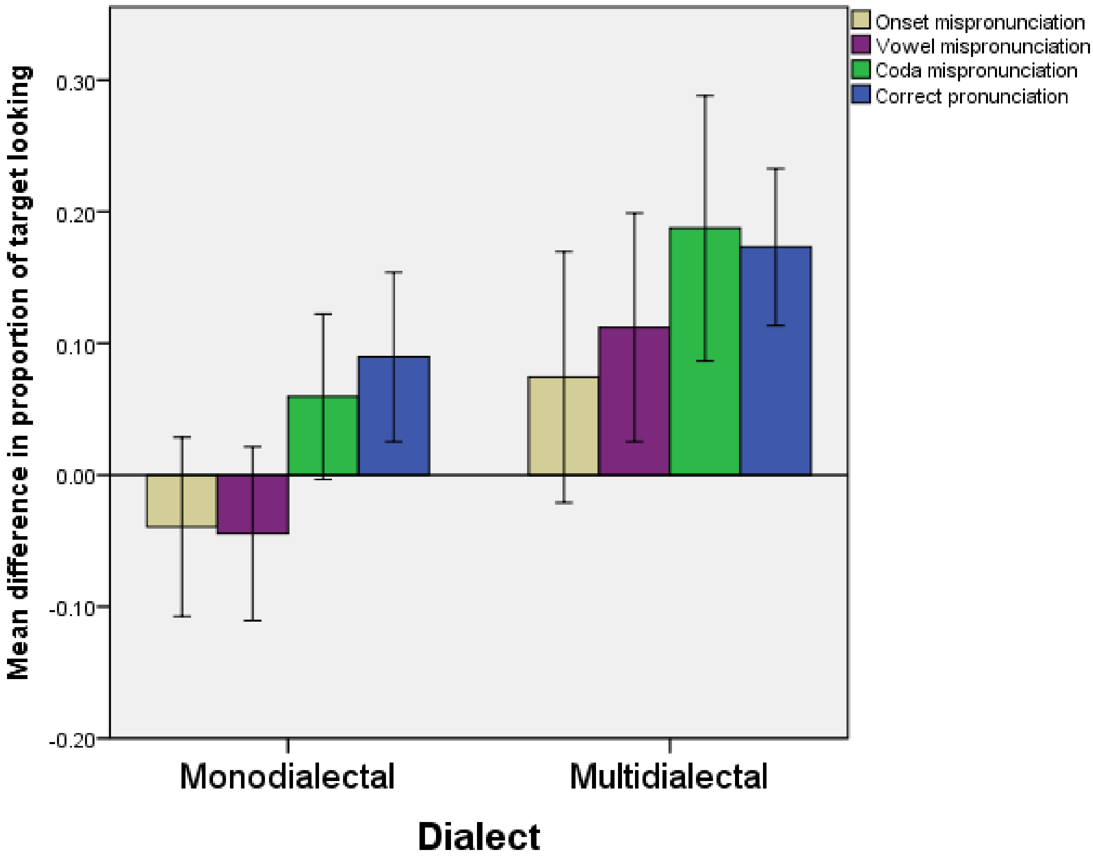

Figure 3-4 - *Mean difference in the proportion of looking times to the target over the distracter (post-naming phase – pre-naming phase) for the multidialectal (left) and monodialectal groups (right). Errors represent 1.5 SE.*

Multidialectal toddlers

For the multidialectal group of toddlers a main effect of Naming was found (F(1,15) = 18.58, p=.001, η_p^2 = .55) and no other significant main effects or interactions (all p's >.05). This suggests that toddlers are looking longer at the target in the post-naming phase than the pre-naming phase in all pronunciation conditions. As with monodialectal toddlers, performance between correct and mispronounced trials was examined using one-tailed t-tests. When considering multidialectal toddlers there were no significant differences between conditions (all *p*'s>.05, one-tailed; correct – mean = .17, SD = .16, onset – mean =.07, SD=.25, vowel – mean =.11, SD =.23, coda – mean =.19, SD =.27).

To make these results directly comparable to the findings of Experiment 1 the difference between pre and post-naming looking times was explored. As with monodialectal toddlers there was an increase in target looking following correct pronunciations of the target word ($t(15)=-4.39$, $p=.001$, $d=1.16$; pre-naming - mean = .46, SD = .15 and post-naming – mean =.64, SD = .13). However, multidialectal toddlers also significantly increased looks at the target following mispronunciations in the coda position ($t(15)=-2.76$, $p=.015$, $d=1.10$; pre-naming - mean = .48, SD = .11 and post-naming – mean =.66, SD = .21), and marginally in the vowel mispronunciation ($t(15)=-1.94$, $p=.072$, $d=.61$;,pre-naming - mean = .52, SD = .13 and post-naming – mean =.63, SD = .16). It is only when the mispronunciation occurred in the onset position that target recognition was impaired ($t(15)=-1.17$, $p=.26$, $d=.15$; pre-naming - mean = .49, SD = .15 and post-naming – mean =.56, SD = .23).

Finally, no correlation between the amount of exposure to the South West dialect and performance on test trials was found (all *p*'s>.05), suggesting that it is general exposure to different dialects that influenced performance rather than a specific amount of exposure.

Novelty effects

To identify whether the novelty of the distracter images influenced toddlers looking behaviour in the pre- and post- naming phases (as has been identified by Mather and Plunkett, 2010, 2012) analyses comparing post-naming looking times to chance (.50) were conducted. The pattern of results does not change. Multidialectal toddlers increased looking to the target following correct pronunciations ($t(15)=4.32$, $p=.001$, $d=1.52$), coda mispronunciations ($t(15)=3.175$, $p=.006$, $d=1.12$) and vowel mispronunciations ($t(15)=3.257$, $p=.005$, $d=1.15$) and in monodialectal toddlers increased looking to the target followed correct pronunciations ($t(20)=4.46$, $p<.001$, $d=1.38$), coda mispronunciations ($t(20)=4.60$, $p<.001$, $d=1.42$). All other p's >.05.

3.2.3 Discussion

In Experiment 1 multidialectal toddlers were found to identify a target image even after hearing a mispronounced label, with this effect stronger for mispronunciations of the onset consonant than the medial vowel, whereas monodialectal toddlers only identified the target when its label was correctly pronounced. The current experiment sought to replicate and extend the findings of Experiment 1, adding a coda mispronunciation and using unfamiliar distracter images. By testing toddlers with mispronunciations in the coda position the following explanations of the results from Experiment 1 could be explored: first, variable exposure might lead to a general flexibility of multidialectal toddlers' representations of words; second, multidialectal toddlers may be more sensitive to vowel changes than consonant changes; finally, the effects observed in Experiment 1 might be due to the position of the mispronunciation in the word. In addition, the inclusion of unfamiliar distracters might allow multidialectal toddlers to demonstrate specificity by removing the opportunity for the auditory label to be compared with both images (as seen in White & Morgan, 2008). Altogether, the stimuli changes between Experiment 1 and the current experiment yielded a similar pattern of results, although some differences were observed that will be discussed.

In the current experiment, in line with the findings from Experiment 1, a difference was found in performance between the two dialect groups. Monodialectal toddlers responded as expected from the literature, demonstrating well specified representations. There was an absence of target recognition in mispronunciation trials and clear target recognition following correct pronunciations, as is frequently found in monolingual populations (e.g. Mani et al., 2008; Mani & Plunkett, 2007, 2010; Swingley & Aslin, 2000, 2002). In contrast, multidialectal toddlers not only increased target looking following correct pronunciations but, unlike monodialectal toddlers, increased target looking following mispronunciations, in some conditions.

Interestingly, multidialectal toddlers' performance on mispronunciation trials did not differ significantly from performance in correct pronunciation trials. This indicates that mispronunciations were not detected by this group of toddlers and were treated similarly to correct pronunciations, wherever they might be in the word. However, when comparing looking times in the post-naming phase as compared to the pre-naming phase, there was no evidence of an increase in target looking in the onset mispronunciation condition. This performance is similar to that observed by Swingley (2005) with toddlers showing an emerging ability to detect mispronunciations that is not yet developed enough to be evident in all positions, or for performance to differ from correct pronunciations. Overall, these results further support the claim that long term exposure to variability influences toddlers' performance with mispronunciations and extends this to cases where mispronunciations occur in the coda position.

The most notable difference between the design of Experiment 1 and the current experiment on these trials was the introduction of an unfamiliar distracter image. It seems reasonable then to suppose that it was the presence of an unfamiliar distracter image that allowed toddlers to demonstrate the specificity of their representations for familiar words and influenced performance with onset mispronunciations. This is a similar effect to that observed by White and Morgan (2008) where toddlers showed graded sensitivity to the number of feature changes when an unfamiliar distracter was present, something which had not been demonstrated with a similar procedure and familiar distracters (Mani & Plunkett, 2007). In this situation, with unfamiliar distracters, the auditory label could equally relate to the novel image and the target and if toddlers are using a strategy of Mutual Exclusivity they would exclude the object for which they already have a name (e.g. cup) in the presence of an unfamiliar word (Woodward & Markman, 1991). The fact that multidialectal toddlers did not increase target looking from baseline following onset mispronunciations of words suggests that their stored representations contain some degree of specificity; however this is only apparent experimentally in the presence of an unfamiliar distracter. When unfamiliar distracters are used toddlers cannot use the distracter to support the decision making process and target recognition is reduced.

This study originally set out to explore three proposals specifically related to the phonetic specificity of the representations of multidialectal toddlers. The first of these explanations, that exposure to variability results in a general expansion of phonetic categories in order to accommodate variability flexibly (Schmale et al., 2011), seems unlikely. The results of the current experiment indicate that multidialectal toddlers' representations may be sufficiently specified that mispronunciations can be detected in certain conditions, at least in an onset position with unfamiliar distracters. Instead of a general phonetic flexibility arising out of variable exposure, these results suggest that toddlers have developed strategies to overcome variability, such as using the remaining unaltered phonemes in the word to guide recognition and exclude the other potential candidates that the speaker could be referring to. When the alternative candidate (the distracter) cannot be ruled out, target recognition is no longer evident, at least in the onset mispronunciation condition (in contrast to Experiment 1). This strategy based explanation provides only a partial account of multidialectal toddlers' performance as target recognition is seen following coda and word medial mispronunciations.

The performance differences related to the position of the mispronunciations in the words weaken the explanation that vowels are better represented in the lexicon than consonants. Instead, these differences point to an explanation related to the position of the mispronunciation in the word rather than to the nature of the mispronounced phoneme. When word onsets are mispronounced toddlers can immediately exclude the target as a candidate for the label, especially when combined with an unfamiliar distracter. To explain why coda mispronunciations are treated similarly to correct pronunciations, one has to refer to the Cohort Model of word processing (Marslen-Wilson & Welsh, 1978), whereby an auditory stimulus is processed incrementally and lexical candidates are discarded as more phonetic information is presented.

To clarify, when mispronunciations are heard and there is no perfect match with the stored representation, no recognition is observed in monodialectal toddlers. However, multidialectal toddlers behave in a way that would be expected with adults following the Cohort Model framework. Multidialectal toddlers reject the target as a candidate following an onset mispronunciation and this effect reduces as the position of the mispronunciation in the word progresses. As the word unfolds in time multidialectal toddlers begin to exclude candidates, in an adult-like way, so that by the time the coda is heard fewer candidates remain and in the majority of cases the decision about the identity of the word is decided. In summary, multidialectal toddlers' failure to reject mispronunciations could be taken to demonstrate faster and more adult like on-line processing of speech.

An alternative explanation related to previous findings from studies looking at coda specificity in familiar words considers these results developmentally. It has been demonstrated across a number of studies that specification of the coda position occurs somewhat later than specification of phonemes in earlier word positions (Levelt, 2012), although this seems to be task dependant and specification has been shown as young as 11 months (Swingley, 2005). What is clear from previous findings is that the coda phoneme is not as robustly represented in the lexicon as that in the onset position when using the same tasks at similar ages. Considering this, the results of the multidialectals in the current experiment could be due to a delay in the specification of the coda position. To formalise this further, exposure to variable input might result in a delay in the formation of robust representations of familiar words in toddlers as only the multidialectal and not the monodialectal toddlers, for whom input variability is reduced, demonstrate specificity of the onset but not of the coda. A further test of this hypothesis that coda specification follows a developmental trajectory in multidialectal toddlers would be to test older toddlers using the same paradigm. If it is the case that multidialectal toddlers are delayed then at a later age they should demonstrate similar performance to monodialectal toddlers with coda mispronunciations when tested at an older age.

To conclude, the results of Experiment 2 further support the claim that long term variability from the input influences toddlers' ability to detect mispronunciations of familiar words. Toddlers exposed to more than one dialect of a single language did not identify a target following an onset mispronunciation in the presence of an unfamiliar distracter; yet they recognised a target image following mispronunciations in a word medial and coda position. However, whether this is indicative of a general delay in phonetic specificity of their representations or enhanced adult-like online processing is unclear at this stage with the available data.

3.3 Conclusions

The studies presented here clearly demonstrate that exposure to dialectally variable input influences performance in a mispronunciation task. In both studies toddlers exposed to variable pronunciations of words on a regular basis looked longer at a target image following correct and incorrect pronunciations of familiar words. In Experiment 1 all monodialectal toddlers presented with single feature mispronunciations of the onset consonant and medial vowel of familiar words paired with familiar distracters only fixated the target following correct pronunciations. Interestingly, a difference was found with multidialectal toddlers, who also displayed longer looking times to the target image following mispronunciations of both onset and medial positions. In contrast, Experiment 2 presented similar groups of toddlers with familiar words correctly pronounced or mispronounced in one of three positions, the onset consonant, the medial vowel or the coda consonant, pairing familiar targets with unfamiliar distracters. These results showed a clear naming effect following correct pronunciations for all toddlers but once more found a difference between the dialect groups. This difference arose as a result of performance in the medial vowel and coda consonant mispronunciation trials, in which multidialectal toddlers fixated the target despite the label being mispronounced.

Considering that the only differences between Experiments 1and 2 were the addition of a mispronunciation location (the coda) and the introduction of unfamiliar distracters it seems reasonable to assume that the unfamiliar distracter supported multidialectal toddlers in demonstrating phonetic specificity. However, this was only found with onset mispronunciations; when the medial vowel or coda was changed, multidialectal toddlers increased target looking after naming. This difference in performance across studies and in different word positions suggests that toddlers may use different strategies for target identification or exclusion depending on the language environment in which they are raised.

A first interpretation of these results is that multidialectal toddlers' representations of familiar words are lacking the specificity required to identify mispronunciations of familiar words. However, the results of Experiment 2 discount this explanation as toddlers are able to identify mispronunciations of the onset consonant when paired with an unfamiliar distracter. An alternative interpretation is that specificity in multidialectal toddlers' representations is delayed. At the age tested in these studies (20-21 months) it is possible that this ability is emerging and therefore only evident in the optimal conditions, for example, when the distracter image is unfamiliar as in Experiment 2. This developmental explanation follows previous evidence demonstrating later detection of mispronunciations to the coda of familiar words than onset mispronunciations (Levelt, 2012). In Experiment 2 multidialectal toddlers failed to reject mispronunciations of the coda yet detected mispronunciations in the onset position, as would be expected of younger toddlers. To clarify this it would be necessary to test older toddlers to identify whether this ability emerges later in multidialectal toddlers.

A third explanation is that rather than being delayed multidialectal toddlers are demonstrating adult-like performance and employing a Cohort Model strategy for online speech recognition earlier than their monodialectal peers. It could be the case that multidialectal toddlers are faster in the development of a word recognition strategy, such as that described by the Cohort Model, in order to accommodate their variable exposure. A mismatch in the onset position has a greater negative impact for recognition than mispronunciations of the later segments (Cole & Jakimik, 1980). This explanation suggests that multidialectal toddlers make their decision regarding the intended target faster than monodialectal toddlers. The conclusion here is that exposure to variability is beneficial and leads to earlier adult-like processing than the uniform exposure of monodialectal toddlers.

At this stage, with the available data, it is not possible to tease apart these explanations. One point to note here is that all of the mispronunciations used here were created by manipulating the standard pronunciation by a single feature and are unlikely to reflect any changes that toddlers will have experienced regularly in their input. This suggests that toddler's performance cannot be explained as a direct influence of exposure to the changes but instead attributed to a more general influence of variability. Perhaps, a better test would be to present toddlers with pronunciations that they have experienced in their language environment. In the following chapter we test toddlers with naturally occurring dialect differences from the local environment.

Chapter 4.

Are multidialectal toddlers better than monodialectal toddlers at recognising dialect variants?

The studies presented in Chapter 3 suggest that multidialectal toddlers, who hear variable pronunciations of words as part of their daily language exposure, respond differently in mispronunciation tasks to monodialectal toddlers, for whom exposure is - overall - uniform. In these tasks, the mispronunciations toddlers heard were created following a system based on the number of phonetic feature changes, rather than specifically relating to existing dialectal variation. Given that multidialectal toddlers demonstrate target recognition when hearing arbitrarily created mispronunciations of words, it seems reasonable to expect that this ability should extend to naturally occurring dialectal differences, e.g. the word 'cup' is pronounced as /kʌp/ across most of the UK but as /kʊp/ in the Midlands and North of England. These pronunciation differences are non-contrastive, that is they both refer to the same object despite differing phonetically, so multidialectal toddlers hearing these are required to accommodate both of these in the lexicon as representative of the single object 'cup'. The following studies seek to explore how toddlers perceive naturally occurring deviations in the pronunciation of words, focusing specifically on allophonic variation testing the same two populations of toddlers as Chapter 3, those toddlers who are routinely exposed to dialect variability and those who are not.

Within the literature the term allophone is used in a number of different ways, here it is used to refer to phones that map onto the same phonemic category. Further to this there are classic cases of allophony commonly discussed: sounds in complementary distribution and sounds in free variation (Seidl & Cristia, 2012). Sounds in complementary distribution refer to cases where the allophone is determined by the context it will occur in. For example, light /l/, as in 'lawn', and dark /l/, as in 'full', are allophonic, they map onto the same phoneme, but are non-overlapping in the contexts in which they occur. The second classic case, free variation, refers to the situation where a phoneme is realised differently in the same lexical position but there is no change to meaning, rendering the pronunciation difference irrelevant lexically. Within free variation cases, there are different types; in this chapter the focus is on glottal stops and deletion, specifically rhoticity. The studies presented here explore whether the effects observed in Chapter 3 are also present when the pronunciation differences in words are naturally occurring and plausible in speech, rather than experimentally created resulting in non-words.

It has been suggested that allophonic variation in speech provides information beyond the meaning of the words being spoken. Ladd (2006) suggests that allophones can be meaningful sociolinguistically and as a result the variants can be highly salient to the listener. However, experimentally it has been found that adults do not discriminate allophones in complementary distribution as well as they do phonemes, which is the case for behavioural (Peperkamp, Pettinato, & Dupoux, 2003; Whalen, Best, & Irwin, 1997) and electrophysiological measures (Kazanina, Phillips, & Idsardi, 2006). Currently, much of the available information surrounding allophones in free variation is descriptive, focussing on discussing the prevalence of this form across languages. It is suggested that allophones in free variation are widely used by speakers of all languages (English – Bloch, 1941; Wells, 1982; Korean - Martin, 1951; German – Moulton, 1947). These descriptions suggest that allophonic variation of both types, complementary and free variation, is present in all languages and that it is necessary for listeners to adapt to the conventions of the languages they speak in order to understand when a lexical change is indicated.

In adults it has been demonstrated that the processing of both allophonic forms when in free variation requires some familiarity with, and therefore exposure to, the contrast being tested. Scott and Cutler (1984) tested British English speakers' ability to process an American English pronunciation of words such as 'total' where the medial /t/ is tapped. Participants were asked to choose between two sentences selecting the one that was best expressed by the sentence they heard. When presented with the tapped variants British English speakers who had lived in the UK all their lives had difficulty identifying the correct sentence in this task, yet had no problem with the untapped versions. In contrast, British English speakers who had lived in the USA for some time, and as such had some exposure to this particular allophone, identified the correct sentence following both pronunciation types.

A similar finding has been reported by Sumner and Samuel (2009) where listeners heard General American (GA) or New York City (NYC) pronunciations of /r/ final words such as 'baker'. These words can be produced with a word final /ə/ produced similarly to 'uh', the typical form for GA dialect speakers or /ɚ/ where the sound includes the /r/ and is produced as '-er' as is typical for the NYC dialect of American English. Participants were categorised according to their language background and exposure to each of these pronunciation types with three groups identified, those who had always lived in NYC and produced words with /ə/ final, those who had always lived in NYC and produced words with /ɚ/ in the final position, and a group who had primarily been exposed to GA and spoke with that dialect themselves. The experiment was a lexical decision task where participants were asked to make a decision about whether the second item presented was a word or not. If the preceding word matched in the dialect of production, responses should be faster than when there was a mismatch. Of interest is performance in the dialect mismatch condition for listeners unfamiliar with one of the dialects, the GA group. Sumner and Samuel (2009) found that task performance was negatively influenced by a lack of exposure to the NYC form of this pronunciation; the NYC dialect caused difficulties for the GA listeners. In the NYC exposed groups the same difficulties were not apparent: they were successful in all conditions, even when these productions did not match their own verbalisations, suggesting that exposure from the surrounding environment and through conversing with other speakers is sufficient for adapting the stored representation to accommodate this form.

The evidence for infants and toddlers is somewhat different, with very young infants being able to discriminate allophones (Hohne & Jusczyk, 1994) before a decline is observed with age (Seidl et al, 2009; but see Jusczyk, Hohne and Bauman, 1999). This decline in discrimination abilities is unsurprising as toddlers learn that these differences are not lexically relevant: they do not signal a change in meaning between words, and so can be ignored. At 2 months of age Hohne and Jusczyk (1994) showed that infants are able to discriminate between 'nitrate' and 'night rate' using a HAS procedure. In this procedure infants are given a nipple to suck which records the rate of sucking in conjunction with an auditory stimulus. When a stimulus is interesting the sucking rate will be high and will drop off as the child begins to lose interest. Upon presentation of a new stimulus sucking rate will once again increase if the infant has noticed the difference. In this experiment infants were familiarised to one of the variants and then they heard the other during the test phase. If they increase sucking on presentation of the new stimuli then it is assumed that they could discriminate the allophonic variation of /t/ productions, a cue that has been shown to signal word boundaries in adults (Hockett, 1958; Lehiste, 1960; Nakatani & Dukes, 1977). Hohne and Jusczyk (1994) found that infants were able to discriminate allophonic differences occurring on a /t/ or /r/ when in a syllable juncture position, suggested to be a pre-requisite to later discrimination of allophonic variation necessary for segmenting speech.

A similar finding is reported in 10.5 month olds but not 9 month olds in a segmentation task (Jusczyk et al., 1999). In this study infants were presented with isolated words and then tested on phrases containing those words or an allophonically different pronunciation. At 10.5 months infants successfully identified the target word in the passages following familiarisation, whereas at 9 months infants were unsuccessful. Initially this result seems to contradict the finding that at 2 months old infants use allophonic information to discriminate words. However, the authors suggest that this was instead due to task demands. In Hohne and Jusczyk (1994) the infants were required to simply discriminate the two different pronunciations, whereas the task in Jusczyk et al.

(1999) was more challenging. In Jusczyk et al. (1999) infants must extract the words from continuous speech in order to identify them; this prevented them from fully utilising the allophonic information present. This suggests that toddlers are able to use allophonic information, under the right conditions, to differentiate words.

In contrast with these findings Seidl, Cristià, Bernard, and Onishi (2009) tested 4 and 11 month infants on their ability to discriminate vowel nasality across two different languages. In Quebec French vowel nasality is a phonemic cue that signals a change in meaning whereas in English it is an allophonic cue and does not differentiate words. Infants heard syllables where nasal vowels were systematically followed by fricatives and where oral vowels were followed by stops. The English learning 11 month old infants for whom vowel nasality was allophonic did not learn the systematic association between the two intra-syllabic phonemes and could not generalise this rule to new syllables. However, the French toddlers succeeded in the same task. The additional finding that at 4 months of age English infants were able to learn this regularity suggests that sensitivity to the difference between oral and nasal vowels declines when it is not phonemic in the native language. When the difference is allophonic, at 11 months English learning infants do not differentiate between this allophonic variation suggesting they have mapped the two realisations, nasal vowel and oral vowel, onto the same phoneme. That is, they do not distinguish between allophones and treat them as phonologically equivalent.

