Word Learning in Bilingual Children

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I declare that this thesis is my own work completed solely by myself under the supervision of Professor Padraic Monaghan and Dr Marije Michel, and that it has not been submitted in substantially the same form for the award of a higher degree elsewhere.

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List of Abbreviations

ASD	Autism Spectrum Disorder
BPVS III	British Picture Vocabulary Scale – Third Edition
CELF-P2	Clinical Evaluation of Language Fundamentals – Preschool-2
CHAT	Codes for Human Analysis of Transcripts
CLAN	Child Language Analysis
CSSL	Cross-Situational Statistical Learning
DRNEG	Density Score of Negation Expression
DRNP	Density Score of Noun Phrase
DRVP	Density Score of Verb Phrase
EAL	English as an Additional Language
ECM	Emergentist Coalition Model
GI	Guiraud Index
GLM	Generalised Linear Mixed-Effects
LME	Linear Mixed-Effects
LO	Lexical Overlap
ME	Mutual Exclusivity
MLU	Mean Length of Utterance
NOUN	Novel Object and Unusual Name
SES	Socio-Economic Status
SYNLE	Left-Embeddedness
SYNNP	Mean Number of Modifiers per Noun Phrase
SYNSTRUTt	Syntactic Structure Similarity
TTR	Type-Token Ratio
ZPD	Zone of Proximal Development

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Thesis Abstract

In a 21st-century super-diverse world, young children are likely to speak different first languages which are not the majority language of society. For some children, preschool is one of the few environments where they experience this majority language. A pressing issue encountered by preschool teachers is how to communicate with these children and how to help these children acquire the majority language they need for a successful school entry. Building a repertoire of words in the majority language is one of the first steps. Strategies that monolingual children use to map words to their referents in the environment have been of interest for 60 years. However, less is known about the early development of word learning in bilingual children. This thesis, therefore, seeks to understand how monolingual and bilingual children utilise different strategies to learn words using experimental methods and look at how preschool teachers communicate with children in a preschool setting via naturalistic observation. The ultimate goal of this thesis is to identify and develop strategies that preschool teachers can use to foster children's development of the majority language.

In two experimental studies, this thesis examined (1) how monolingual and bilingual preschoolers learn words from speakers of different languages through mutual exclusivity and the acceptance of lexical overlap, and (2) whether and how socio-pragmatic cues influence monolingual and bilingual language learners' learning of one-to-one and two-to-one word-object mappings through cross-situational statistics. In two observational studies, this thesis looked into whether and how preschool teachers in a UK setting communicated differently with monolingual preschoolers and preschoolers learning English as an additional language (EAL). The

thesis also set out to identify the linguistic features of preschool talk that could predict preschoolers', especially EAL children's, language development.

The findings of the experimental studies show a complex interaction between the different word-learning strategies and prior language experience, and the results suggest that word-learning strategies available to monolingual and bilingual learners are the same but used differently. The findings of the observational studies show that preschool teacher talk to EAL children, in terms of lexical diversity and syntactic complexity, affects the children's development of English, suggesting that preschool teachers' language use could scaffold and support EAL children's acquisition of English. The findings of this thesis suggest that matching language input to EAL children's English level and setting up learning situations that closely mimic those of bilingual word learning may be helpful strategies for preschool teachers to support EAL children's English development.

Chapter 1: Literature Review

1.1 Introduction

Young children's ability to learn words is impressive. Children typically learn their first words by 12 months of age, and in less than 2 years, they progress from only knowing just a few words to being able to learn an average of more than 3 words per day (Fenson et al., 1994). This learning rate, which has led Pinker to call children "lexical vacuum cleaners" (Pinker, 1994, p. 151), is striking not only given young children's limiting cognitive abilities, such as poor reasoning skills and memory, but also because the complexity of the task of word learning. This complexity is in part due to the reference problem – there are infinitely many possible referents in the environment for a word (Quine, 1960). Quine likened this problem with that of a linguist attempting to determine the meaning of words in an unfamiliar foreign language: the linguist hears a speaker of the foreign language utter: "*Gavagai*!" while a rabbit is running past. The problem for the linguist is that the word uttered by the native speaker has many candidate referents – it could refer to the rabbit, a part of the rabbit, such as its ears, the running action, the colour of the grass in the background, and many more.

The reference problem is not the only problem that makes word learning complex. Words do not always refer to tangible things; they can be used to refer to categories or concepts, which is referred to as the extension problem (Rowland, 2014). To successfully learn a word, one has to be able to not only map a word to a referent, but also know what to generalise or extend the word to. So, after figuring out what *gavagai* means, say rabbit, in the moment; one also has to be able to understand that *gavagai* refers to other rabbits – not just a particular rabbit, but not other, even similar-looking, animals, such as kangaroos or mice. Yet, despite these fundamental difficulties, young children still seem to succeed in learning words relatively easily.