Similarly, Dietrich, Swingley, and Werker (2007) found that 18-month-old English learning toddlers did not discriminate two words differing only on vowel duration, a cue that is not lexically relevant in English (the English lexically contrasted tense/lax contrasts as in ‘peak’/‘pick’ uses duration but also formant position to distinguish between these vowels). In contrast, Dutch learning toddlers for whom the contrast is lexically relevant discriminated the two words. Dietrich et al. (2007) used a Switch task to familiarise toddlers with two novel objects each paired with words that differed only on the length of the vowel. During the test phase toddlers saw the same object paired with the same auditory stimulus or they ‘switched’ the auditory stimulus for the opposite object. If toddlers identify the contrast they will look longer during switch trials; this was only the case for the Dutch learning toddlers with no difference in listening times between same and switch trials evident for the English learning toddlers. This suggests that language experience influences toddlers' interpretation of the phonetic variation in the words they are hearing. Toddlers for whom the difference is lexically relevant use this contrast to discriminate words whereas those whose language doesn't use this difference do not discriminate the contrast.

The evidence discussed so far suggests that toddlers are sensitive to some forms of allophonic variation at a young age but not to all types. It is worth recalling here that many of the studies discussed so far have focused on allophones that are in complementary distribution, which could present a different challenge for toddlers than those in free variation. Specifically, studies demonstrating discrimination of allophones in young infants have looked at allophones in complementary distribution (Dietrich et al., 2007; Hohne & Jusczyk, 1994; Jusczyk et al., 1999). What is evident is that older infants do not discriminate allophones in free variation from 11 months: they treat these as a single variant of a phoneme (Seidl et al., 2009). Additionally, the task differed across these studies, which could explain the performance differences across the different ages when combined with the different allophone types.

Experiments 3 and 4 use IPL to test for toddlers' recognition of familiar words produced with allophones that occur in free variation; that is, these allophones occur on a single phoneme in the same position in a word but do not indicate a meaning change. Following the results from Experiments 1 and 2 combined with those of Dietrich et al. (2007) and Seidl et al. (2009), it would be expected that toddlers' discrimination of the allophonic pronunciations will vary as a function of language exposure. Specifically, toddlers exposed to range of pronunciations, variable input, will identify the target after both pronunciations, whereas those toddlers hearing fewer pronunciation deviances will recognise only a single pronunciation. However, it is equally possible that all toddlers will have learned that the contrasts tested are allophonic and as such can be ignored, leading them to recognise both variants equally.

4.1 Experiment 3 – Recognition of two allophonic pronunciations of familiar words: glɒʔl stɒps[1]

This experiment is the first in this series examining the perception of naturally occurring within-language speech variation in mono and multidialectal toddlers, and its focus is on glottal stops. A glottal stop is a feature of speech that occurs when the vocal folds are firmly pressed together so no air can pass through them, hence the term stop. They typically occur on the voiceless plosive phonemes /p/, /t/, and /k/. Glottalisation occurs frequently across all regional dialects of the UK, particularly amongst young people (Roach, 2005) and urban class speakers (Ladd, 2006). It is not a lexically relevant contrast: it doesn't signal a change in meaning, thus it is a form of allophonic variation. However, it is not the case that a glottal stop can be used in all places where a voiceless plosive is present. Glottal stops are most commonly found in a syllable final position before a consonant, e.g. 'Scotland', or used to mark a syllable boundary, e.g. 'football'. The next most common use is before a syllabic nasal, e.g. 'button', followed by in a word final position before a word beginning with a vowel, e.g. 'got it'. Glottalisation can also occur immediately before a syllabic /l/, e.g. bottle, with the least frequent realisations being before a vowel e.g. 'butter' or between vowels when the phoneme affected is a /p/, e.g. 'puppy' (Redi & Shattuck-Hufnagel, 2001). All of the examples given here except the final one affect the voiceless plosive /t/ as this is the most common phoneme affected. The glottalisation of /p/ and /k/ are restricted to cases where the following consonant has the same place of articulation as the glottally realised phoneme, making these instances rare but not impossible.

[1] The phonetic transcription of 'glottal stops'. This is the specific allophone to be explored in this experiment, a full explanation of glottal stops is provided.

Currently little research has examined toddlers' perception of glottal stops in the words they are learning. O'Brien (2010) reports adults' discrimination of syllables that contain glottal stops for all three phonemes /p/, /t/ and /k/, from those that don't. It was additionally found that in all 3 instances glottal stops were considered to have the same perceptual saliency as non-glottal versions when in an intervocalic position This similarity was measured by comparing the response times of participants when deciding whether 2 auditorily presented syllables were the same or different. For different trials long response time is suggestive of similarity between the phonemes as the distinctiveness is harder to identify, whereas shorter response times suggest that the decision was an easy one to make.

In contrast, when the same three phonemes were tested in a released coda position, where the vocal tract opens and air can flow through, and an unreleased coda position, where the vocal tract remains closed and prevents the flow of air, differences are observed. When the released coda position was glottalised, /p/ and /k/ were harder to detect than /t/; the fact that it took participants longer suggests that they are more similar to the glottal stop than /t/ is. However, the exact opposite occurs in the released coda position with the /t/ being harder to differentiate from the glottal stop. O'Brien (2010) proposes from these findings that these phonemes (/p/ and /k/) are perceptually more similar to the glottal stop than /t/.

To date, only one study specifically investigated glottal pronunciations in toddlers, and it focused at the prevalence of glottal stops in child-directed-speech. Foulkes, Docherty, and Watt (2005) analysed the speech of mothers directed at their young children, aged between two and four years. They identified that when directing speech towards their children mothers used pronunciations containing glottal stops significantly less frequently than when addressing adults. In speech to adults around 90% of all words that could be glottalised were produced as such, in comparison to only 36% in child-directed speech. This suggests that, typically, for toddlers the pronunciations of words are likely to be non-glottal pronunciations. Interestingly, this differed when considering the age and gender of the children. When directing speech towards male children mothers were more likely to use glottal pronunciations then when addressing females. In addition the younger children were the more likely non-glottal pronunciations would be used. These findings suggest that on the whole toddlers are unlikely to be highly familiar with glottal pronunciations from the speech of their input.

The current experiment will test mono- and multidialectal toddlers' recognition of familiar words produced with or without glottal stops. There are three possible outcomes to consider. First, if multidialectal toddlers' long-term exposure to variable pronunciations leads them to be more accepting of general variation, the performance of the two groups would differ. Specifically, monodialectal toddlers would recognise only one pronunciation, the one they are familiar with, whilst multidialectals would recognise both, suggesting that exposure to variability influences performance with naturally occurring pronunciation deviations, in a similar way to experimentally manipulated mispronunciations. Second, if minimal exposure to specific forms is necessary for recognition then both groups could behave similarly and accept both pronunciations. In this scenario minimal exposure to a contrast would be sufficient for the creation of a flexible representation, even when this exposure does not occur immediately prior to testing, as was the case in White and Aslin (2011). Finally, mono and multidialectal toddlers could respond similarly and identify the target following one pronunciation only. In this case the non-glottalised versions would be the most likely candidate being the most encountered form from the input (Foulkes et al., 2005).

4.1.1 Method

English learning toddlers aged 21 months saw pairs of images accompanied by an auditory label at the mid-point of each trial. The auditory label was produced either with or without a glottal stop. Three types of glottalisation were tested: marked, less marked and novel. Both marked and less marked cases affect the production of /t/ in spoken words, The marked case is that which differs from the most common form, in this case marked describes a situation where glottalisation is less common and less marked describes the cases where it is much more frequent. Glottalisation of a /t/ is considered less marked when followed by /l/ or /n/, marked when followed by a vowel, and novel when the 'p' is glottalised as this is very rarely heard in speech but is not phonologically impossible. Toddlers' looking times to the target following naming were recorded with an increase in the post naming phase indicating recognition of the label.

Participants

Thirty-six participants aged 21 months were successfully tested for this experiment, all were raised in the South West of England. Additional toddlers were tested but excluded due to fussiness (2), technology failure (3), did not complete enough trials (7) and not enough exposure to either the local accent or the additional accent (8). Two groups of infants were tested: monodialectals (N= 18, 9 boys, mean age = 21 months, 3 days) and multidialectals (N= 18, 9 boys, mean age = 21 months, 3 days). All parents were asked to complete the OCDI (3 parents of multidialectal toddlers failed to do so) and no significant differences were found between the two groups (mean understanding scores – monodialectals = 299 words (SD=87) and multidialectals = 296 words (SD=73; $t(31)=.10$, $p=.92$, $d=.03$); mean production scores – monodialectal = 157 words (SD=103) and multidialectal = 145 words (SD=86; $t(31)=.36$, $p=.72$, $d=.13$).

Infants were classified as mono- or multidialectal at the time of testing to ensure that all possible orders were completed by both groups. The way in which infants were classified was identical to that in previous studies presented in this thesis. For multidialectal toddlers the mean exposure to the local accent was 44% (SD = 17). A complete list of dialects spoken by the parents of multidialectal infants can be found in Table 4.1.

Table 4.1 - *List of dialects heard by the multidialectal toddlers included in the experiment. Both parents of monodialectal infants spoke with a British South West dialect. Toddlers 9, 10, 13, and 18 heard the local dialect only from their childcare provider; however, the behaviour of these toddlers followed the same pattern as the others in the multidialectal group. For toddler 3 there was no father figure, this toddler also heard the local dialect from a childcare provider.*

Child	Multidialectal		% Exposure to
	Mother	Father	South West
1	South West	Scotland	74
2	South West	South Africa	38
3	Cambridge		27
4	South East	South West	40
5	South West	South East	31
6	South West	Manchester	74
7	Birmingham	South West	39
8	London	South West	27
9	West midlands	London	33
10	Derby	Cambridge	31
11	South West	Liverpool	56
12	South West	Hampshire	62
13	Lancashire	Stoke-on-Trent	39
14	Birmingham	South West	26
15	Birmingham	South West	26
16	South West	South East	46
17	South West	South East	74
18	South East	South East	43

Stimuli

There were nine disyllabic target and distracter pairs chosen from the OCDI as known by infants at this age (see Table 4.2 for average percentages of toddlers who know these words). There were two phonemes glottalised in the experimental stimuli, /t/ and /p/, all in a word medial position and at the end of the first syllable. Within the /t/ cases were two types of glottalisation, marked and less marked. The marked case occurs in words such as ‘butter’ where the /t/ occurs pre-vocalically. In the less marked case, in words such as ‘bottle’, the /t/ is followed by a syllabic nasal, specifically in this study /n/, or a syllabic /l/. In both of these instances toddlers may have heard both pronunciations in the ambient speech surrounding them as the presence of a glottal stop is increasing (Wells, 1982), however, it has been found that this is not necessarily the case in child-directed speech, particularly for girls (Foulkes et al., 2005). In contrast, novel cases are where the glottal stop occurs on the 'p' between vowels, such as in 'nappy'. It is unlikely in these cases that toddlers would have heard the glottalised pronunciations regularly, if at all. For a full list of the stimuli used including phonemic transcriptions see Table 4.2.

Images depicting each of the eighteen words were selected, all were colour photographs of objects presented on a white background covering a similar amount of space overall. All objects were judged to be good exemplars of the intended object by experimenters and independent observers.

Table 4.2 - *Phonetic transcriptions of the 9 test words produced by the same speaker both with and without a glottal stop: vowel duration and mean formant values (percentages in brackets denote the number of toddlers who typically understand these words at 21 months)*

	Target	Non-glottal	Glottal	Distracter
Marked				
	Butter (57%)	bʌtə	bʌʔə	Bucket (67%)
	Water (79%)	wɔ:tə	wɔ:ʔə	Window (89%)
	Potty (93%)	pɒti	pɒʔi	Pillow (61%)
Less Marked				
	Bottle (86%)	bɒtl	bɒʔl	Balloon (89%)
	Button (79%)	bʌtn	bʌʔn	Bubble (78%)
	Kitten (56%)	kɪtn	kɪʔn	Carrot (78%)
Novel				
	Puppy (71%)	pʌpi	pʌʔi	Penguin (56%)
	Paper (71%)	peɪpə	peɪʔə	Pasta (72%)
	Nappy (100%)	Næpi	næʔi	Necklace (61%)

The auditory stimuli were recorded by a single female speaker of the local British dialect, South West of England. The same speaker recorded both the glottal and non-glottal pronunciations of the target words. The target words were presented to infants in the carrier phrase 'Look, *TARGET'.* The duration, pitch and intensity of each of the recordings were measured and the means are reported in Table 4.3 for each of the pronunciations types. There was no difference between glottal and non-glottal pronunciations in duration and pitch, however, there was a significant difference in intensity between the two ($t(16)$=2.803, p=.013, d=1.32). This difference is due to the glottal pronunciations words having more energy than the non-glottal ones. This is not unexpected as glottal stops add energy to the following phoneme (Balas, 2011).

Table 4.3 - *Acoustic characteristics of the 9 test words in each pronunciation – glottal and non-glottal: mean duration, pitch and intensity (standard deviations presented in brackets).*

Pronunciation	Duration (ms)	Pitch (Hz)	Intensity (dB)
Glottal	447 (49.89)	217.56 (8.68)	80.86 (1.25)
Non-Glottal	465 (36.69)	203.68 (23.54)	79.40 (.94)

Procedure

Toddlers were seated approx. 86cm away from a wide screen TV in a highchair with pictures measuring 36cm across the diagonal and 31cm apart, see appendix D for diagrams of the setup from an aerial and front view perspective. Initially toddlers saw a familiarisation trial to improve attention in the test phase: a flower and a spider with the flower always named. The test phase consisted of two blocks of nine trials with the onset of the target word occurring at the mid-point of the trial, splitting the trial into a pre and post naming phase. In block one each trial was 5000ms with word onset occurring at 2500ms and in block two each trial was 7000ms with word onset at 3500ms[2]. Each block contained all nine pairs and, for half of the infants, four glottal and five non-glottal pronunciations in block one and five glottal and four non-glottal in block 2 (the reverse for the other half).

The presentation of the three types of word was controlled with no more than 2 of each condition (marked, less marked, and novel) appearing consecutively. Throughout the experiment and across participants the target appeared equally often on the left and right and not one pair of images systematically followed another pair. A target appearing on the right in block one would appear on the left in block two, with all pairs presented in a new order. A central smiley was presented between trials to redirect toddlers' attention and maintain looking; all trials were initiated by the experimenter when the toddlers looked at

[2] The difference in trial duration across blocks was due to an experimenter error during programming identified at the analysis stage. A t-test was conducted comparing toddlers performance across block one and two, $t(71)=-.744$, $p=.46$, $d=.12$. As this was not significant further analyses consider both blocks together.

the smiley.

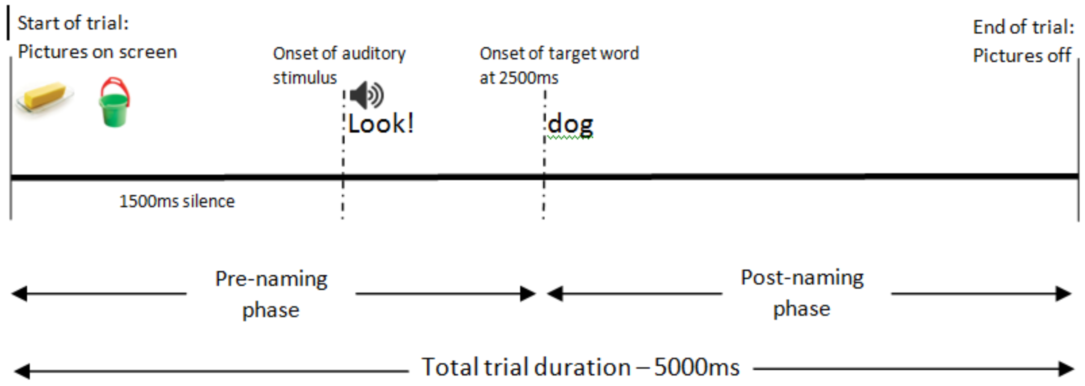

Figure 4.1 *Time line of experimental procedure in Block 1 starting from the left with a total duration of 5 seconds. For Block 2 the procedure was identical except that there was 2500ms of silence and the onset of the target word occurred at 3500 ms.*

Scoring

Coding was conducted in the same manner as for chapter 3. A sample of 10% of all videos was coded by a second skilled coder with an inter-experimenter agreement Intraclass Correlation Coefficient of .959 (Shrout & Fleiss, 1979).

4.1.2 Results

Following the retention criteria used in Chapter 3, 78% of all trials were retained for analysis and all analyses were conducted on the PTL measure. Due to the repetition of trials for each participant, the number of removed trials is larger than would typically be expected as for each target word a toddler was reported not to know, two trials were recorded, one from each block.

Glottal vs non-glottal pronunciations

Data were analysed using a mixed model ANOVA with the within-participant factors Pronunciation (glottal and non-glottal) and Naming (pre and post), and the between-participant factors Dialect (mono and multidialectal) and Gender (male and female). There was a main effect of Naming ($F(1,32)=17.90$, $p<.001$, $\eta_p^2=.359$) and an interaction between Naming and Pronunciation ($F(1,32)=20.14$, $p<.001$, $\eta_p^2=.386$). This interaction can be seen in Figure 4.2 and suggests that toddlers are identifying the target in one pronunciation type only, treating the other as a mispronunciation of the word. The absence of any interactions with Dialect (all *p*'s>.05) and Gender (all *p*'s>.05) suggest that performance is the same across these groups of toddlers and as such further analyses combine the data from all toddlers.

The interaction between Naming and Pronunciation was explored to identify the pronunciation condition in which toddlers were correctly fixating the target. It was found that looks to the target increased in the post-naming phase, as compared to the pre-naming phase, following non-glottal pronunciations ($t(35)=-5.95$, $p<.001$, $d=1.43$; pre-naming – mean =.49, SD =.10, post-naming – mean =.63, SD =.13) but not glottal pronunciations ($t(35)=-.42$, $p=.67$, $d=.09$; pre-naming – mean =.52, SD =.09, post-naming – mean =.54, SD =.12). This suggests that in all toddlers the presence of glottalisation was sufficient for them to treat the words they were hearing as mispronunciations.

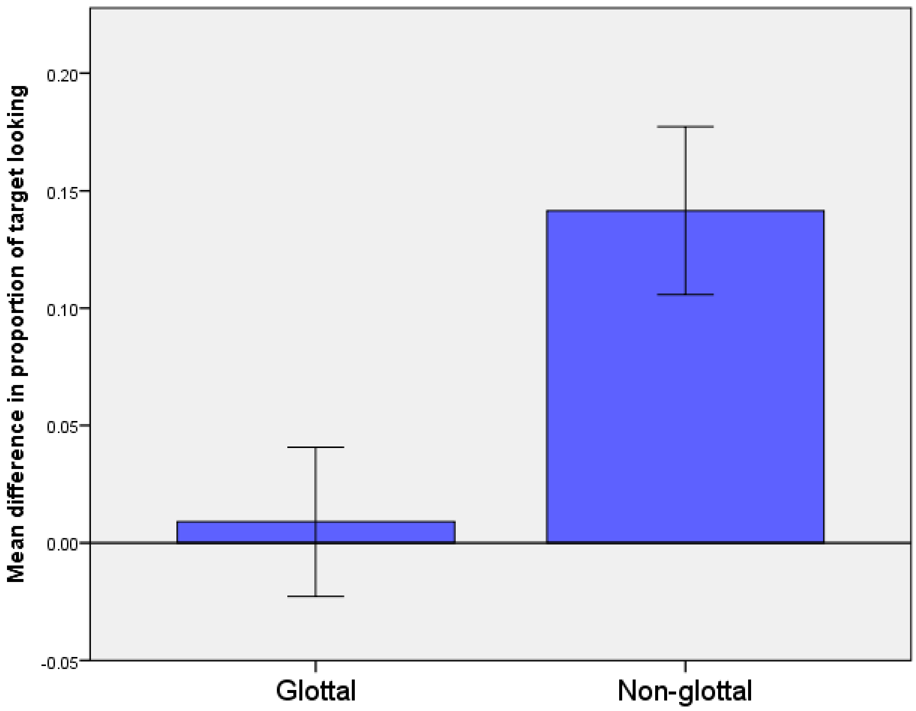

Figure 4.2 – *Mean change in the proportion of target looking (post-naming phase – pre-naming phase) for the glottal (left) and non-glottal (right) pronunciations. Error bars indicate +/- 1.5 SE.*

Marked, less marked, and novel pronunciations

Due to the expectation that toddlers would not recognise the glottal pronunciations in the novel condition, where the /p/ was affected, additional analyses were conducted separating the 3 word types, marked, less marked and novel. A mixed model ANOVA was conducted with the within-participant factors Naming (pre and post), Legality (marked, less marked and novel) and Pronunciation (glottal and non-glottal) and the between-participant factor Dialect (mono and multidialectal). This analysis revealed a main effect of Naming ($F(1,34)=13.80$, $p=.001$, $\eta_p^2=.289$), an interaction between Naming and Pronunciation ($F(1,34)=23.92$, $p<.001$, $\eta_p^2=.413$) and a main effect of Legality ($F(1,68)=3.79$, $p=.028$, $\eta_p^2=.100$). There were no significant interactions with Dialect (all *p*'s>.05).

Table 4.4 – Percentage of words known by toddlers up to 18 months of age according to OCDI norms, grouped by legality categories.

Word Type	13	14	15	16	17	18
Marked	7%	16%	29%	46%	38%	44%
Less Marked	9%	23%	30%	44%	41%	47%
Novel	4%	18%	30%	42%	49%	55%

To explore the main effect of Legality a series of t-tests were completed (see Figure 4.3), these t-tests showed that for the less marked ($t(35)=-2.03$, $p=.05$, $d=.51$; pre-naming – mean =.46, SD =.14, post-naming – mean =.54, SD =.17) and the novel($t(35)=-3.19$, $p=.003$, $d=.64$; pre-naming – mean =.53, SD =.16, post-naming – mean =.63, SD =.17) conditions there was a significant increase in target looking following naming, this was not the case for the marked case ($t(35)=-1.27$, $p=.21$, $d=.26$; pre-naming – mean =.56, SD =.10, post-naming – mean =.60, SD =.19). This unexpected finding could be due to a confound with word familiarity: the marked words (butter, water, potty) are likely to be more recently learned, as corroborated by CDI data suggesting that fewer toddlers understand the words in this category than those from the other categories (see Table 4.4). The fact that these words are learned only recently could be influencing the toddlers' looking behaviour in the post-naming phase.

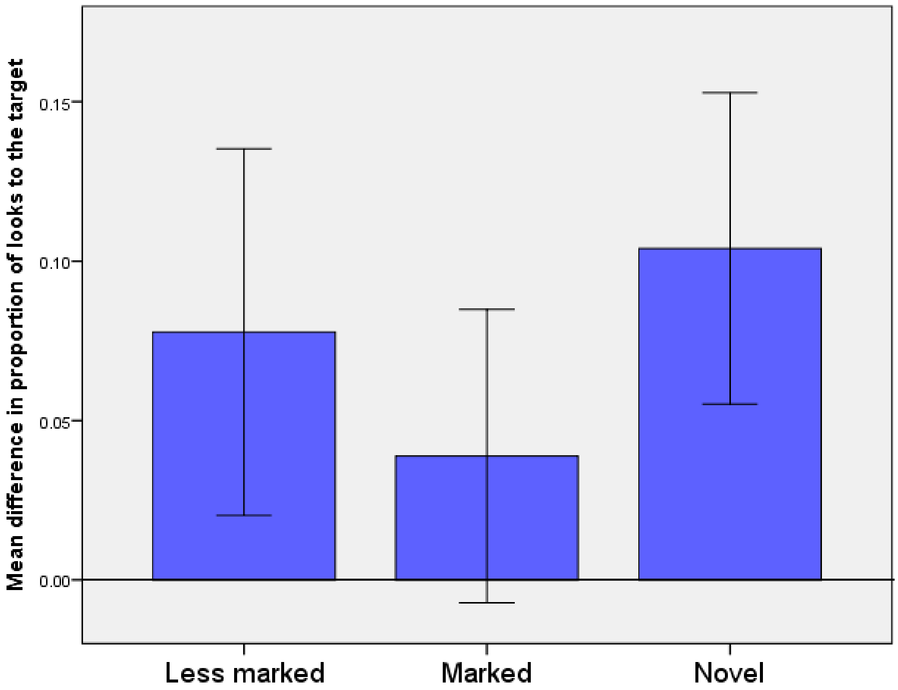

Figure 4.3– *Mean change in the proportion of target looking (post-naming phase – pre-naming phase) for the Less marked words - bottle, button and kitten (left), Marked words – butter, water, potty (centre) and Novel words – paper, puppy and nappy (right) pronunciations for all trials combined (glottal and non-glottal). Error bars represent +/- 1.5 SE.*

Based on the theoretical assumption that the glottal trials would be those where differences would be observed in the different legality conditions these trials were examined independently and can be seen in Figure 4.4. An ANOVA revealed a main effect of Legality (F(2,70)=3.26, p=.044, η_p^2=.085). T-tests were conducted to identify whether toddlers demonstrated target recognition in any of the conditions, this is most likely in the less marked condition – the form they are likely to have experienced. This was not the case, there was no evidence of target recognition in any of the legality conditions, less marked (t(35)=.037, p>.05, d=.07; pre-naming – mean =.58, SD =.15, post-naming – mean =.56, SD =.25), marked (t(35)=.319, p>.05, d=.01; pre-naming – mean =.48, SD =.19, post-naming – mean =.48, SD =.22) and novel(t(35)=-.612, p>.05, d=-.12; pre-naming – mean =.55, SD =.17, post-naming – mean =.58, SD =.24). This further confirms that glottalised pronunciations impede target recognition in toddlers.

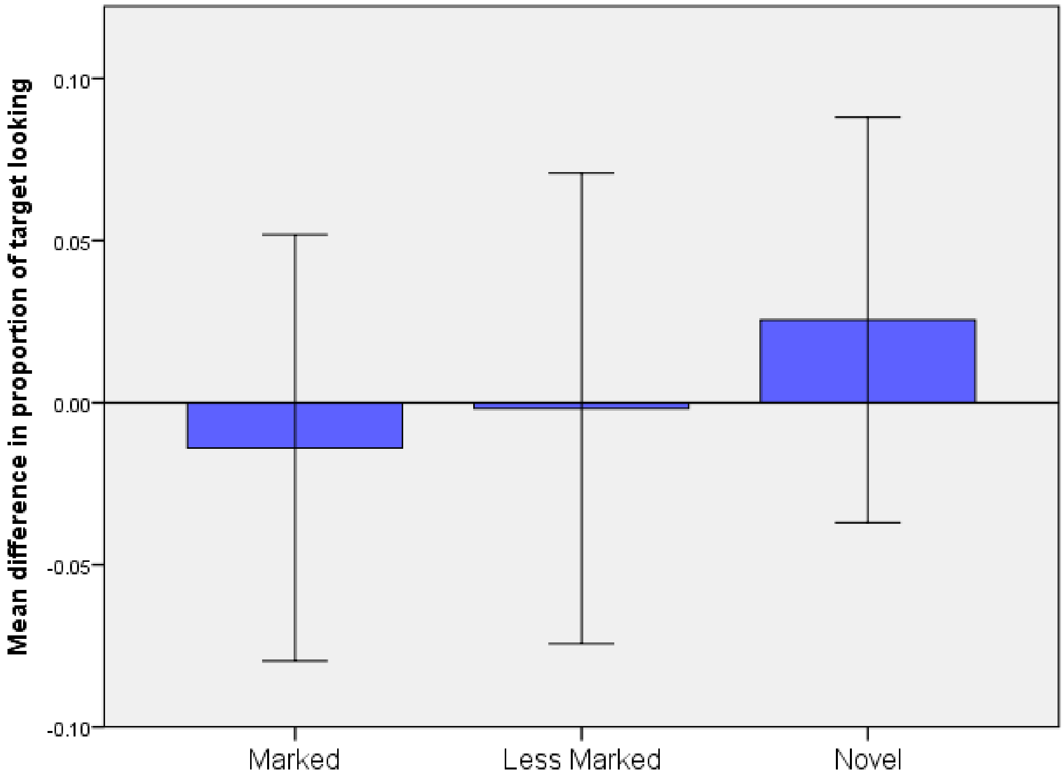

Figure 4.4 – *Mean change in the proportion of target looking (post-naming phase – pre-naming phase) for the Marked words – butter, water, potty (left), Less marked words - bottle, button and kitten (left), and Novel words – paper, puppy and nappy (right) pronunciations for the glottal trials only. Error bars represent +/- 1.5 SE.*

4.1.3 Discussion

The present experiment sought to explore whether the effects found in the studies in Chapter 3, where multidialectal toddlers ignored mispronunciations and fixated the target image, extend to naturally occurring pronunciations differences in familiar words. Monodialectal and multidialectal toddlers were tested with pronunciations of words that differed by whether a phoneme was present or replaced with a glottal stop, specifically /t/ and /p/. The results of Experiment 3 show clear recognition of words when the pronunciation was non-glottal, and no recognition for any of the glottal pronunciations, irrespective of toddlers' dialect background. The presence of a glottal stop in familiar words negatively impacted recognition of a target image; toddlers hearing glottal pronunciations of familiar words behaved as would be expected when hearing mispronunciations (Mani et al., 2008; Mani & Plunkett, 2007, 2010; Swingley & Aslin, 2000, 2002). Given the results of the studies reported in Chapter 3 it was expected that mono and multidialectal toddlers would respond differently to allophonic pronunciations of the same words. Specifically, multidialectal toddlers were expected to recognise both pronunciations, whereas monodialectals' performance was less easy to predict although there was a general expectation of recognition of a single form. This difference was not identified; all toddlers responded similarly, treating glottalised familiar words as mispronunciations.

Although this finding is not entirely unexpected for the monodialectal toddlers, it is a surprising finding for the multidialectal toddlers. Multidialectal toddlers identify the target following familiar word mispronunciations that they are unlikely to have ever heard used in speech (see Chapter 3) but fail to demonstrate the same flexibility across a contrast that occurs naturally as demonstrated in the current experiment. The two pronunciations toddlers hear during testing are actual pronunciations that they might have been exposed to, albeit infrequently (Foulkes et al., 2005). Indeed, a less surprising result would have been one where all toddlers, both monodialectal and multidialectal, identified the target following both pronunciations of the target words. This would be compatible with the current literature on allophonic variation where toddlers accept both pronunciations for a word when a contrast is allophonic in the language they are learning (Dietrich et al., 2007; Seidl et al., 2009).

One explanation for the disparity between the current results and the results of other studies is related to the amount of exposure to the allophone tested. Both Seidl et al. (2009) and Dietrich et al. (2007) used allophones affecting vowels, which are typically more variable than consonants in speech. The variability of vowels could lead toddlers to be generally more flexible in their acceptance of natural differences with vowels. It could even be the case that toddlers have been exposed to both variants of the allophone tested by Seidl et al. (2009) and Dietrich et al. (2007) during their language learning and applied a learned rule about these phonemes to the instances used during testing. Given that child-directed speech contains few instances of glottalised pronunciations (Foulkes et al., 2005) toddlers may have had insufficient exposure to this form of allophonic variation to successfully learn a rule that could be exploited in the current experiment.

A second related explanation for these results focuses on the amount of difference between the two pronunciations of the words. The difference between a word produced with a glottal stop and one without does not only reflect on the consonant, but also spreads to the preceding vowel. Before a glottal stop, there is the auditory impression that the preceding vowel is cut short, which is caused by a drop in amplitude enhancing the perception of vowel shortness (Ogden, 2009). As such the difference between the two pronunciations is due to two phonemes, the preceding vowel and the consonant. When comparing this altered variant to the stored representation, the mismatch may be too great for successful recognition. In contrast, in the experiments reported in Chapter 3 we changed only a single phoneme. It is entirely possible that multidialectal toddlers' representations have some degree of flexibility and can accommodate changes to a single phoneme but pronunciations affecting more than one phoneme, as in the glottal variants, deviate too much from the stored representation, the non-glottal variant, and recognition is impaired.

In summary, mono- and multidialectal toddlers in this experiment demonstrated a preference for a non-glottal pronunciation of familiar words despite the previous finding that multidialectal toddlers identify a target following single feature mispronunciations of familiar words. These results suggest that toddlers respond differently to allophonic variation and mispronunciations. Our interpretation of these findings includes a lack of exposure to the specific contrast and the degree of perceptual difference between glottal and non-glottal pronunciations. The impact of the level of exposure to the dialectal variant is explored in the following experiment by using a contrast to which toddlers are frequently exposed, and dividing the groups of toddlers not by general exposure but by exposure to the specific contrast being tested.

4.2 Experiment 4 - Recognition of allophonic pronunciations of familiar words: a tale of two cities

In Experiment 3 we found that toddlers did not recognise a variant of words when presented in forms that occur naturally in speech, despite the fact that Experiments 1 and 2 show that multidialectal toddlers look longer at a target image following single feature mispronunciations. One explanation for these surprising results is that toddlers lack sufficient exposure to this form of allophony (glottalisation) to succeed in this task. To explore the proposal that exposure is necessary for target recognition of both possible variants, in this experiments toddlers heard pronunciations of familiar words differing only by the presence or absence of rhoticity. To control for exposure to this contrast toddlers were grouped based on whether their parents' pronunciations included rhoticity or not.

Rhoticity affects the phoneme /r/ and is specifically related to whether or not it is realised in the pronunciation of a word; rhoticity is typified by the insertion of /r/ post-vocalically resulting in the production of a tense r-coloured vowel (Ladefoged, 2001). In all dialects /r/ occurs before vowels, e.g. 'carry', however, it varies across dialects whether /r/ is permitted post-vocalically. In many dialects words that include /r/ orthographically are pronounced without the realisation of /r/, for example, 'farm' is pronounced as/fɑ:m/. Alternatively in rhotic dialects, such as those of Scotland, Ireland, the South West and most North America, the same word would be pronounced as /fɑ:rm/ where the /r/ is present (Hughes & Trudgill, 1996). The specific realisation of rhoticity in speech implicates the preceding vowel. The vowel is typically longer for rhotic than non-rhotic pronunciations due to the trill characterising the post-vocalic approximant /r/. Additionally the third and fourth formants are typically lower in rhotic than non-rhotic vowels. These dialect specific pronunciation differences make rhoticity a good candidate for studying recognition of allophonic variation in toddlers.

4.2.1 Experiment 4a - Recognition of allophonic pronunciations of familiar words: rhoticity in a rhotic city

Experiment 4a is an adaptation of a published paper: Floccia, C., Delle Luche, C., Durrant, S., Butler, J., and Goslin, J. (2012). Parent or community: Where do 20-month-olds exposed to two accents acquire their representation of words? Cognition 124, 95-100.

The dialect spoken in the South West of England is differentiated from other UK dialects by the presence of rhoticity (Trudgill, 2004). As such, toddlers living in the South West are exposed to rhoticity from the surrounding locality even if their parents speak with non-rhotic dialects of English. This makes rhoticity a good candidate for exploring the effect of exposure on allophonic recognition in toddlers from this region. All toddlers raised here should be familiar with the rhotic form, however, there will be a sub-group of toddlers who regularly hear non-rhotic pronunciations of familiar words if one or both of their parents pronounce words non-rhotically. It is thus possible to identify groups of toddlers for whom rhotic pronunciations dominate (rhotic only exposure) and for whom exposure to both variants is present in the input (mixed exposure).

In the current experiment these two groups of toddlers were presented with a series of trials where the target label was produced by either a rhotic or non-rhotic speaker. There are a number of predictions that can be made about how toddlers could respond across the different trial types in each of the dialect groups. First, all toddlers could recognise both rhotic and non-rhotic pronunciations equally, suggesting that they have an understanding of the allophonic nature of rhoticity. Second, if exposure is necessary, the rhotic only exposure group would recognise only rhotic pronunciations of words and treat the non-rhotic tokens as mispronunciations, while the mixed exposure group would identify the target following both pronunciation types. Finally, all toddlers could demonstrate a preference for one variant over the other; it would be expected in this scenario that the rhotic only group would prefer the rhotic pronunciations over the non-rhotic ones. However, the mixed group could display a preference in either direction as they are exposed to both variants: the to-be-recognised variant would be determined by the amount of exposure to each pronunciation type from their input. For example, rhotically dominant toddler would prefer the rhotic versions of the words, whereas a toddler for whom non-rhotic pronunciations are dominant would show recognition only for the non-rhotic labels.

4.2.1.1 Method

In this experiment we tested infants aged 20 months on recognition of familiar words heard with either a rhotic or non-rhotic pronunciation. Pairs of images were presented on screen along with a target label part way through the trial. Toddlers were separated into two groups, those toddlers who heard only rhotic pronunciations from their parents because both had this feature in their accent, and those toddlers who heard a mix of rhotic and non-rhotic pronunciations because either one or both of their parents had an accent where rhoticity is absent. All toddlers were raised in the South West where rhoticity is a common feature of the local accent and so will all have some exposure to rhotic pronunciations from the surrounding environment.

Participants

There were thirty-six toddlers (18 girls) successfully tested for this experiment, all were born and raised in the South–West of England. Additional children were tested and their data excluded due to fussiness (1) and experimenter error (3). Their dialect and the amount of exposure to each accent was ascertained via a background questionnaire focusing on the time spent in a local nursery/child minder, and time spent with each parent (Cattani et al., in press). The rhoticity of the parents' accent was also evaluated through analyses of their production of words (e.g. mirror; Ladefoged, 2001) recorded (over the phone for most fathers) and analysed by a trained native listener blind to parents self-report. If both spoke with rhoticity the children were categorised as Rhotic Only Exposure (18 children, including seven girls), and as Mixed Exposure if one or more parent spoke non-rhotically (18 children, including 11 girls; see Table 4.2 for dialects of exposure). In the mixed group the mean percentage exposure to non-rhotic pronunciations was 73% (SD = 22). Parents filled in the Oxford CDI (Hamilton et al., 2000), with no significant differences found between the scores of the two groups -mean understanding scores – rhotic only exposure = 145 words (SD=80) and multidialectals = 166 words (SD=93; t(25)=.63, p=.54); mean production scores – rhotic only exposure = 105 words (SD=99) and multidialectal = 66 words (SD=62; t(25)=-1.25, p=.22).

Table 4.5 – *Dialects spoken by the parents of the 18 children in the rhotic only group (left) and the mixed exposure group (right). In the mixed exposure group, children with non-rhotic parents are listed first (NR only) and children with one non-rhotic parent only are listed below (Mixed). For the latter, the parent with rhotic features is in bold. "Neutral" refers to a Received Pronunciation (RP) or standard British English accent. These labels have been given by parents themselves, and the rhoticity (or the absence of) in their speech has been further attested by their reading aloud of a list of words and an analysis of their recordings by a trained native listener (see the stimuli section).*

Rhotic only exposure		**Mixed exposure**		
Mother	**Father**	**Mother**	**Father**	**Type of exposure**
Plymouth	Plymouth	Neutral	Neutral	NR only
Plymouth	Plymouth	Neutral	Nottingham	NR only
Plymouth	Plymouth	Neutral	Northern Ireland	NR only
Yorkshire	Somerset	Neutral	London	NR only
Plymouth	Plymouth	Dorset	Dorset	NR only
Cornwall	Devon	Somerset	Devon	NR only
Devon	Gloucester	London	Birmingham	NR only
Plymouth	Plymouth	South West	South West	NR only
Plymouth	Plymouth	Suffolk	Suffolk	NR only
Plymouth	Plymouth	**Plymouth**	Lincoln	Mixed
Plymouth	Plymouth	**Plymouth**	Yorkshire	Mixed
Plymouth	Plymouth	South Wales	**Plymouth**	Mixed
Devon	(no father)	**Plymouth**	Norfolk	Mixed
Plymouth	Plymouth	**Plymouth**	Reading	Mixed
Plymouth	Plymouth	**Devon**	Neutral	Mixed
Canada	Plymouth	Australia	**Plymouth**	Mixed
Plymouth	Plymouth	**Plymouth**	Neutral	Mixed
Devon	Devon	**Plymouth**	Lancashire	Mixed

Stimuli

Twelve test words with a rhotic/non-rhotic accent contrast (e.g. 'arm') were selected from the OCDI along with 12 paired distracters, with the addition of 14 control words and four training items with no rhotic ambiguity (e.g. 'foot'; see Table 4.3).

Corresponding colour pictures judged as being good exemplars of these words by the experimenters were also selected.

Table 4.6 - *List of target and distracter pairs for training, test and control trials. Note that for training and control pairs each word could be equally the named target or the distracter image*

	Target words	Distracters
Training	Boat	Ball
Training	Cake	Cow
Test	Arm	Eye
Test	Bear	Bath
Test	Bird	Bed
Test	Butterfly	Banana
Test	Car	Cup
Test	Chair	Chicken
Test	Door	Dog
Test	Finger	Foot
Test	Fork	Fish
Test	Hair	Hand
Test	Horse	Hat
Test	Tiger	Train
Control	Bowl	Book
Control	Brush	Bread
Control	Bunny	Bottle
Control	Bus	Bike
Control	Slide	Swing
Control	Spoon	Sock
Control	Tooth	Tongue

Four female speakers recorded the test words, two of whom had local rhotic accents and two non-rhotic accents (RP, i.e. British English as spoken in the media). The duration, pitch, amplitude, and formant distributions for each word were extracted using Praat (Boersma, 2002; Table 4.7), with each measure entered into separate repeated measures ANOVAs with the factors of accent (rhotic versus non- rhotic) and speaker (two per accent). The duration of the rhotic productions were longer than the non-rhotic ones (568.2 ms versus 531.3 ms, main effect of accent: $F(1,11)=6.1$, $p=.031$, $\eta_p^2=.36$), with this difference also reflected in vowel duration (336.7 ms versus 308.5 ms, $F(1,11)=10.8$, $p=.007$, $\eta_p^2=.50$), due to the inclusion of the trill characterising the post-vocalic approximant /r/ in rhotic speech. Also characterising rhoticity, the third (and fourth) formants were lower in rhotic than non-rhotic vowels (Hay & Maclagan, 2006; F3: 2390 Hz vs 2996 Hz, main effect of accent: $F(1, 11)$=120.4, p< .001, η_p^2=.92; F4: 3764 Hz vs 3994 Hz, $F(1, 11)$= 37.3, p< .001, η_p^2=.77). Two additional female speakers with a non-rhotic accent (RP) recorded the control and training words.

Procedure

Toddlers sat in a highchair approximately 180cm away from a projection screen; eye movements were recorded by two cameras positioned directly above the visual stimuli. Auditory stimuli were delivered via a centrally located speaker. See Appendix C for diagrams of the setup from an aerial and front view perspective.

Toddlers were presented with 21 pairs of images, one of which was the named target, the other an unnamed distracter. Two pairs were used for training, with the remaining 19 forming the experiment stimuli (12 test and seven control pairs, Table 4.6). Each child heard half of the target test objects named with a rhotic accent and half with a non-rhotic accent. Image pairs were presented in random order, with the presentation side of the target image counterbalanced across participants. Each 5000 ms trial consisted of a 2500 ms pre-naming phase followed by a 2500 ms post-naming phase beginning with the onset of the target word in the carrier sentence "Look! Target".

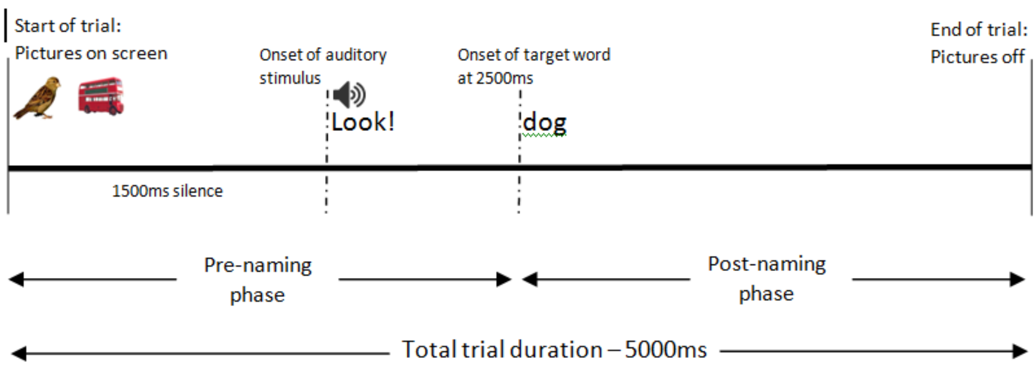

Figure 4.5 - *Time line of experimental procedure starting from the left with a total duration of 5 seconds*

Table 4.7 - *Acoustic characteristics of the 12 test words produced by the four speakers: vowel duration and mean formant values (standard deviations are given in brackets)*

Pronunciation	Speaker	Vowel	*F*1 (Hz)	*F*2 (Hz)	*F3* (Hz)	*F*4 (Hz)
Non-rhotic	Speaker 1	300.4	630.6	1647.8	2890.3	3885.9
	Speaker 2	316.6	671.0	1612.2	3100.7	4102.7
Rhotic	Speaker 3	322.0	611.6	1488.5	2304.6	3826.3
	Speaker 4	351.5	752.7	1656.1	2474.5	3701.6

Scoring

Video scoring was completed and the data analysed in the same manner as the previously reported studies. A second experimenter scored 10% of the videos independently, with an inter-experimenter agreement Intraclass Correlation Coefficient of 0.909 (Shrout & Fleiss, 1979).

4.2.1.2 Results and Discussion

Following the retention criteria of Chapter 3, there were 84% of all trials retained for analysis and all analyses were conducted on the PTL measure. The data were analysed in a mixed model ANOVA with the within-participant factors Naming (pre and post) and Pronunciation (control, rhotic, and non-rhotic) and the between-participant factor Exposure (rhotic only and mixed). There was a main effect of naming ($F(1,32)=17.90$, $p<.001$, $\eta_p^2=.359$) and an interaction between naming and pronunciation ($F(2,68)=3.92$, $p=.02$, $\eta_p^2=.103$).

Figure 4.4 suggests that all toddlers are identifying the target following control and rhotically pronounced labels but not the non-rhotic pronunciations. There were no main effect of exposure or interactions with exposure (all *p*'s>.05) suggesting that regardless of their exposure toddlers responded similarly. As such, all further analyses consider all toddlers together (see Figure 4.7).