Young children's ability to overcome the reference and extension problems has given rise to strands of research looking at how they figure out the meanings of words in the past 60 years (Bloom, 2000). Some researchers (e.g., Markman, 1994; Markman & Hutchinson, 1984; Markman & Wachtel, 1988; Mervis & Bertrand, 1994; Waxman, 1989) hold the view that young children possess some learner-internal, innate biases to constraint the number of potential referents in the environment for a word (Golinkoff, Mervis, & Hirsh-Pasek, 1994; Markman, 1990). Others (e.g., Baldwin, 1993; Tomasello & Akhtar, 1995) have suggested that children rely on socio-pragmatic cues, such as properties of communicative contexts, to solve the reference problem. Yet still, others (e.g., Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Smith & Yu, 2008) argue that children use learner-external cues, such as linguistic input and word-referent co-occurrences, to guide their learning. More recently, some researchers (e.g., Hollich, Hirsh-Pasek, & Golinkoff, 2000; Pruden, Hirsh-Pasek, Golinkoff, & Hennon, 2006) integrated the different accounts of word learning and proposed that children can use multiple cues to learn the meaning of words.

Notwithstanding, all these theories are based on findings with monolingual children, less is known about the early development of word learning in bilingual children. Here, "bilingual children" is broadly defined as children who can speak or are exposed to more than one language. Dissimilar to their monolingual counterparts, who only need to learn one-to-one word-referent mappings, bilingual children, in order to be proficient in all the languages they speak, have to learn to map multiple words to one referent (i.e., form many-to-one word-referent mappings). Some recent studies (e.g., Byers-Heinlein & Werker, 2009; Kalashnikova, Mattock, & Monaghan, 2015) have started to look at whether bilingual experience would lead bilingual children to use word learning strategies differently than monolingual children.

Understanding whether and how bilingual children utilise word learning strategies differently than monolingual children has important applied implications. In a 21st-century super-diverse world, young children are more likely to be bilingual than monolingual (Vertovec, 2007). In some cases, young children are not simultaneous bilinguals (i.e., learning multiple languages from birth), but sequential bilinguals (i.e., learn one language from birth and then learn more languages at a later age). Of these sequential bilinguals, many learn an additional language at preschool, as their first language is not the majority language of society. This poses great challenges to preschool teachers – how should they communicate with these children, and how can they help them learn the majority language? Although some successful interventions have been documented, they are mostly context-specific, such as addressing a group of children speaking the same first language, or require additional resources, such as teachers running extra sessions, which may not be applicable to all situations (Murphy & Unthiah, 2015). Understanding word learning in bilingual children, especially the influence of linguistic input, can help us identify strategies that preschool teachers can adopt to foster the language development of children learning the majority language as an additional language.

This chapter will first review the different accounts of word learning in relation to monolingual language development, and then discuss what is different and what we know about word learning in bilingual children. Then, intervention studies aiming to foster majority language development in learners acquiring it as an additional language in preschool settings and the literature on teacher-child interaction in preschool settings will be reviewed.

1.2 Intrinsic Biases of Word Learning

Traditionally, young children's ability to overcome the reference and extension problems have been discussed in terms of intrinsic biases, which are learner-internal biases that help young children to constrain the problem space by limiting the number of potential referents in the environment for a word. These biases could be broadly classified into two categories: lexical constraints and socio-pragmatic cues. Lexical constraints guide the learning of word-referent mappings by providing information about permissible mappings, whereas socio-pragmatic cues guide the formation of word-referent mappings based on speaker intentions.

1.2.1 Lexical Constraints

According to the lexical constraints approach, children's word learning is guided by a set of innate biases (Woodward & Markman, 1998). Markman (1989) proposed that young children use three such biases to guide them to learn word meanings: the whole-object assumption – a word refers to a whole object, not a part or a property of it, mutual exclusivity (ME) – every object has one and only one name, and the taxonomic assumption – words refer to objects from the same category. These three biases are assumed to work together to help young children organise the otherwise unstructured problem space, of infinitely many possible word-referent mappings, in a systematic way. For instance, young children are more likely to choose the entire object as the referent of a word when they are shown an unfamiliar object and hear a novel label (Carey, 1978; Markman, 1990). Yet, when they are presented with a novel label and an object that they already know the name of, the ME bias would override the whole-object assumption and lead them to map the label to a part or a property of the object which they do not have a name for (Markman & Wachtel, 1988). The taxonomic assumption would then guide young children to extend a word to things that are in the same category (Markman & Hutchinson, 1984).