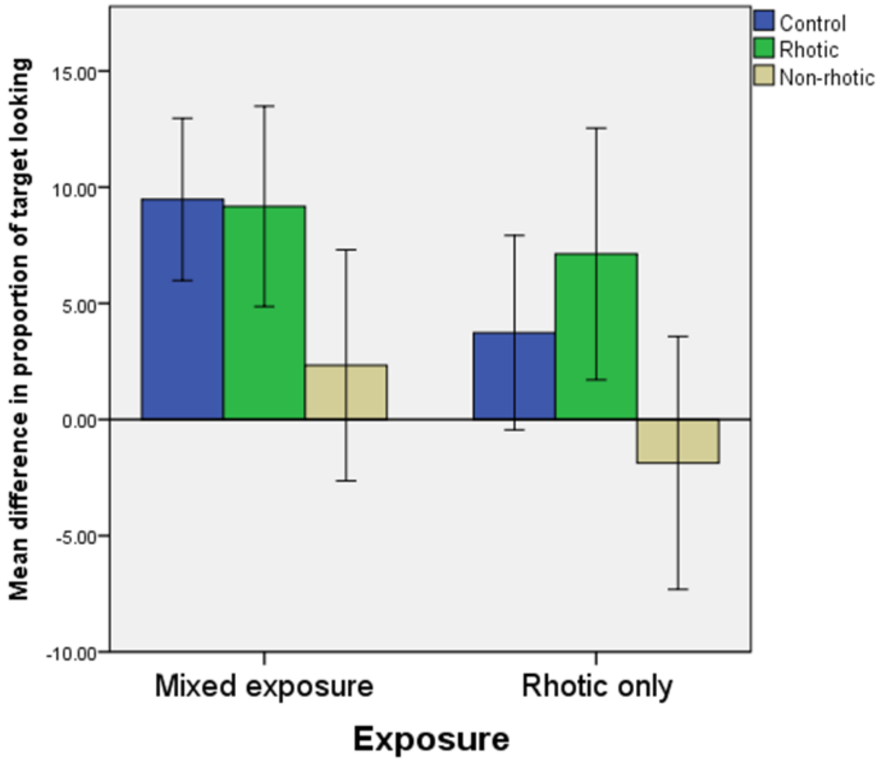

Figure 4.6 – *Mean difference in the proportion of target looking in each trial type as a function of toddlers' exposure: mixed exposure (left) and rhotic only exposure (right). Errors bars represent +/- 1.5 SE*

To further explore the interaction between naming and pronunciation and identify the conditions where naming was present a series of t-tests were conducted comparing the mean difference in toddlers' looking behaviour from the pre- to post- naming phase between the control condition and the non-rhotic and rhotic conditions. Toddlers' performance in the control conditions provides a baseline to which performance in the rhotic and non-rhotic trials can be compared as in these two conditions toddlers' performance could be the same as the control trials or differ. When comparing performance in the non-rhotic trials (mean = .07, SD = .11) with the control trials (mean = .00, SD = .15) there is a significant difference in performance ($t(35)=-2.05$, $p=.048$, $d=.49$) suggesting that toddlers are failing to identify the target following non-rhotic pronunciations. Alternatively, when comparing performance on rhotic trials (mean = .08, SD = .14) with control trials (mean = .07, SD = .11) there is no significant difference in toddlers looking behaviour ($t(35)=.525$, $p>.05$, $d=.12$). This indicates that toddlers have identified the target in rhotic trials similarly to control trials. Taken together these results demonstrate recognition of the target following rhotic but not non-rhotic pronunciations.

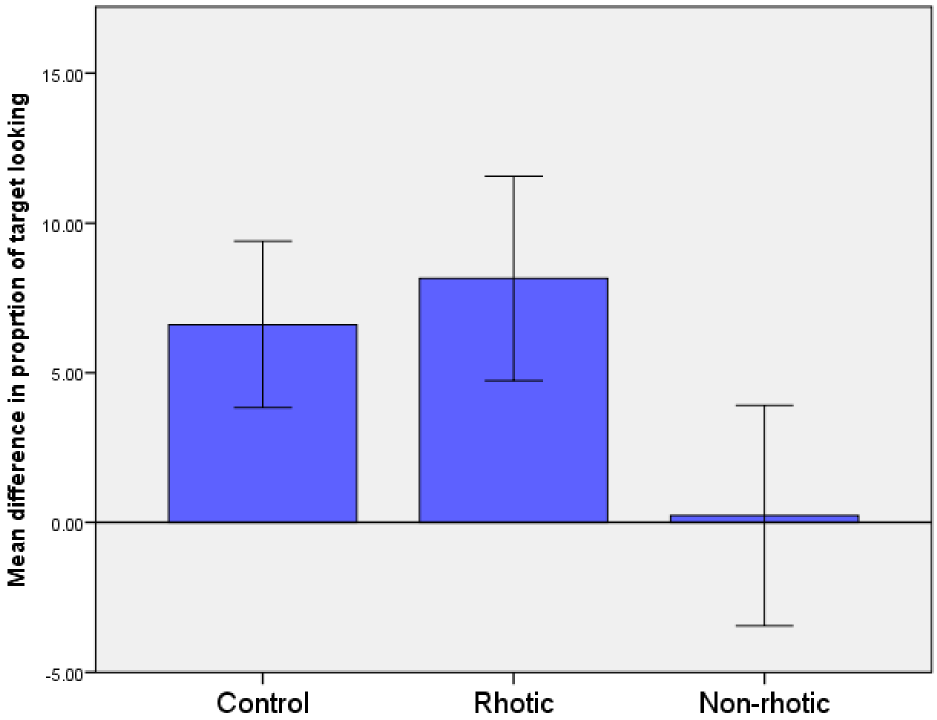

Figure 4.7 - *Mean difference in the proportion of looking times for all toddlers for each of the three trial types, control(left), rhotic (centre) and non-rhotic (right). Errors bars indicate +/- 1.5 SE.*

To be able to consider these results alongside Experiments 1, 2 and 3 performance in the pre and post-naming phases for each condition was analysed. A significant increase in looking towards the target was found for control (t(35)=-3.57, p=.001, d=.66; pre-naming - mean = .49, SD = .08 and post-naming – mean =.56, SD = .11) and rhotic trials (t(35)=-3.57, p=.001, d=.62; pre-naming - mean = .50, SD = .12 and post-naming – mean =.58, SD = .14). However, this difference was not significant following non-rhotic pronunciations (t(35)=-.09, p=.93, d=.02; pre-naming - mean = .52, SD = .14 and post-naming – mean =.52, SD = .15). The mean proportion of exposure to non-rhotic pronunciations was 73.2% (SD 22.4). Correlations between this measure and the difference in the proportion of looking time for rhotic, non-rhotic, and control words were not significant (rhotic: r(15)=-.08, p=.77; non-rhotic : r(15)=.002, p=.99; control: r(15)=.18, p=.52) .

The results of this experiment demonstrate that toddlers raised in a rhotic environment recognise only rhotic pronunciations of familiar words, regardless of their exposure. Both groups of toddlers tested were regularly exposed to rhotic pronunciations from the local environment. However, for one group exposure also included non-rhotic pronunciations from at least one of their parents. In this mixed group, for whom exposure included both rhotic and non-rhotic pronunciations, toddlers did not fixate the target in the non-rhotic test trials. This suggests that exposure alone is insufficient for recognition of allophonic variants of words but instead points to an explanation whereby toddlers' phonological representations contain only a single form, determined by the surrounding environment and not by exposure or parental influence. This would be the first evidence of such an early socially driven influence for one pronunciation over another and would complement other studies demonstrating the same effect in older children. It has been reported that dialect acquisition often reflects the dialect of the local community rather than that of the immediate family (Kerswill & Williams, 2000; Starks & Bayard, 2002; Tagliamonte & Molfenter, 2007).

One alternative explanation for these findings concerns the stimuli themselves; maybe rhotic pronunciations are preferred by toddlers for other reasons. One reason might be that rhoticity itself is particularly salient to toddlers and makes the match between these words and the lexical representation stronger; historically rhoticity has prevailed. A second reason could be that rhotic tokens provide greater disambiguation among words than non-rhotic tokens. In order to test this possibility Experiment 4b tests a group of toddlers who are rarely (if ever) exposed to rhotic pronunciations, toddlers raised in Oxford.

4.2.2 Experiment 4b – Recognition of allophonic pronunciations of familiar words: Rhoticity in a non-rhotic city

The results of Experiment 4a suggest that exposure to rhoticity in the local environment dictates a preference for familiar words to be pronounced rhotically, and that this preference is driven by the local community dialect rather than parental influence. That is, even those toddlers that heard predominantly non-rhotic pronunciations from their parents did not preferentially fixate the target following non-rhotic pronunciations. This surprising result suggests that toddlers' representations are primarily influenced by the pronunciation used in the community environment rather than in the home environment. These findings also demonstrate that all toddlers are able to discriminate between the two pronunciations as they showed consistent target looking upon hearing only one variant, the rhotic pronunciation. Contrary to explanations of expansion of phonetic categories when exposed to foreign accented speech (Schmale et al., 2011), toddlers exposed to both variants of these pronunciations do not seem to have broadened their phonetic category for /r/. Instead the evidence presented here suggest that toddlers have a single canonical representations based on the pronunciation most commonly encountered in the local community.

One proposed explanation for the preference for rhotic pronunciations is that the rhotic stimuli themselves are more salient to toddlers, which might influence their performance in this task. To explore this possibility, the same experiment, using identical stimuli and procedure, was carried out in collaboration with the Oxford Babylab. The dialect of Oxford is non-rhotic (Hughes & Trudgill, 1996) and as such toddlers raised in Oxford by non-rhotic parents will have minimal (if any) exposure to rhotic pronunciations of words. If the results of Experiment 4a are due to the characteristics of the rhotic pronunciations then the Oxford toddlers may recognise only the rhotic pronunciations similarly to the South West toddlers. Alternatively if Oxford toddlers recognise both pronunciations this would support the claim that the rhotic stimuli themselves drive recognition, but that being raised in a predominantly non-rhotic environment leads to recognition of non-rhotic variants as well, unlike the toddlers tested in Plymouth. Finally, toddlers may show target recognition following non-rhotic pronunciations only, supporting the proposal that exposure to rhoticity is required for successful recognition of rhotic pronunciations and that the community environment dictates the preferred pronunciation.

4.2.2.1 Method

Toddlers raised in Oxford, where rhoticity is uncommon, aged 20 months, were tested in this experiment. All toddlers had parents whose accents were non-rhotic. They completed the same task as the toddlers in Experiment 4a, viewing the same stimuli pairs and hearing the same rhotic and non-rhotic speakers. By doing this we can explore the proposal that toddlers' representations are influenced by their environment and rule out the suggestion that rhotic pronunciations are more appealing to toddlers and therefore are the preferred representation.

Participants

Twenty-one toddlers were successfully tested for this experiment. All infants were monolingual English and born and raised in the Oxford area of England (N= 21, 7 boys, mean age = 20 months, 9 days). Additional infants were tested but excluded due to failure to calibrate (1), fussiness (2), technological issues (8) and incomplete data (5). No infants were reported to have any developmental delays, hearing problems or were born more than six weeks prematurely. Parents were asked to complete the OCDI, toddlers understood an average of 294 words (SD = 64) and produced on average 137 words (SD = 97).

The toddlers' parents were recorded following the same procedure as in Experiment 4a and no parents were reported to have rhotic features in their speech by an expert listener familiar with rhoticity (see Table 4.8 for a full list of the dialects spoken).

As rhoticity is not a feature of the dialect of Oxford (Wells, 1982) it can then be considered that these infants would be unfamiliar with the rhotic pronunciations of words.

Table 4.8 - *Dialects spoken by the parents of the 21 children tested. "Neutral" refers to a Received Pronunciation (RP) or standard British English accent. These labels have been given by parents themselves, and the rhoticity (or the absence of) in their speech has been further attested by their reading aloud of a list of words and an analysis of their recordings by a trained native listener (see the stimuli section of Experiment 4a).*

	Mother	Father
1	Kent	South West
2	Swindon	Surrey
3	Oxford	Oxford
4	Oxford	Portsmouth
5	Oxford	Oxford
6	Oxford	Cornish
7	Watford	Southampton
8	Oxford	Oxford
9	Essex	Oxford
10	Cumbria	North West England
11	Oxford	Oxford
12	Oxford	Cumbria
13	London	Oxford
14	North London	North London
15	Lancashire	Oxford
16	Neutral	Neutral
17	Neutral	Somerset
18	Sussex	Leicestershire
19	Northern Ireland	Cambridgeshire
20	Oxford	Oxford
21	Oxford	Oxford

Stimuli

Infants were presented with identical trial orders and auditory stimuli as those used in Experiment 4a.

Procedure

Toddlers were seated on their carers lap approximately 65cm from a 23inch screen with 1920 by 1080 resolution. Eye movements were recorded by a Tobii TX300 eyetracker with a sampling rate set at 60Hz. Auditory stimuli were presented through a centrally positioned speaker. The experiment was presented using Matlab.

All other aspects of the experimental procedure including trial duration and number were identical to Experiment 4a.

4.2.2.2 Results and Discussion

Following the retention criteria of Chapter 3, 75% of all trials were retained for analysis and all analyses were conducted using the PTL measure. Data were analysed using a mixed model ANOVA with the factors Naming (pre and post) and Pronunciation (control, rhotic, and non-rhotic). There was a main effect of Naming (F(1,20)=6.99, p=.016, η_p^2=.259) but no main effect of Pronunciation and no interaction between Naming and Pronunciation. Due to the nature of the design, any preference for the rhotic or non-rhotic pronunciations could be masked statistically by increased target looking at the control trials. To explore this further a series of t-tests were conducted on the individual conditions to confirm a naming effect. As expected a significant increase in target looking during the post naming phase as compared to the pre naming phase was observed in the control trials (t(20)=-2.978, p=.007, d=.45; pre-naming - mean = .50, SD = .13 and post-naming – mean =.56, SD = .12). Of particular interest for this experiment is performance in the critical trials, those in which the words are rhotically or non-rhotically produced. Here we see a difference in the two trial types, the non-rhotic pronunciations elicited an increase in target looking (t(20)=-3.263, p=.004 d=.61; pre-naming - mean = .50, SD = .12 and post-naming – mean =.57, SD = .11) but the rhotically pronounced trials did not (t(20) = -.463, p=.648, d=.12; pre-naming - mean = .48, SD = .10 and post-naming – mean =.50, SD = .15). This can be seen clearly in Figure 4.8 and suggests that toddlers recognise only the non-rhotic pronunciations of familiar words.

As with Experiment 4a t-tests were carried out comparing the rhotically pronounced trials and the non-rhotically pronounced trials with the control trials. When considering performance in the non-rhotic trials (mean = .07, SD = .10) as compared to performance in the control trials (mean = .06, SD = .09) there is no difference observed ($t(20)=.586$, $p>.05$, $d=.14$). In addition, there is no significant difference in performance on control trials (mean = .06, SD =.09) when compared to rhotic trials (mean =.01, SD = .15; $t(20)=1.688$, $p>.05$, $d=.35$). However, considering the results from the t-tests on the individual trial types these results should be treated with caution, recall that there was a significant difference in looking times between the pre and post naming phases in the control and non-rhotic conditions. It should also be noted that in Experiment 4b, as compared to Experiment 4a, fewer toddlers were tested which would have reduced statistical power when comparing conditions directly. To identify whether this is a result of a lack of statistical power and make Experiments 4a and 4b comparable it is necessary to increase the number of toddlers tested in Experiment 4b.

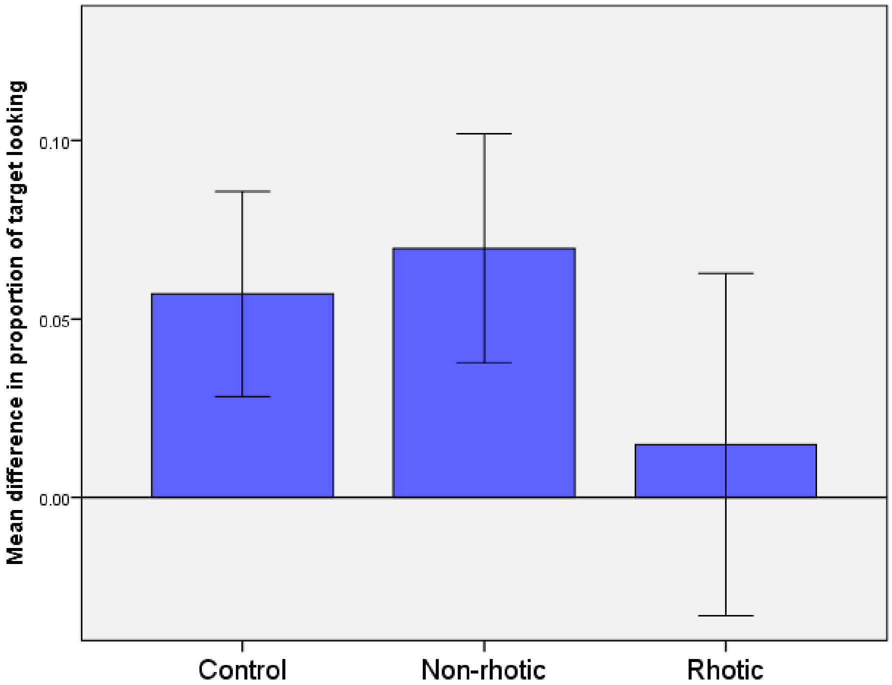

Figure 4.8 - *Mean change in the proportion of target looking (post-naming phase – pre-naming phase) for the control (left), non-rhotic (centre) and rhotic (right) pronunciations. Error bars indicate +/- 1.5 SE.*

To further explore toddlers' representation of rhotic and non-rhotic pronunciations of words, this experiment tested toddlers for whom rhotic pronunciations are missing in the input. If rhoticity is a feature of speech preferred by toddlers then the Oxford toddlers should perform similarly to those tested in the South West in Experiment 4a, or would recognise both pronunciations equally. This was not the case: toddlers who are not exposed to rhotic pronunciations treat them as mispronunciations of familiar words. These findings show that it is not a specific feature of rhoticity that is influencing toddlers' performance in Experiment 4a, instead supporting the claim that the phonological representations of toddlers are determined by the variants heard in local community rather than parental influence, as young as 20 months, and similarly to older children (Kerswill & Williams, 2000; Starks & Bayard, 2002; Tagliamonte & Molfenter, 2007).

4.2.3 Discussion

Across the two studies reported here toddlers demonstrated a preference for the pronunciation that matched that of the community in which they were being raised. Those toddlers living in the South West, where rhotic pronunciations are prevalent, fixated the target image only when its label was produced rhotically. Conversely, the Oxford raised toddlers, where rhoticity is uncommon, fixated the target only following non-rhotic labels. Of particular interest in these experiments are the results from Experiment 4a in which two groups of toddlers were tested. In the first group the toddlers heard rhotic pronunciations from both of their parents and the local community, whereas in the second group toddlers also heard non-rhotic pronunciations from at least one of their parents. This suggests that it is not simply the case that toddlers' preferences arise from exposure but that they are selecting the form that matches the local community as their primary representation. This is the first time such a preference has been identified at such a young age; this ties in with findings with older children for whom with dialect acquisition seems to be determined by the integration within the community rather than the family (Kerswill & Williams, 2000; Starks & Bayard, 2002; Tagliamonte & Molfenter, 2007).

Additionally, the findings of Experiment 4b rule out an explanation based on the rhotic tokens themselves attracting recognition. If rhoticity contained a specific feature that encouraged recognition, then the Oxford toddlers, despite no prior experience with rhotic forms, would have identified the target following the rhotic pronunciations. Instead, an asymmetry is observed in the findings in the two cities suggesting that the presence or absence of rhoticity in the community dialect is the key factor explaining performance. Of course, it could still be the case that regularly encountering rhotic pronunciations leads toddlers to adopt this variant as the dominant form due its specific features. However, with the data we have here it is not possible to validate this claim. The ideal situation to test this proposal would be one in which rhotic pronunciations are present in the family setting but the dialect of the community is predominantly non-rhotic. In this situation it would be possible to identify whether the community accent provides the preferred representation or whether rhotic pronunciations themselves are driving this effect.

What is evident from the results here is that all toddlers discriminate the two pronunciations, with the recognised variant being that of the surrounding community, rhotic for Plymouth toddlers and non-rhotic for Oxford toddlers. The fact that this is the case for all of the toddlers tested in the South West, regardless of parental pronunciation, suggests that even at this young age toddlers have a single representation stored in the lexicon, as determined by the environment. However, it seems very likely that the mixed exposure group of toddlers raised in the South West have the ability to recognise words spoken in their non-rhotic form as they will encounter these from their parents; in which case this poses an interesting case for future research in confirming a number of points. Firstly, we would need to confirm that toddlers faced with mixed exposure do indeed recognise both forms successfully; then it would be interesting to establish the situations that lead to recognition for one pronunciation over the other. For example, children could be encouraged to process speech in a rhotic-style by listening to a few minutes of non-rhotic speech before the testing in a procedure similar to White and Aslin (2011) and van Heugten and Johnson (2012, 2014).

In accordance with the explanation suggested for the results of Experiment 3, that the difference between the two pronunciation types is large enough to disrupt recognition, rhotic pronunciations also differ from non-rhotic ones on two phonemes. The vowel preceding the /r/ is lengthened in addition to the effect on the /r/ consonant itself (Ladefoged, 2001). This further supports the claim that the difference between rhotic and non-rhotic pronunciations could, as with the glottal stops, disrupt successful recognition of the target. In both glottalisation and rhoticity, pronunciations differ on more than one phoneme resulting in a larger deviation from the stored variant as compared to the single phoneme changes tested in Experiments 1 and 2. Recall that the single phoneme deviations in Experiments 1 and 2 were not detected as mispronunciations by multidialectal toddlers. What is evident from these results is that the preference observed in Experiment 4a is not specific to rhotic pronunciations; it is not more salient for toddlers, as recognition of rhotic and non-rhotic pronunciations and moderated by toddlers community exposure.

To conclude, the evidence from Experiment 2 suggests that toddlers have a single, canonical, representation of the words they are learning even when exposed to more than one type of pronunciation. It is also suggested that the representation of this word is determined by the variant used in the local community rather than from the home environment. Finally, it is suggested that it is the number of phonemes affected by rhoticity that can explain the lack of recognition of multiple variants by toddlers exposed to both forms.

4.3 Conclusions

The studies presented in this chapter aimed to explore multidialectal toddlers' representations of words that differ in pronunciation naturally, with a particular focus on glottalisation and rhoticity. Both of these pronunciation differences are allophonic; the pronunciation of the word can vary but its meaning is consistent. Based on the findings of Experiments 1 and 2 it was expected that mono and multidialectal toddlers would behave differently with these pronunciations, with multidialectals better able to accommodate such variation. This was not the case: all toddlers performed similarly and identified the target following only one variant of the target word. In Experiment 3 all toddlers recognised only the non-glottal pronunciations, that is, those that are dominant in the input they are hearing. In Experiments 4a and 4b this pattern was replicated with recognition of only the pronunciation that dominates in the local community. For toddlers raised in Plymouth these were the rhotic pronunciations and for Oxford toddlers the non-rhotic pronunciations.

These results point strongly to an interpretation based on exposure to the type of variation being tested in conjunction with social influences driving the selection of the canonical form when exposure to more than one variant is present. However, these results differ from Experiments 1 and 2 where general exposure to dialect variation led to multidialectal toddlers' acceptance of mispronunciations for familiar words. One main difference between these sets of studies is the nature of the change: the mispronunciations created in Experiment 1 were strictly controlled and targeted only single feature changes to a single phoneme. In the experiments reported in this chapter the changes reflected natural pronunciations differences that are likely to occur both within and between speakers and affect not only the target phoneme but also the surrounding ones as well, typically the vowels. These additional phoneme alterations, differences in vowel duration and different realisations of the /t/ or /r/, between the two pronunciation types, could be enough for toddlers to treat them as new words rather than different pronunciations of the same word. The data presented in this thesis cannot at this time draw any firm conclusions regarding these explanations and further research will be needed.

Chapter 5.

Does dialect variability influence the use of a word learning strategy – Mutual Exclusivity

Young infants and toddlers are experts at learning language yet this is not without challenges. This thesis has presented evidence that the presence of long-term variable input can constitute an obstacle to word processing. Until now this thesis has focussed on what children are learning about the specific sounds and words they are hearing, however, toddlers are also engaged in forming object meaning mappings: linking words to objects. In order to achieve sound to object mapping, a range of strategies are thought to be employed (for a full discussion see Chapter 2.1). The focus for this chapter is the effect of within-language variation on the use of the disambiguation strategy, most commonly considered as part of the Mutual Exclusivity bias (Woodward & Markman, 1991).

5.1 Experiment 5 – Using the Mutual Exclusivity strategy to learn new words – monodialectal and multidialectal toddlers?

Disambiguation is used to explain the phenomenon by which an infant relates a novel word to an object in their environment that is, as yet, unnamed, as opposed to accepting the novel word as a second name for an object they already have a name for. For example, upon seeing a familiar object, ‘car’, and an unfamiliar object, ‘train’, and hearing the unfamiliar word ‘train’ that has no object referent, the child will map the novel word ‘train’ to the novel object ‘train’ rather than attach it as a possible other word for ‘car’, thus learning a new word. In much of the literature the terms Mutual Exclusivity and disambiguation are used to refer to the same phenomena. For the purposes of clarity, in this thesis disambiguation will be used to describe the effect observed when children select (either physically or by looking depending on the paradigm used) the novel object over a familiar object when hearing a novel word; Mutual Exclusivity will be used to discuss the motivation for this, that is the reluctance of toddlers to apply a second label to the same object.

The first studies investigating disambiguation used an object selection task (Markman & Wachtel, 1988); in this task toddlers are presented with a novel and a familiar object and asked to pass one of them to the experimenter. The experimenter would ask for either the familiar object named with the familiar name or the novel object by using a novel word. If children apply Mutual Exclusivity for learning new words they should employ a strategy of disambiguation, that is, when hearing the novel word hand the experimenter the novel object for which they have no name. This method has been used to demonstrate reliable disambiguation in pre-school children (Au & Glusman, 1990; Hutchinson, 1986).

Since these early studies researchers have sought to identify when children begin to use disambiguation to learn new words. Liittschwager and Markman (1994) find evidence of disambiguation in 16 months toddlers with the inclusion of a training phase where the experimenter taught them a novel object-word pairing alongside familiar word and object items. During the test phase the experimenter requested that the child give one of the items, either familiar or newly learned, to a puppet. Success was measured by how likely they were to choose the target object correctly, that is selecting the newly learned object following the request with the newly learned word. With this procedure toddlers at 16 months reliably handed the puppet the named object. Markman, Wasow, and Hansen (2003) report a similar finding with 15 month toddlers using the object selection task. In this study there was no explicit training, however, toddlers did play with the familiar object prior to testing. The results of these two studies with these very young toddlers could be explained by the presence of social-pragmatic cues as a result of the experimenter-child interaction. The experimenter could have unwittingly provided the toddler with unconscious cues as to which object they were asking for. It is well established that from a very young age toddlers are sensitive to social cues from adults

(Baldwin, 1993; Baldwin et al., 1996; Houston-Price, Plunkett, & Duffy, 2006). Houston-Price et al. (2006) demonstrate how speaker gaze direction influences the learning of a novel word-object pairing. They used an IPL procedure to present toddlers with a pair of novel objects and a central face; when the auditory stimulus was heard the face turned to look at the picture. They found that toddlers successfully learned the word-object pairing at 15 months using only the gaze cue suggesting that this is a powerful mechanism for early word-learning.

One way of controlling the presence of unintentional pragmatic cues from experimenters is to remove the adult-child interaction element and instead use an IPL procedure to assess disambiguation. Using this method Halberda (2003) tested for disambiguation in toddlers aged 14, 16, and 17 months. Toddlers were presented with a series of trials where a known object was paired with either another known object or a novel object. On trials where a novel object was present half of the trials had the familiar object named and half the novel object named. The trials where the novel object was named were the critical trials for identifying disambiguation. On these trials toddlers, if successfully disambiguating, should increase looking at the novel object following naming due to exclusion of the familiar object that already has a label assigned. On all trials the target object remained on screen and 'danced' while the distracter disappeared. Halberda (2003) found that infants demonstrated this pattern of performance, and therefore disambiguation, only at 17 months of age and not at the younger ages of 14 and 16 months. In fact, at 14 months infants demonstrated a preference for the familiar object even after hearing the novel word. These results suggest that infants are able to use the disambiguation strategy, in the absence of an experimenter, only when they have acquired some words in their lexicon, suggesting a developmental trajectory with performance improving with age. Whilst this does not discount the use of disambiguation at younger ages, it suggests that it is not a straightforward process of Mutual Exclusivity but is reliant on other situational information.

The IPL procedure has been found to reliably assess disambiguation in toddlers with replications of Halberda's (2003) findings by Mather and Plunkett (2012) in 22 month olds, Byers-Heinlein and Werker (2009) in 17 month olds and Houston-Price et al. (2010) in 17-22 month olds using the same procedure. At present the youngest age at which evidence of disambiguation has been demonstrated is 10 months old (Mather & Plunkett, 2010). Infants tested by Mather and Plunkett (2010) increased attention to a novel object following a novel label to a greater extent than in a control phase with no label and only a non-directive labelling sequence, 'Look at that, oooh, Look there'. The use of the control phase in this study allowed for infants' general preference for novel objects to be accounted for. In this study the toddlers' looking behaviour following a novel label could not be explained by the novelty of the object itself, but by the introduction of the novel label. Similar findings are reported by Xu, Cote, and Baker (2005) and Dewar and Xu (2010) in 9 to 12 month olds.

Despite the seemingly robust nature of this effect in monolingual toddlers around the middle of the second year, the evidence for bilingual toddlers is less clear. Houston-Price et al. (2010) present evidence suggesting that bilingual toddlers do not use this strategy of disambiguation for learning new words. In a replication of the procedure used by Halberda (2003), they successfully demonstrated disambiguation in monolingual toddlers aged 17-22 months. However, the bilingual toddlers they tested, who were matched for age and vocabulary size, did not show any evidence of disambiguation; that is they failed to show evidence of using a Mutual Exclusivity bias to determine the referent of a novel word. This result seems unsurprising given that the key component of Mutual Exclusivity is the assumption that each object has only one name, an assumption violated by the very nature of the bilingual infants' input. For the bilingual child each object in their environment has two names, one for each of their languages.

A similar pattern of results is observed in a study by Byers-Heinlein and Werker (2009) testing monolingual, bilingual, and trilingual toddlers aged 17-18 months. Using the same IPL procedure they found clear evidence of disambiguation in monolingual toddlers. However, unlike Houston-Price et al. (2010) they found some evidence of disambiguation for the bilingual toddlers, and not at all in trilingual toddlers. One possible explanation for the disparity in the bilingual results of these two studies is the inclusion of feedback regarding the target object by Byers-Heinlein and Werker (2009). In their study the target image remained on screen and moved around at the end of the trial, a manipulation that did not occur in the Houston-Price et al. (2010) procedure. This additional cue to the identity of the target object at the end of a trial may have been sufficient to influence children's responding in the later trials leading to the observation of disambiguation. Despite this difference, the findings from Byers-Heinlein and Werker (2009) and Houston-Price et al. (2010) clearly demonstrate that learning more than one language influences a toddler's ability to disambiguate and suggests that they do not systematically apply the Mutual Exclusivity assumption when learning words.

At an older age, 27 months, this difference between monolingual and bilingual toddlers is no longer apparent. I. Frank and Poulin-Dubois (2002) found no difference in the application of Mutual Exclusivity, and therefore disambiguation, in monolingual and bilingual toddlers. In the training phase of this study, an experimenter familiarised the child with the objects they would encounter, both the familiar and unfamiliar ones, labelling the last novel object encountered with a novel word. A second experimenter would then refer to the same object with a different novel name. During the testing phase the toddler was asked to select, from the same four objects, one of the familiar items and the object previously assigned the novel label. The critical manipulation was that the two experimenters spoke the same language in one condition and different languages in another condition. . In both the single and dual language conditions all toddlers – monolingual and bilingual - demonstrated evidence of adherence to Mutual Exclusivity by applying a novel name to the unnamed object, regardless of their own language exposure.

Additional evidence that bilingual toddlers can use disambiguation when learning words is found by Byers-Heinlein, Chen, and Xu (2014), using an object selection task. Toddlers were taught a novel object-word pairing and then tested in disambiguation trials with that object and another novel object and word. At 24 months both monolingual and bilingual toddlers successfully used Mutual Exclusivity to identify the referent of a novel object when training and test trials were conducted by an English speaker. Following the English trials a second set of training trials were presented by a Mandarin speaker, a language which none of the toddlers were familiar with. In these trials only the monolingual toddlers correctly selected the target object, whilst the bilingual toddlers did not show evidence of disambiguation. Byers-Heinlein et al. (2014) suggest that the bilingual toddlers have an awareness that the Mandarin speaker could be referring to the same object as the English speaker as a result of their own language experience. This additional knowledge, that in some situations words can have two labels, then led them to override the Mutual Exclusivity response and not use disambiguation to identify the target object. This evidence suggests that by 2 years of age bilingual toddlers are able to use Mutual Exclusivity and successfully disambiguate although their use of this strategy across languages is still unclear.

The common theme of this thesis has been the testing of a subgroup of monolingual infants whose language input is variable in a similar way to bilinguals: the multidialectal population. Of particular interest for the current experiment is that multidialectal toddlers hear some objects labelled differently by each of their parents, for example, 'bairn' for 'baby' if one of their parents is from Scotland or Yorkshire. These dialect-related lexical differences are present in addition to pronunciation differences discussed in detail in Chapter 2.5.2. If, as is suggested by Byers-Heinlein and Werker (2009), language input influences children's use of the Mutual Exclusivity strategy in disambiguation and subsequent word learning, then a lack of disambiguation in multidialectal infants might also be expected.

One study that looks specifically at the effect of accent variability on word learning was conducted by Schmale et al. (2011). They taught 24-month-olds novel word-object pairings in either a foreign or local accent and then tested them in the opposite accent, using a variant of the IPL procedure. Toddlers who were trained on the novel words in the foreign accent looked longer to the target picture when hearing the word in the local accent, suggesting they had successfully learned the words. In contrast, those toddlers who were trained in the local accent showed no target preference when tested in the foreign accent, suggesting that their representations of the newly learned words was specific to the local accent. That is, when words are learned in an unfamiliar accent, the resulting representation is more able to accommodate variation and allows for generalisation to other instances or accents. In contrast, the familiar accent training condition creates a more specific representation that does not allow for abstraction across other accented instances of the word. This indicates that variability has a facilitative effect during word learning if this learning phase occurs in an unfamiliar accent. At this point however it remains unclear whether continual exposure to variability when learning words has a general facilitative effect on word learning.

Although there is currently no empirical evidence looking at word learning and continual dialect exposure, it was demonstrated in Experiments 1 and 2 that multidialectal toddlers' performance in a mispronunciation task differs to that of their monodialectal peers. These experiments used an IPL procedure and presented mono- and multidialectal infants with single feature mispronunciations of familiar words. Monodialectal infants behaved as expected and rejected the mispronunciations, however multidialectals behaved differently. Upon hearing a mispronunciation, e.g. 'gat' for cat, multidialectal infants still looked longer at the corresponding picture, behaviour taken as indicative of recognition. This is the first experiment to demonstrate the impact of continual dialect related variability on the phonetic specificity of familiar words. However, this effect was limited to mispronunciations and did not extend to naturally occurring variation in pronunciations, e.g. allophonic variation and rhoticity, where all toddlers behaved similarly, as seen in Experiments 3 and 4.

The current experiment seeks to identify whether mono and multidialectal toddlers equally use a Mutual Exclusivity strategy to disambiguate a novel and familiar object or whether multidialectal infants' performance is akin to that of bilingual toddlers where no or limited disambiguation is seen. Using an IPL procedure, similar to that of Halberda (2003) and Houston-Price et al. (2010), toddlers aged 18 and 24 months old were presented with pairs of images and heard one labelled. In some trials the label was familiar and in others it was the novel label 'dax'. On novel label ('dax') trials it is expected that toddlers who are successfully disambiguating should look longer at the novel image (garlic press) as they reject a second label for the familiar object with which it is paired. As such, performance on the novel label trials is of most interest in this experiment as these are the trials where toddlers can demonstrate disambiguation and where any differences that might exist between dialect groups would be apparent.

It is predicted that monodialectal toddlers will behave as expected from the previous literature at this age (Byers-Heinlein & Werker, 2009; Halberda, 2003; Houston-Price et al., 2010) and look longer to the novel object when hearing the novel label. The monodialectal group of toddlers tested here is likely to be most representative of the monolingual infants tested in previous studies (Byers-Heinlein & Werker, 2009; Halberda, 2003; Houston-Price et al., 2010), based on experience of previous studies in the Plymouth population where monodialectal toddlers are typically more abundant than multidialectal toddlers. Multidialectal infants could respond in one of two ways: they could respond similarly to their monodialectal peers and look more to the novel object following a novel label. Alternatively, if hearing multiple dialects affects word learning in the same way as hearing multiple languages then no evidence of disambiguation will be observed. Finally, by comparing children at 18 and 24 months improvements in performance across the two ages might emerge, in particular for the multidialectal toddlers who might initially fail to disambiguate the novel object. This would fit with the evidence from bilingual toddlers reported by I. Frank and Poulin-Dubois (2002) and Byers-Heinlein et al. (2014).

5.1.1 Method

English learning toddlers aged 18 and 24 months were presented with pairs of images (familiar and novel objects) accompanied by either a known or novel word.

Preferential fixation to the novel object when accompanied by the novel word would suggest that toddlers use the strategy of Mutual Exclusivity in deciding which object is being named (e.g. Markman, 1989).

Participants

Seventy-nine monolingual English speaking toddlers (47 aged 18 months and 32 aged 24 months) born and raised in the South West of England were successfully tested for this experiment. Each age group was further subdivided into 2 groups, monodialectal or multidialectal, based on the dialects the toddlers were regularly exposed to. All toddlers were identified as monodialectal or multidialectal prior to testing and this was confirmed following the same procedure as the previous studies reported in this thesis (See Table 5.1 for a full list of multidialectal toddlers dialect input, including percentage exposure to the local dialect). The amount of exposure to each dialect was calculated using the same criteria as all other studies in this thesis.

18 Months

Forty-seven toddlers aged 18 months completed this experiment, monodialectals (N=23, 9 boys, mean age = 18 months, 0 days) and multidialectals (N=24, 14 boys, mean age = 17 months, 29 days). The average exposure to the local dialect of multidialectal toddlers as calculated using the language exposure questionnaire (Cattani et al., accepted) was 45% (range: 26 – 75%), toddlers outside of this 25-75% range were excluded as is typical in bilingual research (Pearson et al., 1997). An additional 28 toddlers were tested but their data excluded due to incorrect exposure amounts to the local dialect (13), inattentiveness (4), non-completion (6), familiarity with the novel object (1), and technical issues (4). Forty-six parents completed the OCDI (Hamilton et al., 2000) with no significant difference found between the two groups (receptive vocabulary $t(21)=-1.14$, $p=.27$, $d=.24$; productive vocabulary - $t(21)=-.81$, $p=.43$, $d=.37$).

24 Months

Thirty-two 24 month toddlers completed this experiment, monodialectals (N=16, 7 boys, mean age = 23 months, 25 days) and multidialectals (N=16, 7 boys, mean age = 24 months, 1 day). An additional 14 toddlers were tested but excluded due to non-completion (4), technology failure (1), incorrect exposure to the local dialect (8), and experimenter error (1). Parents were asked to complete the OCDI (Hamilton et al., 2000)and scores were obtained for 30 toddlers (2 multidialectal toddlers parents did not complete the CDI) with no significant difference found between the two groups for receptive vocabulary ($t(13)= -1.22$, $p = .25$, $d=.49$); however there was a significant difference for production scores with multidialectal toddlers reported as saying a significantly larger number of words ($t(13)= -2.52$, $p = .026$, $d=.81$).

Stimuli

As is typical in these studies (Byers-Heinlein & Werker, 2009; Halberda, 2003; Houston-Price et al., 2010) participants saw 4 different objects during test trials, 3 of these were familiar (car, cup and ball) and 1 was novel (a garlic crusher). The familiar objects were the same as those used by Houston-Price et al. (2010) and Halberda (2003). Due to findings from Mather and Plunkett (2012) highlighting the importance of novelty for successful disambiguation, we used the same novel object as that used by Houston-Price et al. (2010) where toddlers successfully disambiguated. The novel object was deemed as unfamiliar for these toddlers by questioning parents following the experiment; only one parent reported that her child was familiar with this object and for this reason her data were excluded. Each object appeared in 4 different colours to maintain toddlers' interest in the later trials with no two objects of the same colour presented together. An additional 2 objects (shoe and hat) were presented as training trials to familiarise toddlers with the procedure prior to the critical trials. Images were deemed good exemplars of the intended target by adult observers.

Table 5.1– *List of the dialects multidialectal toddlers heard from each of their parents separated by age group. Percentage exposure to the local dialect is reported. All other toddlers heard only the local accent from their parents and childcare providers.*

Child	**Multidialectal**		**% Exposure to South West dialect**
18 Months	**Mother**	**Father**	
1	Wales	Reading	35
2	South West	South East	59
3	Hampshire	Wales	32
4	South West	London	68
5	Midlands	South West	33
6	South West	Guernsey	51
7	Reading	Oxford	39
8	Nottingham	South West	44
9	South West	London	60
10	South Africa	South Africa	50
11	Mid South	Birmingham	40
12	Mid South	Birmingham	40
13	South West	Oxford	52
14	South East	South East	39
15	South West	Australia	72
16	Welsh	South West	39
17	Welsh	South West	34
18	South West	South Africa	37
19	Lancashire	Stoke-on-Trent	42
20	South West	Wales	75
21	Black Country	Black Country	26
22	West Coast America	South West	61
23	South East	South East	32
24	Kent	Kent	26
24 Months			
1	Wales	South West	25
2	South West	Midlands	73
3	South West	Wales	75
4	Herefordshire	Sussex	26
5	South West	Liverpool	56
6	South West	Lincolnshire	75
7	South West	Manchester	27
8	South West	Midlands	75
9	South West	South East	57
10	Lancashire	Stoke-on-Trent	32
11	South West	Scotland	74
12	Scotland	South West	34
13	South West	Wales	36
14	Derbyshire	South West	30
15	Birmingham	South West	39
16	Midlands	South West	28

Following previous studies auditory stimuli were recorded by a female native speaker of the local dialect in a child directed manner. The four target words were recorded (car, ball, cup and dax for the novel object) and presented to toddlers in each of three carrier phrases (“Look at the x”, “Where is the x”, “Find the x”). For the training trial children heard only a non-directive phrase ‘Look.....look’ to familiarise them with the pairs of images and the presence of an auditory stimulus, as was the case in Houston-Price et al. (2010). A single exemplar of each of the carrier phrases was used and spliced to each of the target words to ensure that this did not influence looking behaviour. All of the target words were heard paired with each of the carrier phrases equally often.

Procedure

The experimental setup used for this experiment was the same as for the previous studies reported here, see appendix D for diagrams of the setup from an aerial and front view perspective. The procedure used in this experiment was a replication of Houston-Price et al. (2010). Participants first saw a training trial where two familiar objects, not included in the test stimuli, were presented and one was named in order to familiarise them with the procedure. This was followed by 24 test trials each lasting 7 seconds where pairs of images were presented on screen. The onset of the target word occurred at 3500ms into the trial, splitting the trial equally into pre and post naming phases. The experimenter manually started each trial when toddlers fixated a centrally located smiley face that appeared between all trials. The 24 test trials were separated across 2 blocks of 12 so that learning throughout the experiment could be assessed. Each block of 12 contained 6 trials where both the target and distracter were known (KK trials) and 6 trials that included the novel object. For 3 of the 6 novel object trials the novel object was the distracter (KU trials) and for the other 3 the novel object was the target (UK trials).

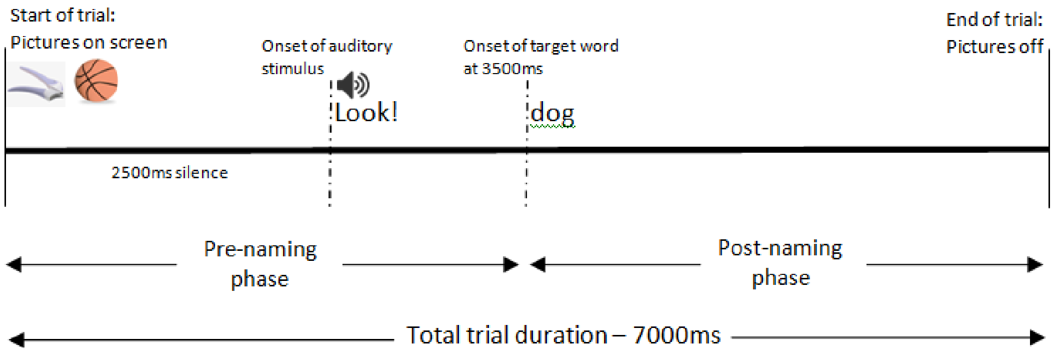

Figure 5.1 - *Time line of experimental procedure starting from the left with a total duration of 7 seconds*

Throughout the experiment targets were presented equally often on the left and the right side of the screen, counterbalanced across children. The order of presentation of trials was also counterbalanced with no child seeing more than 2 of the same trial type consecutively.

Scoring

The scoring protocol was the same as for all other studies. The coded data was used to calculate the amount of time toddlers spent looking at each of the target and distracter images in both the pre and post naming phase of each trial. Fixations occurring between 367ms and 2000ms for 18 month olds and 233ms and 2000ms for 24 month olds after the onset of the target word were considered for analysis based on previous research (e.g. Swingley & Aslin, 2000).

5.1.2 Results

Analyses were conducted only on trials where toddlers looked at both images during the trial; these criteria retained 87% of all trials. The PTL measure was used as in previous studies reported in this thesis. A mixed model ANOVA with the within-subject factors Naming (pre and post) and Trial type (KK, KU and UK) and the between-subject factors Age (18 and 24 months), Block (first 12 trials and second 12 trials) and Dialect (Mono- and Multi-dialectal) was conducted. A main effect of Naming was observed

(F(1,73)=74.81, p=<.001, η_p^2=.51), suggesting that there was a significant difference between target looking in the pre and post phases as suggested by Figure 5.2. This increase in target looking in the post naming phase as compared to the pre-naming phase is confirmed in each of the trial types by t-tests (KK trials -t(78)=-9.56, p<.001, d=1.50; pre-naming - mean = .48, SD = .14 and post-naming – mean =.62, SD = .18, KU trials - t(78)=-6.00, p<.001, d=.84; pre-naming - mean = .48, SD = .07 and post-naming – mean =.61, SD = .10 and UK trials - t(78)=-2.77, p=.007, d=.43; pre-naming - mean = .50, SD = .15 and post-naming – mean =.57, SD = .20).

An interaction between Naming and Age (F(1,75)=13.91, p=<.001, η_p^2=.16) was observed suggesting that the two age groups were looking differently during the pre and post naming phase. As a result of this interaction further analyses consider the two age groups independently. Finally, an interaction between Block and Trial type (F(2,146)=3.25, p=.04, η_p^2=.04) was found indicating that toddlers behaved differently across blocks (Figure 5.3). This finding was due to performance on UK trials improving during block two: there was no naming effect for UK trials in block one (t(78)=-1.37, p=.185, d=.21; pre-naming - mean = .49, SD = .19 and post-naming – mean =.54, SD = .24) whereas in block two there was a significant increase in target looking following naming (t(78)=-2.47, p=.016, d=.42; pre-naming - mean = .50, SD = .21 and post-naming – mean =.60, SD = .27), although there was no significant difference in UK trial between the two blocks (t(78)=-1.15, p>.05; block 1 – mean =.04, SD = .31 and block 2 – mean =.10, SD =.37). For both KU and UK trials there was a significant naming effect in both blocks (all p's <.001; KU trials block 1 - pre-naming - mean = .49, SD = .17 and post-naming – mean =.62, SD = .23 and block 2 - pre-naming - mean = .47, SD = .18 and post-naming – mean =.63, SD = .22 and KK trials block 1 - pre-naming - mean = .49, SD = .08 and post-naming – mean =.64, SD = .12 and block 2 - pre-naming - mean = .48, SD = .14 and post-naming – mean =.59, SD = .18) and no difference between performance across blocks (all p's >.05; KU trials block 1 – mean =.13, SD = .27 and block 2 – mean =.16, SD - .26 and KK trials block 1 – mean = .15, SD = .16 and block 2 – mean = .11, SD =.23).

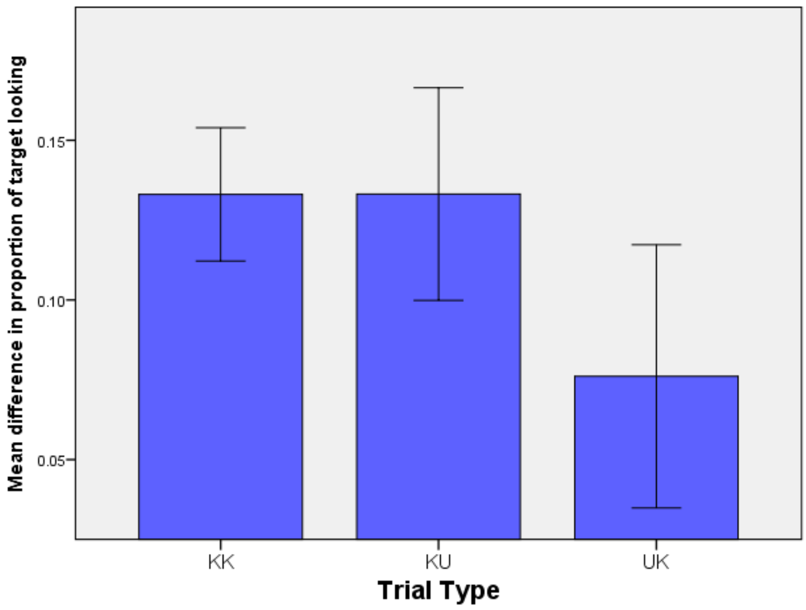

Figure 5.2 – *Mean difference in the proportion of target looking between the pre- and post-naming phases for each of the trial types, KK (left), KU (centre) and UK (right) for all toddlers. Error bars represent +/- 1.5 SE.*

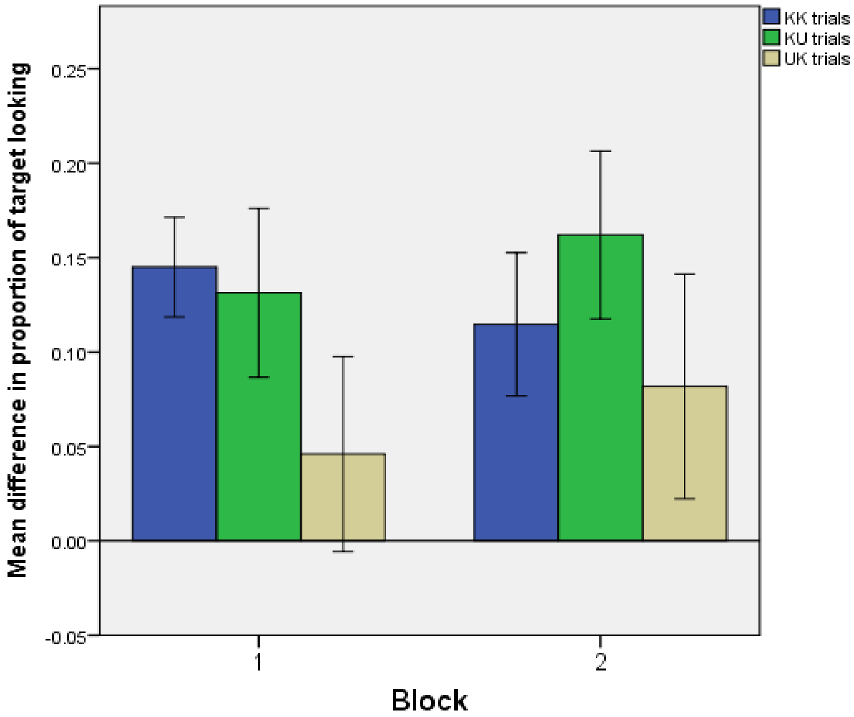

Figure 5.3 – *Mean difference in the proportion of target looking between the pre- and post-naming phase in each block: the first 12 trials (left) and the second 12 trials (right). Error bars represent +/- 1.5 SE*

Last but not least, no interactions were observed with Dialect for either the 18 or 24 month group of toddlers, confirming that toddlers performed similarly irrespective of dialect (all *p*'s>.05). This suggests that exposure to dialect variability did not influence toddlers' performance in disambiguation trials.

18 Months

A mixed model ANOVA was conducted on this subset of the data with the within-subject factors Naming (pre and post) and Trial type (KK, KU, and UK) and the between-subject factors Dialect (mono- and multi-dialectal) and Block (first 12 trials and second 12 trials). There was a main effect of Naming (F(1,44)=16.76, p=<.001, η_p^2=.28) indicating that toddlers were looking longer to the target in the post naming phase than the pre-naming phase. There was also an interaction between Naming and Trial type (F(1,88)=4.11, p=.020, η_p^2=.09) suggesting that this difference observed between the pre and post naming phases was modulated by the type of trial; specifically, looking times in the UK trials was reduced as compared to the other trial types (see the left columns of Figure 5.4). Further statistical tests confirm this difference in performance across trials with longer looks to the target in the post naming phase as compared to the pre-naming phase for KK trials (t(46)=-5.37, p<.001, d=1.05; pre-naming - mean = .49, SD = .07 and post-naming – mean =.59, SD = .11) and KU trials (t(46)=-3.79, p=.002, d=.67; pre-naming - mean = .49, SD =.14 and post-naming – mean =.59, SD = .15) but not for UK trials (t(46)=.59, p=.56, d=.12; pre-naming - mean = .50, SD = .16 and post-naming – mean =.52, SD = .19). This suggests that the younger toddlers in this experiment are not using Mutual Exclusivity as they are looking equally to the target and distracter in the pre and post naming phases during the UK trials.

24 Months

These data were analysed using a mixed model ANOVA with the same within- and between- subject factors as for the 18 month toddlers. There was a main effect of Naming (F(1,29)=55.48, p<.001, η_p^2=.66) indicating a difference between target looking in the pre and post naming phase. The absence of a significant interaction between Naming and Trial type (F(1,58)=.20, p=.82, η_p^2=.007) suggests that toddlers are performing similarly in all trials and thus demonstrating clear disambiguation, as can be seen in the right 3 columns of Figure 5.4. Finally, the ANOVA revealed a marginal interaction between Block and

Naming (F(1,58)=3.00, p=.058, η_p^2=.09), indicative of a difference in target looking between pre and post trials dependant on which block they appeared in. This difference is illustrated in Figure 5.5 with the difference in target looking between pre and post naming phases for UK trials only significant in the second block (UK trials block one - t(31)=-1.55, p=.131 d=.39; pre-naming - mean = .50, SD = .20 and post-naming – mean =.59, SD = .23, UK trials block two - t(31)=-3.89, p<.001, d=1.06; pre-naming - mean = .47, SD = .21 and post-naming – mean =.71, SD = .23). This suggests that repeated exposure to the novel object and word pairing was necessary for successful disambiguation at this age as this did not occur in the early trials, an unsurprising finding given results from Mather and Plunkett (2009) suggesting that stimulus repetition has an influential role for demonstrating the use of Mutual Exclusivity.

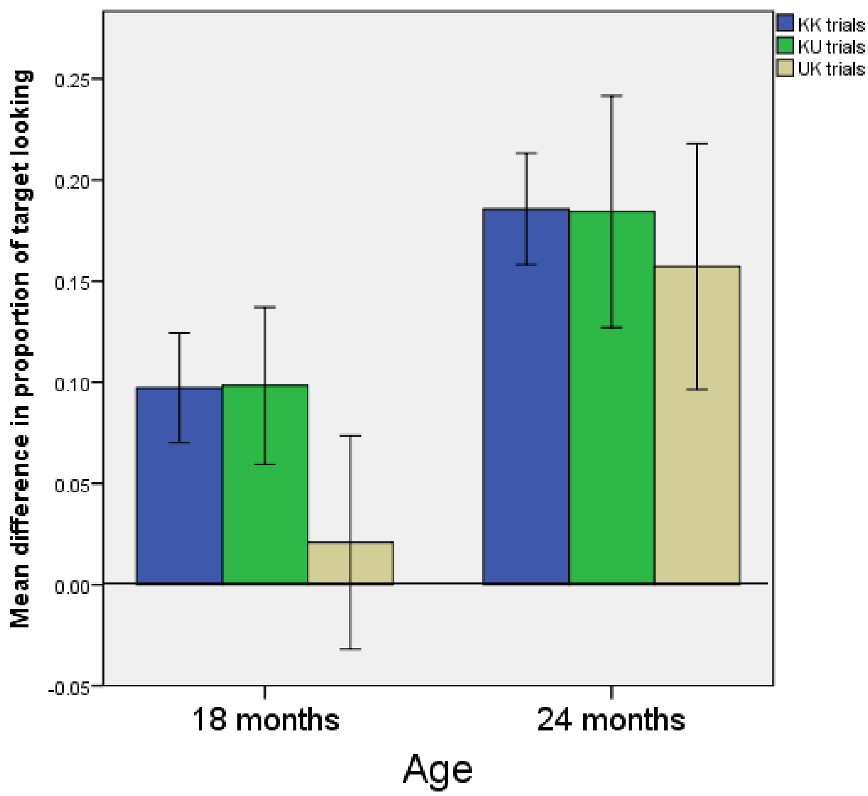

Figure 5.4- *Mean difference in the proportion of target looking between the pre- and post-naming phases for each of the trial types, KK (left bar), KU (centre bar), and UK (right bar), as a function of age group, 18 months (left) and 24 months (right). Error bars represent +/- 1.5 SE*

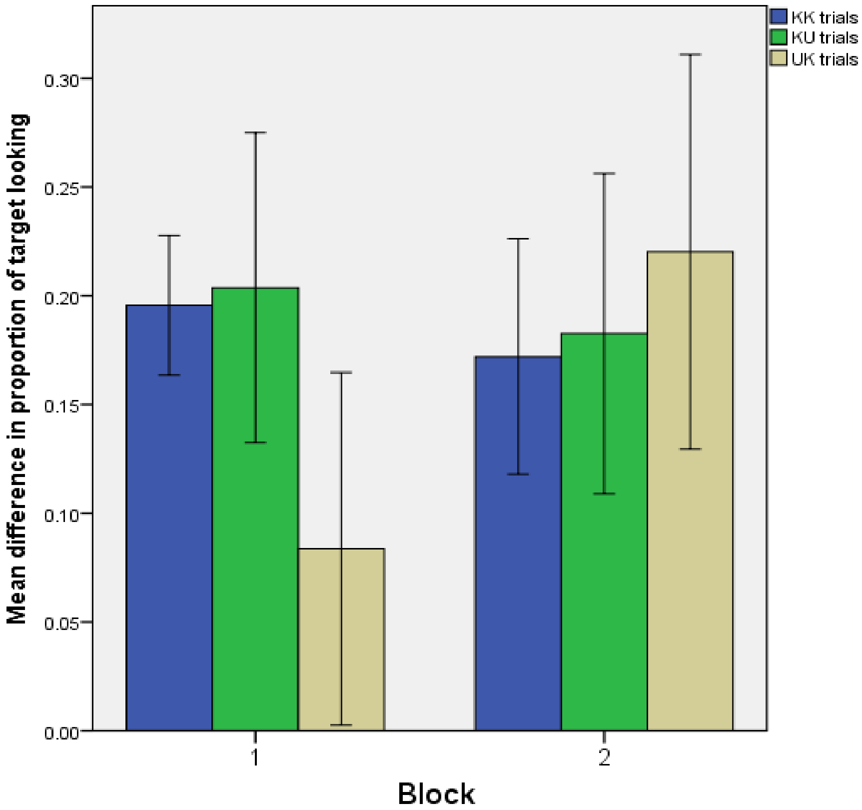

Figure 5.5 - *Mean difference in the proportion of target looking between the pre- and post-naming phases in each block, the first 12 trials (left 3 bars) and the second 12 trials (right 3 bars) for each of the trial types, KK (left), KU (centre), and UK(right). Error bars represent +/- 1.5 SE*

The findings thus far demonstrate that in this experiment the older toddlers, but not the younger toddlers, are reliably using disambiguation. This unexpected finding at 18 month conflicts with reports of use of disambiguation in toddlers as young as 17 months and will be explored in detail in the discussion section. However, in an attempt to understand this disparity additional analyses have been conducted on the data from this subgroup of toddlers focussing specifically on links that have been observed with vocabulary measures in other studies (e.g. Bion, Borovsky, & Fernald, 2013; Houston-Price et al., 2010).

Novelty effects

It is important to consider that for half of the trials presented to toddlers at least one of the images on screen is novel, whether this is the target or the distracter. It has been demonstrated that novelty can influence toddlers looking behaviour in tasks such as this (Mather and Plunkett, 2010; 2012). To rule this out analyses were conducted comparing pre- and post- naming looking times to chance (.50) for each age group. For both the 18 and 24 month toddlers looking times to the target during the pre-naming phase were not significantly different to chance on any trials where a novel image was present (all *p*'s >.05). When comparing post naming looking times to chance the same pattern of results is observed as in the above analyses at both ages. At 18 months looking is significantly different to chance for KK trials ($t(46)=5.81$, $p<.001$, $d= 1.20$; mean =.59, SD = .11) and KU trials($t(46)=4.11$, $p<.001$, $d= .85$; mean = .59, SD = .15 but not for UK trials ($t(46)=.767$, $p>.05$, $d= .16$; mean = .52, SD = .19). In the 24 month group toddlers increase looking times to the target in the post-naming phase above chance levels in all three conditions (KK - $t(31)=9.89$, $p<.001$, $d=2.47$; mean = .66, SD = .09, KU - $t(31)=4.43$, $p<.001$, $d= 1.11$; mean = .66, SD = .20 and UK - $t(31)=4.35$, $p<.001$, $d=1.09$; mean = .65, SD = .19). These findings rule out any explanation of these results as being driven by a preference for the either object during either the pre- or post-naming phases.

Vocabulary Measures

To identify whether the lack of evidence of disambiguation at 18 months was due to a difference related to receptive or productive vocabulary scores, correlations were conducted between trial performance and OCDI scores. For one 18 month toddler the OCDI was not returned by the parent and her data were not considered. As would be expected, the scores on both productive and receptive vocabulary were correlated ($r(46)=.47$, $p=.001$). The only correlation with performance at this age was between receptive vocabulary and KK trials ($r(46)=.29$, $p=.05$) with all other *p*'s >.05. This suggests that the general performance of the younger group of infants was not related directly to their vocabulary scores, however, when faced with two familiar images those with a larger receptive vocabulary demonstrated better performance than those with a smaller receptive vocabulary. The lack of correlation with productive vocabulary at this age could be due in part to the relatively few words that toddlers of this age are producing as it is around this age that toddlers begin to increase their productive vocabulary (L. Bloom, 1973; Gopnik & Meltzoff, 1986, 1987; Nelson, 1973, 1988). For analyses considering the vocabulary data using a median split see Appendix E.

The lack of clear evidence of disambiguation in the 18 month olds, even after further exploratory vocabulary analyses, indicates that this sample of toddlers does not show evidence of using Mutual Exclusivity in this task. Comparing the vocabulary scores for the toddlers in this experiment with norms for toddlers of the same age suggest that this is not due to the toddlers in this sample having lower than average vocabulary. The median value reported by Hamilton et al. (2000) at this age is around 35% for receptive vocabulary and around 5% for productive vocabulary. The median values for the toddlers in this experiment are 44% for receptive vocabulary and 7.5% for productive vocabulary, setting the median for the toddlers tested here closer to the 75th percentile for receptive vocabulary and between the 50th and 75th percentile for productive vocabulary. Therefore the high vocabulary group when the data are split in this way can reliably be considered as such.

5.1.3 Discussion

The present experiment sought to investigate the use of Mutual Exclusivity in mono- and multidialectal 18 and 24 month toddlers using a version of the IPL procedure that has been shown to allow toddlers to demonstrate disambiguation (Bion et al., 2013; Byers-Heinlein & Werker, 2009; Halberda, 2003; Houston-Price et al., 2010). During testing toddlers were presented with sets of trials where pairs of images were presented and one was named. On some trials these objects were both familiar and on others a familiar object was paired with a novel object. The critical trials for toddlers to demonstrate successful disambiguation were those where the novel object was named (UK trials); in these trials toddlers need to exclude the familiar object as the target and assign the novel label to the novel object to be successful.

The findings reported here show clear evidence of disambiguation, and therefore use of Mutual Exclusivity, at 24 months of age but not at 18. All toddlers showed recognition of a familiar target regardless of age with the difference in the two age groups being driven by the different performance in the UK trials. There were no interactions with dialect in either age group suggesting that children in the two dialect groups were performing similarly. That is, neither mono- nor multidialectal 18 month toddlers were successfully disambiguating and both mono- and multidialectal 24 month toddlers were showing disambiguation similarly. The finding that 18 month toddlers did not disambiguate was an unexpected result given previous evidence with monolingual toddlers (Byers-Heinlein & Werker, 2009; Halberda, 2003; Houston-Price et al., 2010) and remained even when considering vocabulary measures. There was no correlation identified between performance in the UK trials and the number of words 18 month olds understood or said and no effects found when this younger age group was split into low and high vocabulary groups.

This lack of evidence of disambiguation at 18 months is surprising given the results from other studies. Liittschwager and Markman (1994) and more recently Suanda and Namy (2013a, 2013b) report disambiguation at or before 18 months using an object selection task rather than an IPL task. The disparity with the present findings and those results could be explained by the absence of any subconscious socio-pragmatic cues from the experimenter in the IPL task (e.g. Baldwin, 1993; Baldwin et al., 1996; Houston & Jusczyk, 2000). The use of the IPL procedure where all social cues are removed could explain why toddlers were unable to demonstrate comparable performance to these object selection paradigm results at 18 months of age.

However, successful disambiguation has been shown at 17 months of age, one month earlier than the current experiment, using the IPL procedure (Halberda, 2003). The precise procedure used by Halberda (2003) differs in some fundamental ways to the current experiment which could explain the differing results. Unlike the current experiment, the object remained on screen and 'danced' at the end of the trial potentially providing toddlers with an additional cue to the referent of the label. In fact, Halberda (2003) addresses this possibility in a second experiment presenting toddlers with the same procedure but without any picture labelled. These toddlers did not increase their looking times to the target suggesting that the auditory label, and not the movement of the target image, is influencing performance in the task; this claim was supported by Byers-Heinlein and Werker (2009) who ran the same follow up experiment with slightly older, 18 month, bilingual toddlers and replicated the finding. However, what has not been shown by Halberda (2003) is whether toddlers accurately identify the novel object in response to the novel label without the additional cue to the identity of the intended target at the end of the trial. Whilst it is clear that this additional movement cue alone is insufficient to guide toddlers' looking behaviour (Halberda, 2003), what is not clear is whether the combination of an auditory label and target movement explains the performance differences between these studies and the current one.

In addition, Halberda (2003) and Byers-Heinlein and Werker (2009) procedures are such that 6 trials where both the target and the distracter are familiar objects are followed by 6 novel label trials. It could therefore be the case that toddlers learn that the labelled object is the one that remains on screen and 'dances' and apply this knowledge to the novel label trials encountered in block 2. In the current experiment the three trial types were mixed from the first trial and the objects disappeared from the screen simultaneously at the end of each trial. These methodological differences could have led to the lack of evidence of disambiguation in the younger age group whilst the older, more experienced, word learners who possess a more robust Mutual Exclusivity bias were able to demonstrate the use of disambiguation in this more challenging situation.

One caveat to this suggestion that subtle differences in procedure influenced the results of the current experiment, are the findings of Houston-Price et al. (2010). The current experiment replicated the procedural details of Houston-Price et al. (2010) using the same auditory phrases and objects, removing the feedback at the end of the trials and presenting 2 mixed blocks of 12 trials. In direct contrast to the current study, Houston-Price et al. (2010) report that the monolingual toddlers they tested demonstrated disambiguation during the UK trials. These disparate findings are difficult to reconcile with the only potential explanation relating to the age of the toddlers tested. The toddlers tested in Houston-Price et al. (2010) were aged between 17 and 22 months with a mean age of 20 months, 2 months older than the mean age of the participants in the current experiment. It could therefore be the case that there is a critical period between 18 and 20 months where toddlers begin to reliably use this strategy. Indeed, Houston and Jusczyk (2000) did explore whether there were age effects among their sample of monolingual toddlers by performing a median split and considering younger and older toddlers separately. They found that even the younger group of toddlers showed clear disambiguation; however, this group still had a mean age of 19 months, one month older than the toddlers tested here. The fact that the toddlers tested in these two studies are in the midst of the vocabulary spurt could explain the onset of disambiguation abilities between 18 and 19 months and explain the differences observed in the two studies.

One final point to note here is that Houston-Price et al. (2010) report a preference for the familiar object in the pre-naming phase leading to approximately equal looking to the target and distracter during the post-naming phase rather than above chance looking. Successful disambiguation is acknowledged because post-naming looks to the target are significantly increased from those in the pre-naming phase; this differs from the findings of this experiment where the pre-naming looking times to each image were similar across all trials.

The present experiment is not the first to fail to find evidence of disambiguation in toddlers. Using an IPL paradigm Bion et al. (2013) tested 18, 24, and 30 month toddlers on disambiguation and subsequent retention of novel word-object pairings. Toddlers were presented with disambiguation trials following the same procedure as those typical of this methodology, a novel and familiar object paired with a novel label. Similarly to the current findings they found no evidence of disambiguation or retention of the novel word-object pairing at 18 months but did show disambiguation at 24 months. Interestingly it was only at 30 months that retention of the novel word object pairings was significantly above chance suggesting that there is a gradual development in toddlers' ability to learn novel words. One key point to note here is that in this study the authors compared post-naming looking times to chance rather than to a baseline preference from the pre-naming phase. When using this baseline preference measure there was a marginally significant increase in looking to the target in the disambiguation trials at 18 months. Bion et al. (2013) argue however that this measure does not necessarily indicate a preference for the novel object and as such this should not be taken as a reliable evidence of disambiguation in the object selection task.

In contrast to Bion et al. (2013) findings, Mather and Plunkett (2011) present evidence of the use of Mutual Exclusivity at 16 months using an adaptation of the IPL procedure. In this study toddlers were presented with a set of training trials that also allowed for a test of disambiguation, a novel and familiar object paired with either a novel or familiar label. During this phase infants saw two different novel objects each paired with a novel word. In a later test phase the novel objects were paired and one of the novel words was heard. Similarly to Bion et al. (2013) and the current experiment, Mather and Plunkett (2011) found no evidence of disambiguation during the training trials. However, they showed that toddlers had learned the novel word when tested with a second novel object as the distracter, looking longer to the trained novel object when hearing the trained novel word. These results from the test phase suggest that infants have applied Mutual Exclusivity during the training trials in order to have learnt the novel object-word pairing, although they didn't find clear evidence of disambiguation during that phase, a finding that extends the Bion et al. (2013) study. One noteworthy consideration when comparing these results is that Mather and Plunkett (2011) added a central video of the speaker in all trials. Although this speaker looked towards the child at all times and gave no cues to which object she was referring to, it could be the case that simply the presence of a person was enough to guide the toddlers in learning words.

The final point to explain – and central to this thesis - is the absence of any difference between the mono- and multidialectal toddlers in the older age group. It has been shown, with an object selection task, that by 24 months bilingual toddlers disambiguate a novel object from a familiar one when hearing a novel label when the language context is made clear (Byers-Heinlein et al., 2014). In this experiment the toddlers were trained on a novel-word object pairing by two speakers who either both spoke English, or where one spoke English and the other Mandarin. Only when both speakers spoke English did all toddlers, mono and bilingual, successfully use Mutual Exclusivity to disambiguate the novel and familiar objects. When both languages were used in the experimental procedure, only the monolingual toddlers' demonstrated disambiguation; bilingual toddlers did not, demonstrating awareness that the two languages could use different words for objects. This suggests that bilingual toddlers have overcome the difficulty in applying the Mutual Exclusivity strategy in a single language by the age of two years, as long as the context is non ambiguous. It then seems reasonable to assume that any difficulties faced by multidialectal infants, if there are any, would follow a similar pattern.

Similarly to the bilingual toddlers in Byers-Heinlein et al. (2014), the multidialectal 24 month old toddlers tested in this study may have learned that speakers can use different words for different objects; however, the situation they were presented with here used a single speaker, much like the single language condition. Following this it seems unlikely to expect any differences in performance between these the dialect groups at this age, which is exactly what we find. Of course, it could be equally likely that dialect exposure does not influence toddlers' use of Mutual Exclusivity at all; however, this is difficult to conclude with any certainty. At 18 months there was no evidence of disambiguation in either mono or multidialectal toddlers which is surprising for both groups.

5.2 Conclusions

To conclude, the current experiment presents no evidence of disambiguation at 18 months, but clear disambiguation at 24 months, using an IPL task. There were no differences identified between mono and multidialectal toddlers at this stage, however it is currently unclear whether with an adapted methodology these would become apparent at earlier ages. In addition it seems that evidence of disambiguation is not a necessary pre-cursor for successful use of Mutual Exclusivity with studies such as those conducted by Mather and Plunkett (2010, 2011, 2012) suggesting that toddlers apply the strategy in the absence of disambiguation behaviour (see Bion et al., 2013 for a different result with slightly older toddlers). Currently, studies investigating disambiguation and Mutual Exclusivity with younger toddlers yields mixed results, possibly due to subtle differences between methodologies, making this an interesting area for further research.

Chapter 6.

General discussion

The primary motivation driving the series of experiments in this thesis was the parallel that had been proposed between bilingual and multidialectal toddlers in terms of the variability in their language experience Albareda-Castellot et al. (2011) and the effect it could have on the development of their lexical abilities. The effect of exposure to variable pronunciations in the language learning environment as a direct result of parental dialect background has been examined over the course of five studies exploring phonetic specificity (Experiments 1 and 2), accommodation of natural pronunciation deviations (Experiments 3 and 4), and word learning task (Experiment 5) using a typical IPL paradigm. Exposure to dialect variability has been carefully controlled for and differences in the performance of children as a function of their linguistic exposure have been identified. These experiments, which are among the first to examine the role of continuous dialectal variability in toddlers' language development, present evidence that dialectal variability influences toddlers' performance on some, but not all, of these tasks.

6.1 Summary of key findings

In the experiments reported in Chapter 3, toddlers were presented with a mispronunciation task commonly used in the literature (Mani et al., 2008; Mani & Plunkett, 2007, 2010; Swingley & Aslin, 2000, 2002), with one critical manipulation: toddlers' exposure to dialectal variation was controlled. In these studies toddlers were separated into two groups – monodialectal and multidialectal. The exposure they received was either consistent across speakers (monodialectal) or varied as a result of at least one parent speaking with a dialect that differed from the local environment (multidialectal). In Chapter 3 detection of mispronunciations in all positions, onset, medial and coda, of familiar monosyllabic CVC words were tested in the two dialect groups. In Experiment 1 pairs of familiar images were presented accompanied by either correct, e.g. 'cat', or mispronounced target labels; the mispronunciations were single feature changes on the onset consonant, e.g. 'gat', or medial vowel, e.g. 'cart'. The performance of the two groups of toddlers differed in this task, with monodialectal toddlers behaving as would be expected from previous studies (Mani et al., 2008; Mani & Plunkett, 2007, 2010; Swingley & Aslin, 2000, 2002), rejecting mispronunciations as acceptable exemplars of the target. In contrast, multidialectal toddlers fixated the target following both correct and mispronounced tokens of the target.

The inclusion of unfamiliar images as distracters in Experiment 2 provided toddlers with an opportunity to discard the target as the intended referent and reveal a level of phonetic specificity not evident in Experiment 1. As in Experiment 1 differences in performance across the two dialect groups were observed, alongside some similarities. First, when mispronunciations of the onset consonant were presented all toddlers rejected these as related to the target word: no explicit naming effect was observed in either group for these trials, demonstrating phonetic specificity. The effect was however clearer in the monodialectal group, as it is the only group where performance on mispronunciation trials differs from the correctly pronounced trials. Second, mispronunciations in the medial vowel position resulted in increased target looking for multidialectal toddlers only, with no target recognition evident in monodialectals. Finally, in the coda position all toddlers failed to reject a mispronunciation, fixating the target similarly to correct pronunciations, however, only the multidialectal toddlers significantly increase target looking in the post- as compared to the pre-naming phase.

The findings of Experiment 2 demonstrate that multidialectal toddlers do indeed store specific word-forms: they reject the label, to some extent, in the onset mispronunciation condition, ruling out an explanation based on impaired representation specificity. Combined, these results suggest that the effects observed in multidialectal toddlers' word recognition are in line with a Cohort-like model of word processing, similarly to what is found in adults (Marslen-Wilson & Welsh, 1978). The model suggests that word recognition occurs incrementally with candidates from the lexicon excluded as more of the word is heard until the uniqueness point - the point at which only one candidate remains - is reached. Using such a process toddlers may select the intended referent at the earliest point in the word where competitors can be ruled out. This would lead to a greater mismatch effect of onset mispronunciations than those occurring in the later word positions, as is found in adults (e.g. Cole & Jakimik, 1978). The results of Experiment 2 suggest that multidialectal toddlers either develop earlier than monolinguals a spoken word recognition device with properties similar to those of the Cohort model, or that their word recognition processes operate faster than those of monolinguals.

In contrast to the experiments in Chapter 3, where the test words were either correct pronunciations or mispronunciations resulting in non-words, the test words used in the experiments in Chapter 4 were existing pronunciations of words. These differing pronunciations are known as allophones: although there are differences in pronunciation there is no change to the meaning of the word, rendering the pronunciation difference irrelevant for target recognition. These are naturally occurring forms of variation and as such toddlers may have some experience with both forms, which would not be the case for any of the mispronunciations in Experiments 1 and 2. In Experiment 3 the allophonic variation tested was glottalisation, such that words such as 'butter' can be produced with the 't' present or with this phoneme replaced by a glottal stop. In this experiment all toddlers, both monodialectal and multidialectal, behave similarly: they all increased target looking following non-glottalised ('t' present) pronunciations but failed to identify the target following glottalised (with a glottal stop in place of the 't') pronunciations. This was a surprising finding given the results of the studies in Chapter 3 where multidialectal, and not monodialectal, toddlers recognised the target following mispronounced tokens.

The explanation proposed for this disparity focuses on exposure to the specific variation tested. First, there is evidence to suggest that toddlers' experience with glottalised pronunciations of words is relatively limited (Foulkes et al., 2005), which could explain the lack of recognition of these variants during testing. One caveat to this explanation is that monodialectal toddlers recognised artificially created variants in Experiments 1 and 2 leading to a second explanation specific to the variants tested. The phoneme modifications in these studies differed in 2 ways. First, those in Experiments 1 and 2 were modified by a single feature within a familiar space (erg, /p/ to /d/) whereas the modifications in Experiment 3 were a form of phoneme deletion, that of the /t/. Secondly, in Experiments 1 and 2 only a single phoneme was modified, this was not the case in Experiment 3 where two phonemes were altered. It could be the case that the additional phoneme alteration in Experiment 3 that was not present in Experiments 1 and 2 explains the difference in the findings. Indeed the glottalised pronunciations of intervocalic consonants modify the preceding vowel in addition to the glottalised phoneme (Ogden, 2009); toddlers might have been more sensitive to these larger acoustic/phonetic differences. With the data from Experiment 3 it is not possible to disentangle these explanations and so Experiments 4a and b were conducted to explore these further: the degree of change between the two word forms is similar to that in Experiment 3 (two phonemes affected) but exposure to each of the variants can be controlled.

In Experiments 4a and b toddlers were presented with a different form of allophonic variation, rhoticity, and rather than separating the groups by dialect exposure they were separated by their exposure to the specific accent feature of rhoticity. In Experiment 4a all toddlers were exposed to some degree of rhoticity from the local environment (e.g. from childcare providers, family friends, etc.) due to living in the South West of England; however, some toddlers were additionally exposed to non-rhotic pronunciations from one or both of their parents. In this experiment all toddlers consistently identified the target following rhotic but not non-rhotic pronunciations, regardless of their degree of exposure to these pronunciations.

Two explanations were proposed for this finding. First, the overall preference for the rhotic variants might result from exposure to rhotic pronunciations from the community accent, which would prevail over the dialect heard at home. Second, performance could be attributed to the features of rhoticity being naturally more salient than the non-rhotic variants for all toddlers. To explore these explanations further, the same experiment was conducted in Oxford, using all of the same stimuli (Experiment 4b). The Oxford toddlers are typically not exposed to rhoticity from the community accent and we ensured that they heard no rhoticity from their caregivers. In Experiment 4b we observed the reverse result of Experiment 4a: toddlers from Oxford identified the target when its label was produced non-rhotically but not when it was produced rhotically. Taken together the results of Experiments 4a and b provide evidence that toddlers' canonical representations are determined by the variant that is typical of the community accent rather than being determined by the accent spoken by the parents. A final, complementary, test of this would be to test toddlers in a non-rhotic community who have rhotic accented parents. If the community pronunciation prevails, these toddlers should recognise only the non-rhotic variants of familiar words; in contrast, if it is exposure to rhoticity itself that sets up the parameters of the representation, then exposure from the parents would lead to recognition of only the rhotic tokens.

In parallel with the influence of the community in determining the stored representation, the failure to recognise both forms of the word, particularly in the mixed group exposed regularly to both variants, could be explained by the amount of acoustic/perceptual difference between the two variants. Similarly to the glottalised and non-glottalised words the rhotic and non-rhotic forms differ on two phonemes, the /r/ and the preceding vowel (Ladefoged, 2001). The alteration of more than one phoneme between the two variants may have influenced toddlers' performance resulting in a lack of recognition of the target when the pronunciation differed from that frequently heard in the community.

To sum up, the experiments presented in Chapter 4 provide evidence consistent with the proposal that toddlers store a single canonical representation that is very likely determined by the external environment beyond the immediate caregivers. However, there is an apparent paradox between the fact that toddlers' representation of familiar words are clearly dialect-specific (Experiments 3, 4a and b), and yet they cannot detect arbitrary mispronunciations in equally familiar words (Experiments 1 and 2). The disparity between the findings of the experiments in Chapter 3 and those in Chapter 4 could be explained by the number of phonemes modified in the variants presented. In Chapter 3, only a single phoneme was altered, and Chapter 4, two consecutive phonemes deviated. In this fourth Chapter the degree of mismatch between the stored representation and the dialect variants, namely, the glottalised, non-rhotic (for South West toddlers) or rhotic form (for Oxford toddlers), may have been too important for toddlers to overcome, even those who are multidialectal or exposed to both variants.

The final experiment in this thesis (Experiment 5) explored toddlers' use of the Mutual Exclusivity constraint and its relationship with exposure to dialectally variable input. In bilingual toddlers Mutual Exclusivity has not been reliably observed (Byers-Heinlein & Werker, 2009; Houston-Price et al., 2010) and it was hypothesised that the variable input experienced by the multidialectal toddler may also lead to a failure to effectively use this strategy. Experiment 5 used a similar procedure to previous studies that reliably found evidence of Mutual Exclusivity in monolingual populations to test 18 and 24 month monodialectal and multidialectal groups of toddlers. Surprisingly no evidence of Mutual Exclusivity was observed at 18 months in either group of toddlers. This is an unexpected result when considering studies that present toddlers with the same task and observe Mutual Exclusivity at the same age (Byers-Heinlein & Werker, 2009; Houston-Price et al., 2010) and even one month younger at 17 months (Halberda, 2003). With the same task and stimuli Experiment 5 demonstrates Mutual Exclusivity at 24 months suggesting that the null result at 18 months was not due to a methodology flaw but to a failure to demonstrate the use of this strategy for word learning at this earlier age. This lack of evidence of Mutual Exclusivity holds for the 18 month old group even when considering a possible correlation with productive and expressive vocabulary, a factor that has been demonstrated to predict Mutual Exclusivity use (Byers-Heinlein & Werker, 2009; Houston-Price et al., 2010; Werker et al., 2002). On closer inspection the youngest UK toddlers to display use of Mutual Exclusivity using this paradigm were at least one month older those tested in Experiment 5 (Byers-Heinlein & Werker, 2009) or with a slightly different paradigm (Mather & Plunkett, 2010, 2011, 2012). At this age a child's vocabulary is rapidly increasing (L. Bloom, 1973; Gopnik & Meltzoff, 1986, 1987) and this difference in age could be sufficient to explain the performance differences observed. Turning to the disparity between the performance of the toddlers in Experiment 5 and those tested in America by Halberda (2003) at exactly the same age, it is possible that American toddlers acquire words earlier and at a faster rate than UK toddlers. Hamilton et al. (2000) reported significant differences between British and American toddlers' vocabulary development when they standardised the Mac Arthur Communicative Development Inventories for Britain, with British children lagging behind their American counterparts. More generally, Bleses et al. (2008) established that across languages toddlers' production and comprehension scores differ at the same ages. These cross-linguistic differences could explain the performance differences observed in the use of Mutual Exclusivity.

When considering the dialect background of the toddlers tested in Experiment 5 no differences were observed between the two dialect groups. This is not a surprising result for either age group of toddlers, although for different reasons. At 18 months none of the toddlers, monodialectal or multidialectal, showed any evidence of using this strategy. Given that the monodialectal group could be considered a 'pure' group of monolinguals then a lack of Mutual Exclusivity here would preclude any expectation of observing Mutual Exclusivity in the multidialectal group who were expected to behave similarly to bilingual toddlers. Similarly, by 24 months the delays observed in bilingual toddlers are becoming less apparent and so similar performance between the monodialectal and multidialectal groups could simply be the result of a developmental improvement in contending with variation, resulting in successful use of this strategy. Of interest for further exploration of this developmental hypothesis would be the performance of toddlers at an intermediary age of 21 months. At this age toddlers may demonstrate use of Mutual Exclusivity not seen at 18 months and still be affected by the dialect variability encountered, so that differences would be observed between these groups of toddlers.

6.2 Theoretical implications

The findings of the experiments reported here provide an interesting insight into the effects of variable input on toddlers' performance in a number of areas related to word processing: mispronunciation detection, identification of allophonic variation and word learning. When tested using an IPL paradigm toddlers exposed regularly to variable input respond differently to mispronunciations of familiar words than monodialectal toddlers in Experiments 1 and 2. However, this was the only instance where a difference between these two groups is observed. There was no difference between monodialectal and multidialectal toddlers when the contrast presented was allophonic, specifically glottalisation (Experiment 3), or when engaged in a word learning task requiring the use of Mutual Exclusivity (Experiment 5). When controlling for exposure to the specific contrast there is once again no difference between those toddlers that regularly experience both variants and those who typically hear one (Experiments 4a and b). The differences observed between the monodialectal and multidialectal groups in Experiments 1 and 2, and between experiments when comparing Experiments 1 and 2 with Experiments 3, 4, and 5 could be interpreted in three ways. First, they may be due to multidialectal toddlers having less specified lexical representations; second, they could be the result of multidialectals behaving in a more adult-like way than monolinguals regarding spoken word recognition processes; finally, they could be explained by differences in the stimuli themselves.

The first interpretation is that the performance differences observed between monodialectal and multidialectal toddlers in familiar word recognition tasks are due to a lack of phonetic specificity in multidialectal toddlers' stored representations, as a result of growing up in a linguistically variable environment (Schmale et al., 2011). When presented with mispronunciations of familiar words, multidialectal toddlers fail to reject the mispronunciation as an exemplar of the target word. By virtue of the variable nature of the input experienced by multidialectal toddlers, their representations need to incorporate and accommodate a wider range of pronunciations, leading to a greater flexibility in what they will allow as representative of a target label. Although the experiments reported here cannot entirely rule out this explanation, they nevertheless pose some challenges to its validity.

Consistently, in onset and medial positions in Experiment 1 with familiar distracters and in word medial and coda positions in Experiment 2 with unfamiliar distracters, multidialectal toddlers accepted mispronunciations of familiar words as labels for target pictures. This is compatible with the view that lexical representations are less well specified in the multidialectal group. However, the absence of any differences between the two dialect groups when the auditory stimuli contain variants naturally occurring in speech (allophones in Experiments 3 and 4) are more difficult to reconcile with this explanation. If multidialectal toddlers' representations are insufficiently specified that arbitrarily created mispronunciations are accepted as referents for a target, then recognition would be expected for the naturally occurring alternative pronunciations in Experiments 3 and 4. When considering toddlers' ability to learn new words, the evidence from Experiment 5 where no differences were found between the dialect groups tested, together with the absence of any differences in vocabulary measures between the two groups in all of the experiments presented here, suggests that words are learned equally well in both monodialectal and multidialectal populations of toddlers.

Of further interest would be to explore toddlers' representations of newly learned words by introducing a recognition task following the mutual exclusivity task, similarly to Bion et al. (2013). They tested toddlers' retention of a novel word immediately after it was encountered in a Mutual Exclusivity task and found target recognition only in 30 month toddlers with performance at chance in retention trials for 18- and 24-month-olds, even for those toddlers who successfully learned the novel word object pairing in Mutual Exclusivity trials. If this same task was carried out with monodialectal and multidialectal toddlers, differences in retention might be observed with monodialectal toddlers successfully retaining the novel word earlier than multidialectal toddlers.

Following this it would also be interesting to identify whether there are performance differences evident if these newly learned words are subsequently mispronounced. It would be expected that monodialectal toddlers' representations would be sufficiently specified from the earliest stages that mispronunciations would be detected and target recognition not observed (Ballem & Plunkett, 2005). In contrast, it is not clear what multidialectal toddlers would do in this task. When presented with mispronounced familiar words multidialectal toddlers fail to reject mispronunciations (Experiments 1 and 2), what is not clear is whether this performance is driven by exposure to variable pronunciations of these specific words, or is due to a more general tolerance of deviant pronunciations in all words. Recall that the words tested in Experiments 1 and 2 were words that toddlers were familiar with and so it is likely they will have heard these pronounced in different ways. If this is specific to the experience of hearing these word forms pronounced differently, then multidialectal toddlers should detect mispronunciations similarly to monodialectal toddlers. Alternatively, if exposure to variable pronunciations leads to a more general flexibility then multidialectals should fail to reject these mispronunciations, fixating the target following a mispronunciation.

In particular, the results of Experiment 2, where multidialectal toddlers rejected the target with mispronunciation occurring on the onset consonant, are problematic for this first interpretation of the results, that multidialectal toddlers' representations are impoverished in their phonetic detail. The successful rejection of the mispronunciations identified in Experiment 2 suggest instead that multidialectal toddlers' representations are sufficiently specified that under the right conditions, e.g. with unfamiliar distracter images, mispronunciations are detected. In fact, it seems that multidialectal toddlers are displaying a more general flexibility in their ability to use their knowledge of the distracter to guide behaviour. When the distracter image is a familiar object, toddlers can compare the auditory target label with their representations of both of these words and identify which is the most likely candidate based on the unaltered phonemes. When the distracter is unfamiliar, this comparison process is not possible and the unfamiliar name unknown object is a contender for the auditory label. Specifically, for multidialectal toddlers the absence of a known competitor image allowed for successful detection of mispronunciations to the onset consonant. This suggests that in Experiment 1 multidialectal toddlers' performance with onset mispronunciations was driven by a comparison process between the target label and the images presented. The use of this strategy seems to be directly related to the dialect exposure of the child as monodialectal toddlers do not apply this same strategy and assign mispronounced labels to the target image.

From this, an alternative explanation of these results is that rather than long-term exposure to accent variation having a negative influence on lexical development, it may have a beneficial effect on performance: multidialectal toddlers' spoken word recognition processes could be considered to be more adult-like, earlier than monodialectal toddlers'. Specifically, exposure to variability would accelerate the use of the lexical neighbourhoods of words to rule out any potential alternatives (distracter images), similarly to adults whose word processing system has been traditionally described using a Cohort model (Marslen-Wilson & Welsh, 1978). In adults the popular view is that of an incremental deactivation of an initial cohort of candidates that share the same initial phonemes until the target word can be identified at the uniqueness point. In this framework, similarly to adults, when a toddler encounters a deviation after the uniqueness point, the impact of a mispronunciation is reduced (Marslen-Wilson & Zwitserlood, 1989).

In the onset mispronunciation condition the mismatch occurs so early in processing that the target image is discarded as a contender when paired with an unfamiliar distracter, e.g. 'cat' as the target and 'shuttlecock' as the distracter image (Experiment 2). When paired with a familiar distracter that shares the onset consonant, e.g. 'cat' as target and 'car' as distracter, both potential referents are equally mismatched with the auditory label, so toddlers have to use the rest of the word for recognition

(Experiment 1) or immediately discount both images as related to the target image and not show any preference, similarly to before naming. This explanation would predict that in a test of Mutual Exclusivity (Experiment 5), where targets and distracters differ on the initial phoneme, e.g. 'cup' and 'dax', multidialectal toddlers would demonstrate earlier Mutual Exclusivity usage than monodialectals as they are able to reject the known image quickly due to the mismatch in the onset phoneme. However, the findings at this stage are unable to support or discount this suggestion as there were no differences observed between the two groups. Further support for this explanation of toddlers' performance can be seen in the results of Experiments 3 and 4. In these studies all toddlers reject deviations that occur in the later part of the word even when these deviations are naturally occurring in speech. If multidialectal toddlers use a Cohort model approach for target identification, such deviations late into the word would be expected to be accepted as they were in Experiment 2, which was not the case. In fact, in both dialect groups, toddlers rejected the glottalised (Experiment 3), non-rhotic (Experiment 4a) and rhotic (Experiment 4b) forms where the mismatch occurs in the later parts of the word.

A final interpretation of these results directly addresses the disparity in the results between the experiments in Chapter 3 and those in Chapter 4. The primary difference in the stimuli across these two experiments is the number of phonemes implicated in the deviant pronunciation: the mispronunciations in Experiments 1 and 2 affected only a single phoneme whereas the allophonic changes of Experiments 3 and 4 modified two consecutive phonemes. The stimuli in Experiments 3 and 4 were produced naturally by speakers and the resulting modifications on two phonemes are typical of these pronunciations in natural speech. In Experiment 3 the speaker was coached on the production of the glottalised variants and the best token were selected for use during testing; however using naturally produced glottalised stimuli meant that the preceding vowel was perceived as being shortened, as is typical when glottalising (Ogden, 2009). This auditory impression is corroborated by a drop in amplitude and a dip in the F_0 (Hillenbrand & Houde, 1996). A similar pattern is observed between rhotic and non-rhotic pronunciations, produced by speakers whose accents naturally contained - or lack - rhoticity. When rhoticity is present the preceding vowel is altered, with longer vowels and lower third and fourth formants as compared to non-rhotic vowels (Hay & Maclagan, 2010). Finally, in the Mutual Exclusivity task (Experiment 5) the novel word, 'dax', differed from the known word on all phonemes, e.g. 'ball', 'cup' and 'car', making it clearly distinct from the target images presented.

The fact that toddlers were presented with one phoneme deviation in familiar words in Experiments 1 and 2, creating pseudo-words, versus two phoneme deviations in Experiments 3 and 4, differing in a naturally occurring way, may be sufficient to explain the performance difference observed between these sets of experiments. One way to explore the impact of the number of mismatching phonemes on word recognition (whether these are valid lexical items or mispronunciations resulting in non-words) would be to create versions of naturally produced variants where only one phoneme is affected. For example, it would be interesting to splice a non-glottalised /t/ with the same segment from the glottalised variant of the word, so as to have no change to the preceding vowel. With only one phoneme implicated in the change it would be expected, based on the findings of Experiments 1 and 2, that monodialectal toddlers would reject the mispronunciation for the target word and show no preference for either picture after naming. In contrast, if the number of altered phonemes is influencing performance in multidialectal toddlers then controlling this by manipulating only one phoneme should result in similar effects to those observed in Experiments 1 and 2: target recognition following a mispronunciation. If multidialectal toddlers performance does not differ when one or two phonemes are implicated this would instead suggest that the effect is specific to allophones, although further experiments would be necessary to confirm this.

In summary, three different explanations are discussed; the first considers that multidialectal toddlers have less well specified representations due to general expansion of phonetic categories as a result of variable exposure. The second proposes that exposure to variable input results in earlier adult-like spoken word processing. Finally, the disparity in the findings might be due to the number of phoneme deviations between the pronunciations encountered and the stored representations. At this time the current data is unable to disentangle these explanations for the differences in toddlers' performance. In addition, it is probable that not one of these explanations alone fully accounts for the influence of long-term exposure to accent-related variability on toddlers' lexical representations. In all likelihood it is a combination of these interpretations, alongside others that have yet to be discovered, that will explain toddlers' behaviour following consistently variable exposure.

6.3 Parallels between multidialectal and bilingual toddlers

The overarching theme of the studies presented throughout this thesis was the influence of variability on toddlers' early representations of words and ability to learn new words. Recall that the theoretical underpinnings for this work lie in the increased linguistic variability experienced by bilingual toddlers and the multidialectal toddlers tested throughout this thesis. However, the input of the multidialectal toddlers and bilingual toddlers also differs along a number of dimensions, making multidialectal toddlers an interesting case for investigation of the effects of phonological variability. These differences are recapped here.

First of all multidialectal toddlers hear a single language, therefore a single set of grammatical rules and morphology, whereas bilingual toddlers face the challenge of having to discriminate the languages they are hearing and having to learn the grammar and morphology for each language. Second, the range of phonemes to learn is greatest for bilingual toddlers who need to acquire the phoneme inventory for each language, but least for monodialectal toddlers, who hear the fewest phoneme variations, with multidialectal toddlers falling somewhere in between, as they hear multiple realisations of a single phoneme across two accents of, here, British English – e.g. /æ/ and /ɑ:/ in words such as 'path'. On the other hand, bilingual toddlers will hear accented pronunciations in both of their languages across regional and foreign accented variation. For example, if Mum is Spanish and Dad English the child may hear Spanish accented English and English accented Spanish from each of them in addition to any regional variations encountered additionally. By testing multidialectal toddlers it is possible to begin to identify the role of input phonological variability for not only multidialectal toddlers but also allows for parallels to be drawn with the influence of variability on bilingual toddlers' performance.

With these parallels in mind and considering the results presented in Chapter 3 of this thesis (Experiments 1 and 2), where multidialectal toddlers accepted mispronunciations of familiar words, it seems reasonable to suggest that phonological variability influences the specificity of representations. To date there have been no studies looking at the specificity of familiar words in the bilingual lexicon, making a direct comparison of toddlers' performance difficult at this stage. It has been demonstrated that bilingual toddlers present with a delay in identifying a single feature change to a newly learned word (Fennell et al, 2007), a finding that could suggest, in conjunction with the evidence presented here for multidialectal toddlers, that a similar pattern would be seen with bilingual toddlers' specification of familiar words. Despite the lack of evidence, it does not seem unreasonable to suppose that the findings in Experiments 1 and 2, which seem to be present as the result of exposure to variable input, would be found in bilingual toddlers who are exposed to greater variability.

Moving to Experiments 3 and 4, the closest case for comparison in the bilingual literature are studies looking at perception of cognates (Ramon-Casas et al., 2009; Ramon-Casas & Bosch, 2010). In bilingual toddlers cognate words are less well specified than non-cognate words: the same mispronunciation that is detected in non-cognate words is not detected when the words are cognates in the two languages of the child. Similarly to cognates in two languages, the two pronunciations presented to toddlers in Experiments 3 and 4 share both meaning and phonemes. Based on the evidence from bilingual toddlers it could have been expected that multidialectal toddlers, exposed to variable pronunciations frequently, would accept both pronunciations. This was not the case and no difference was found between monodialectal and multidialectal toddlers: in all cases toddlers increased target looking only following the dominant pronunciation of the local environment, even when they experienced the alternative pronunciation in the home (Experiment 4a). The results with multidialectal toddlers suggest that the cognate findings in bilingual toddlers are not due to variable exposure but are instead related to another aspect of being bilingual, though precisely what is currently unclear.

Finally, in Experiment 5, further differences between these populations of toddlers emerge. Bilingual toddlers have not been found to use Mutual Exclusivity at the same age as their monolingual peers (Byers-Heinlein et al., 2009; Houston-Price et al., 2010). If these differences were the result of variable input then the multidialectal toddlers would be expected to perform similarly, using Mutual Exclusivity later than monodialectal toddlers. The evidence presented in Experiment 5 of this thesis found no use of Mutual Exclusivity at 18 months in either group of toddlers, and, conversely, Mutual Exclusivity use in both mono and multidialectal toddlers at 24 months. From these results it is difficult to draw any strong comparisons with bilingual toddlers, however, what can be said is that by 24 months any differences due to variable pronunciations are no longer evident and all children, monodialectal, multidialectal and bilingual are using Mutual Exclusivity by this age. Further testing of multidialectal toddlers at 21 months might reveal differences that were not evident at the ages tested in this thesis.

In summary, the precise influence of phonological variability in monolingual and bilingual populations is still unclear and open for discussion; however, it is apparent that this kind of variability has an impact in toddlers' perceptual abilities in some tasks, primarily mispronunciation detection tasks. In terms of the proposals put forward to explain the well established bilingual delays (Cognitive Limitations, Fennell, Byers-Heinlein, et al., 2007; Shared Cognates, Ramon-Casas & Bosch, 2010) it seems necessary that phonological variability be considered as a factor. The evidence thus far is inconclusive and more work needs to be done to establish the role of such variability, The evidence available currently strongly suggests that variability alone does not account for the delays observed in bilingual populations, yet it seems reasonable to propose that a combination of the current proposals would provide the most likely explanation and that any one alone does not entirely explain these delays adequately. What the studies in this thesis provide for this debate is a platform from which further work can build to explore the relative contributions of these proposed theories.

6.4 Methodological limitations and future directions for research

The rationale for this thesis lies in the well-established observation that monolingual and bilingual toddlers differ in some aspects of language development. We asked whether variability in linguistic exposure could account for at least some of the apparent delay observed in bilingual populations, and by extension, we tested whether multidialectal toddlers, who are also exposed to linguistic variability, would develop language differently from monodialectals. As such the primary limitation of this work, and the other work that has been conducted looking at these sub groups of toddlers so far, has been that it has neglected to provide a direct comparison with a bilingual group of toddlers. It is questionable to discuss the differences between monodialectal and multidialectal toddlers in the context of the monolingual and bilingual literature without this group of toddlers being included. Future research in this area should investigate whether there are in fact differences between multidialectal and bilingual toddlers as hypothesised, by directly comparing these groups.

In addition, to date there have been no published studies presenting bilingual toddlers with a standard mispronunciation task using an IPL paradigm. This makes it difficult to draw any conclusions from the results of Experiments 1 and 2 with respect to bilingual toddlers' performance. Based on the results from bilingual toddlers in a Switch task, which is a word learning task (Fennell, Byers-Heinlein, et al., 2007; Werker et al., 2002), it is assumed that bilingual toddlers would respond in a similar way to the multidialectal toddlers tested here, however, this remains to be confirmed experimentally.

At this stage much of the work that has been done with these subgroups of monolingual toddlers and certainly all of the experiments presented in this thesis, has relied on the use of the IPL paradigm. Whilst this paradigm is often used with toddlers of this age it would be necessary for other paradigms to be used to explore the performance of these toddlers at other ages and in other tasks. It could be the case that the lack of significant dialect exposure differences in Experiments 3, 4, and 5 is due to a lack of sensitivity in this paradigm. Other groups who have explored the effect of dialectally variable exposure in monolingual toddlers have used the HTPP (Best et al., 2009; Van Heugten & Johnson, 2013), which is an all-auditory paradigm. To date these studies have focussed on toddlers' discrimination of accented pronunciations whereas the experiments reported here have looked at target recognition. These two tasks tap onto different processes and as such presenting the allophones tested in Experiments 3 and 4 might reveal that toddlers do not discriminate the two forms in the absence of a visual referent. Equally, it could be of interest to present toddlers with correct and incorrect pronunciations of familiar words and identify whether recognition of mispronunciations is present in the absence of images to guide behaviour. Using the HTPP Delle Luche, Durrant, Floccia, and Plunkett (2014) found evidence of semantic priming at 18 months, 3 months earlier than it has been demonstrated with an adapted IPL procedure (e.g. Arias-Trejo & Plunkett, 2009, 2010; Styles & Plunkett, 2009, 2011). This suggests that toddlers' performance can vary as a function of the paradigm used, most likely as a result of the associated task demands, in this case listening to a sequence of words vs matching a stored label with its representative object.

Further to this it would be useful to confirm whether the effects of exposure to variability extend to tasks other than mispronunciation detection, for example, whether they are found in word segmentation tasks, discrimination tasks, and to further explore the effects in novel word learning tasks beyond those reported in Experiment 5. With a legitimate concern for replication in mind, not only is it necessary to extend the range of tasks in which this is tested but also the range of languages. Currently there is research on this topic being carried out in Canada by Johnson and colleagues, in Australia by Best, Kitamura and colleagues and here in the South West of England in the Plymouth Babylab. It would be interesting to explore whether these effects extend to other dialects of British English than where the South West dialect dominates, particularly the Northern England dialects of English in addition to dialects of non-English languages. These additional studies would provide a basis for understanding the exact nature of the impact of variability on toddlers' representations for the words they are learning. Understanding the effects of variability in the multidialectal group, where differences occur only on pronunciations and not across morphological and syntactic information, will also extend and enrich the current research into the impact of bilingualism. This research will additionally be able to help distinguish between those effects seen in bilinguals that are a direct result of variability and those that are influenced by other factors associated with bilingualism, such as switching between two languages.

Finally, the evidence presented in this thesis focuses on a specific age range, around 20 months old. It will be necessary for other work to identify whether these effects are present at other ages and stages in development. It is unclear from the current evidence whether the effects of long-term exposure to dialectally variable speech from birth impact speech development in the earliest stages or whether this is a cumulative effect. For example, the community accent effects seen in Experiment 4 may not be present at earlier ages until infants have spent enough time in the community environment. In addition to identifying when these effects emerge there is scope for research to explore whether early exposure to variable input has any long-term benefits for accommodation and adaption to accented speech in later childhood and adulthood. It is likely that experience dealing with dialects and accents from the earliest stages of language learning improves this ability. However, it may be the case that beneficial effects are observed only in the dialects that the child has experience with and does not lead to a generalised benefit for adaptation and accommodation as is typically found with adults (e.g. Clopper & Pisoni, 2004; Hanulíková & Weber, 2012; Sumner & Samuel, 2009).

6.5 Concluding remarks

This thesis sought to identify and test a sub group of monolingual toddlers who can be compared to bilingual toddlers in terms of the phonetic/phonological variability they are exposed to: multidialectal toddlers. The motivation for the experiments in this thesis was borne out of the bilingual literature where differences between monolingual and bilingual populations have been frequently cited (Bosch & Sebastián-Gallés, 2003; Fennell, Byers-Heinlein, et al., 2007; Ramon-Casas et al., 2009; Werker et al., 2002). One potential explanation for these differences, and the one tested here, is that variability in the input of these toddlers is influencing their performance. By comparing the performance of two subgroups of monolingual toddlers, where the input is variable (multidialectal toddlers) or consistent (monodialectal toddlers) within a single language, this explanation can be tested. No differences were identified between these two groups of toddlers on word learning tasks and when recognising natural pronunciation alternations, but differences were found in a mispronunciation detection task. Specifically, multidialectal toddlers were found to identify a familiar word when it was mispronounced, whereas monodialectals were not. The experiments reported here, along with the few published papers currently available on this topic (Kitamura et al., 2006; Mulak et al., 2013; Van Heugten & Johnson, 2013), represent the emergence of this field of research as a means for exploring the impact of long-term variability on the early development of language. What is clear from the evidence presented throughout this thesis and in recent published work (Kitamura et al., 2006; Mulak et al., 2013; Van Heugten & Johnson, 2013) is that reducing language exposure to two discrete and dichotomous categories is inaccurate. A more realistic picture of toddlers' exposure needs to consider the range of phonetic/phonological/prosodic variability encountered in the language environment. For monolingual toddlers this variation comes in the form of regional within-language variation, and results in the two groups of toddlers this thesis has focused on – monodialectals and multidialectals – with performance differences identified.

When considering the bilingual population it can also be considered that they too are not a homogenous group. In fact, it is very likely that these toddlers will hear an even greater range of phonetic variability than multidialectal toddlers. For example, in the simplest situation, a Spanish-English bilingual toddler with two Spanish parents residing in the South West will hear the South West variant of English, the regional variant of Spanish spoken by their parents plus the Spanish accented English spoken by their parents. Variability in the input of monolingual toddlers has been demonstrated to have consequences for the rate and mode of learning in toddlers throughout this thesis and in work by Kitamura et al. (2006) Mulak et al. (2013) and van Heugten & Johnson, (2013) and so it seems reasonable to suggest that this extends to bilingual populations.

If it is indeed the case that the effects of variability are apparent in the bilingual population, it would be expected to grow even stronger in toddlers where parents code switch (use both languages in the same sentence) to a greater extent, and less evident in parents who code-switch less or follow the "one parent one language" approach with their toddlers. Byers-Heinlein (2013) found that 90% of parents reported regularly engaging in code-switching during interactions with their child suggesting that this is not an unusual situation for the bilingual toddler to face. She examined directly the influence of parental code switching on toddlers' vocabulary development, and found that a higher rate of reported code-switching predicted significantly smaller comprehension scores in 18-month-olds, and smaller productive vocabularies in 2-year-olds. To our knowledge, there are currently no published studies investigating the impact of code switching on phonetic development. However, given its impact on vocabulary development reported by Byers-Heinlein (2013) and the results from studies controlling for variability in monolinguals, it seems likely that differences would be also identified at the phonetic level.

This thesis has presented some of the first evidence that variable exposure influences toddlers' performance in a monolingual population. It is necessary now to pursue this avenue of investigation in order to identify the nature of these effects and their limitations in monolingual populations, whilst simultaneously examining how this evidence translates to a bilingual population. By testing monodialectal, multidialectal and bilingual toddlers in the same experiments and controlling for variability it will be possible to draw parallels between these groups and uncover the role of phonologically variable exposure in early language development.

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Appendices

Appendix A: Elicitation Passage

Below is the passage parents were asked to read, the parent who attended with their child was recorded on the day and the other parent (most commonly the father) was called and recorded over the telephone. This passage is used as it contains most of the sounds of English and is made up of common English words that use a range of difficult sounds and sound sequences (Weinberger, 2003).

Please call Stella. Ask her to bring these things with her from the store: Six spoons of fresh snow peas, five thick slabs of blue cheese, and maybe a snack for her brother Bob. We also need a small plastic snake and a big toy frog for the kids. She can scoop these things into three red bags, and we will go meet her Wednesday at the train station.

Appendix B: Dialect Exposure Questionnaire

Evaluation of the amount of exposure to accents

Abbot-Smith, Arreckx, Cattani & Floccia, Plymouth Babylab

Instructions

Each parent will take a different route through this questionnaire, please complete the section you are directed to in Section A.

Section A: Accent(s) spoken in the home

Do you and your partner…..? (Circle the relevant option and continue to the section indicated)

a)	Both speak with the an accent that is the same as the local area (Both speak with a South West accent)	Go to Section E
b)	Both speak with an accent that is different to the local area (e.g. both have a Manchester accent)	Go to Section B
c)	Speak with different accents where one is the same as the local area (e.g. Mum has a South West accent and Dad a Manchester	Go to Section C
d)	Speak with different accents where neither are the same as the local area (e.g. Mum has a Scottish accent and Dad a	Go to Section D

Section B: Complete this section if both parents speak with the same accent that is not the same as the local area

1	Can you please tell us the additional accent (e.g. Manchester)	

2	In an average week how many hours does your child spend with a local accent speaking childcare provider (nursery,	

3	Over a 24 hour period, how many hours will your child spend sleeping? (include nap times and overnight)	

Additional comments if required.

(Please go to Section E)

Section C: Complete this section if one parent speaks with the same accent as the local area and one with an accent that is different from the local area, e.g. Manchester (referred to as the 'additional accent')

1	Can you please tell us the additional accent (e.g. Manchester)	

2	Which parent speaks with this accent?	

3	In an average week how many hours does your child spend with a local accent speaking childcare provider (nursery,	

4	Over a 24 hour period, how many hours will your child spend sleeping? (include nap times and overnight)	

5	When both parents are present who speaks more to your child?	
a	The additional accent speaking parent?	
b	The local accent speaking parent	
c	We both speak equal amounts	

6	Are there times in a typical week when your child is with just one parent (e.g. always cared for by dad on Saturdays or Mum on	
a	How many hours in an average week with just the additional accent speaking parent	
b	How many hours in an average week with just the local accent speaking parent	

Additional comments if required.

(Please go to Section E)

Section D: Complete this section if both parent speak with different non-local accents (referred to as additional accents).

1	Can you please tell us one of the additional accents (e.g. Manchester)	

2	Which parent speaks with this accent?	

3	Can you please tell us the other additional accent (e.g. Irish)	

4	Which parent speaks with this accent?	

5	Over a 24 hour period, how many hours will your child spend sleeping? (include nap times and overnight)	

6	In an average week how many hours does your child spend with a local accent speaking childcare provider (nursery,	

7	When both parents are present who speaks more to your child?	
a	The first accent speaking parent	
b	The second accent speaking parent	
c	We both speak equal amounts	

8	Are there times in a typical week when your child is with just one parent (e.g. always cared for by dad on Saturdays or Mum on	
a	How many hours in an average week with the first accent speaking parent	
b	How many hours in an average week with the second accent speaking parent	

Additional comments.

(Please go to Section E)

Section E: All parents need to complete this section

1	What is the mothers' highest educational qualification? (please tick)	
a	No qualifications	
b	Below standard for a pass on the school-leaving examination	
c	O-levels/GCSE's or equivalent	
d	A-levels	
e	Tertiary vocational qualifications	
f	an undergraduate degree	
g	a postgraduate degree	

2	What is the fathers' highest educational qualification? (please tick)	
a	No qualifications	
b	Below standard for a pass on the school-leaving examination	
c	O-levels/GCSE's or equivalent	
d	A-levels	
e	Tertiary vocational qualifications	
f	an undergraduate degree	
g	a postgraduate degree	

3	What is the mothers' occupation?	

4	What is the fathers' occupation?	

5	Do you have any other children? Please include their ages below	
	Child 1	
	Child 2	
	Child 3	
	Child 4	

6	What is your child's date of birth?	

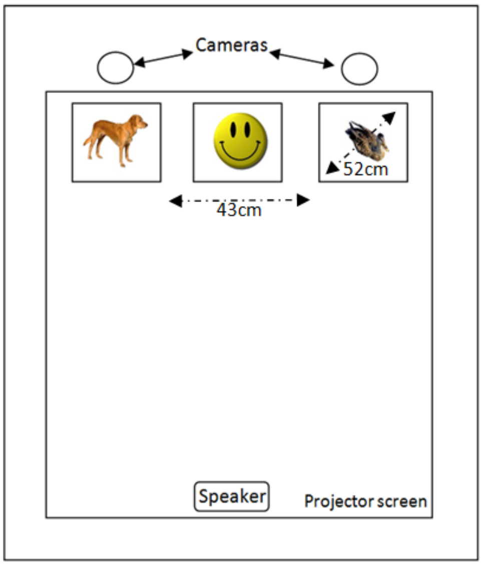
7	What is your child's gender?	

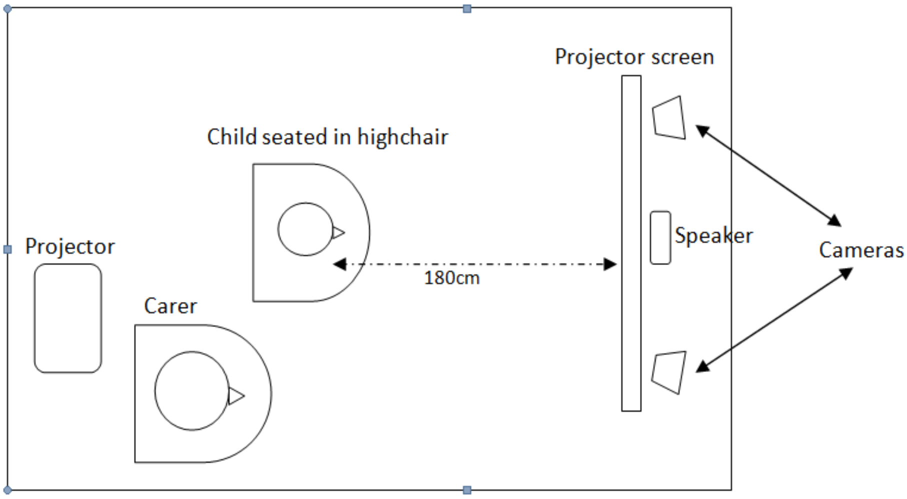
8	Has your child ever had any hearing problems or developmental delays? (please include details)	

9	Was your child more than 6 weeks premature?	

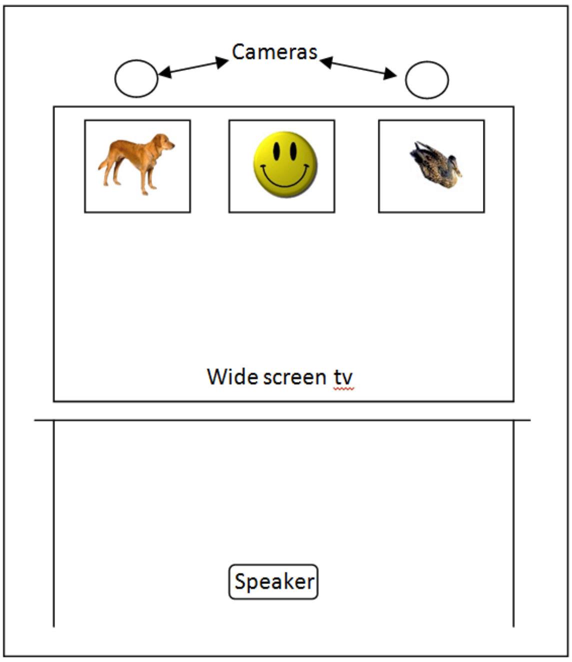
10	Where was your child born?	

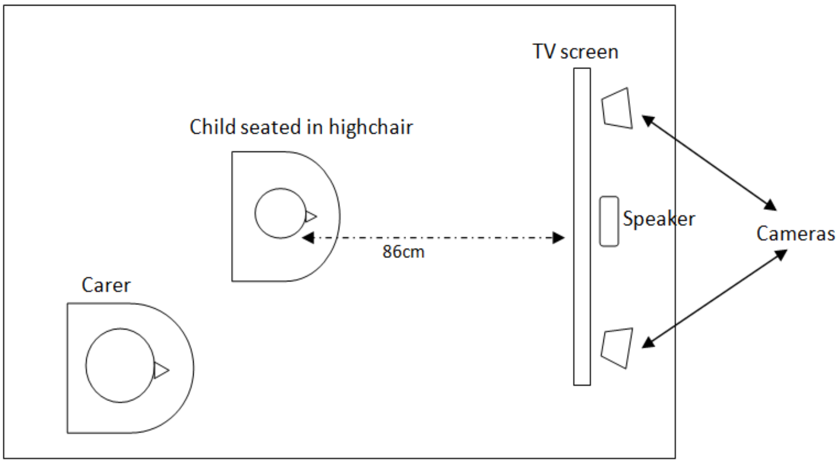
Appendix C: Experimental setup A





Appendix D: Experimental setup B





Appendix E: Median Split analysis (Experiment 5)

An alternative to correlations for looking at the effect of vocabulary is splitting the data in half creating a low and high vocabulary group to explore whether 18 month olds with higher productive vocabularies show evidence of disambiguation (the results for receptive vocabulary are similar and will not be presented here). A mixed model ANOVA with the within subject factors Naming (pre and post) and Trial Type (KK, KU, and UK) and the between subjects factors Vocabulary group (low and high) and Block (first 12 and second 12 trials) revealed no interactions with Vocabulary group or Block. A main effect of Naming was identified (F (1, 87) =19.15, p<.001, η_p^2=.18) and an interaction between Trial Type and Naming (F(2,174)=3.98, p=.023, η_p^2=.04), due to difference in performance across trial types as reported in the main analysis for this group of toddlers. There were no interactions between the two Vocabulary groups (all p's>.05) suggesting that toddlers with both low and high vocabularies performed similarly in this study.