The literature presents ample evidence for the lexical constraints theory. Of all lexical constraints, ME has been the most extensively studied. ME has also been referred to and described under different names, for example Principle of Contrast (Clark, 1987) and Novel Name-Nameless Category principle (Golinkoff, Mervis, & Hirsh-Pasek, 1994). Although these different proposals have slight theoretical differences – whether the driving force is socio-pragmatic in nature (Clark, 1987; Diesendruck & Markson, 2001), or whether it is simply a novelty bias (Horst, Samuelson, Kucker, & McMurray, 2011) – they all guide children to form one-to-one word-referent mappings. Markman and Wachtel's (1988) early study has shown that 3- to 4-year-olds can learn the meaning of new words through the application of ME. They presented the children with two objects, one familiar and one unfamiliar, and a puppet asked the children to pick one of the objects using a novel word. It was found that the children were more likely to pick the unfamiliar object as the referent. This finding could not be accounted for by a novelty preference for the unfamiliar object, as the children's tendency to choose the unfamiliar object was significantly higher than those in a condition where the puppet uttered: "Show me this one", instead of using a label. This finding has been replicated in similar studies with children as young as 10 months, using similar behavioural and looking-time tasks (Clark, 1990; Halberda, 2003; Mather & Plunkett, 2012; Mervis & Bertrand, 1994).

Although the lexical constraints account appears to be an elegant account, as it solves the complex reference problem by appealing to a simple set of constraints to limit the problem space, there has been some debate about whether these constraints are innate or learned and whether they are domain-specific or domain-general. For example, some have argued that ME is not a hard-wired bias, rather, it is a bias that is developed by young children after seeing how words seem to map onto referents. In Halberda's (2003) study, 14- and 16-month-olds failed to show an ME bias, but 17-month-olds' performance was in line with ME. Similarly, Bion, Borovsky, and Fernald (2013) found that 24- and 30-, but not 18-, month-olds demonstrated an ME bias. Bion et al. also discovered that 24- and 30-month-olds' use of ME was correlated with their vocabulary score, suggesting that ME could be a tendency developed out of children's experience of how words map onto referents. In addition, Kalashnikova et al. (2016b) found that 17- to 19-month-olds with a larger receptive vocabulary adhered to ME more reliably than those with a smaller receptive vocabulary. Altogether, this evidence supports that ME is not an innate constraint; rather, it is shaped by a learner's language experience. Yet, ME could still be observed in children who know less than 50 words (Markman, Wasow, & Hansen, 2003). This suggests that ME is available to children with rudimentary lexical knowledge, hence not necessarily a strategy shaped by children's extended experience of word-referent mappings.

Others have argued that lexical constraints may not be domain-specific. For instance, the ME assumption may simply be the result of domain-general pragmatic mechanisms, such that children use what is known and unknown in a given situation to disambiguate the referent of ambiguous expressions (Diesendruck & Markson, 2001). Although a number of studies have shown that words are treated differently than other types of referential expressions (e.g., a fact), such that children only show disambiguation for words, but not facts (e.g., Behrend, Scofield, & Kleinknecht, 2001; Henderson & Graham, 2005), a study by Kalashnikova et al. (2014) found that younger children disambiguated across situations that included words and facts about objects, but older children only employed this inferential reasoning to disambiguate in situations involving words, suggesting a developmental change. These mixed findings have led to critics that word-learning strategies do not have to be innate and domain-specific.

Another problem with the lexical constraints account is that children do not always adhere to the constraints. For example, in Markman and Wachtel's (1988) study, young children chose a part of an object as the referent for a novel word when they were previously given a name for the whole object. This was a clear demonstration that ME had overridden the whole-object assumption. In addition, children have been shown to be able to relax ME and learn multiple labels for an object (e.g., Kalashnikova et al., 2016a). Moreover, strict reliance on lexical constraints would lead to errors in a number of learning situations. For instance, if a child already knew the name of a bunny, say Flopsy; upon hearing the mother calling it a bunny, the ME constraint would lead the child to attach the word "bunny" to entities (e.g., the ears of the bunny) other than the bunny, which would be wrong. If a constraint can be violated, then whatever violates the constraint would be a more useful source for learning. As such, lexical constraints likely only provide initial hypotheses to the child of how words map onto referents, which is far from the whole story of word learning.

1.2.2 Socio-Pragmatic Skills

In light of the shortcomings of the lexical constraints approach, some researchers (e.g., Akhtar & Tomasello, 2000; Baldwin & Moses, 2001; Bloom, 1998, 2000) contemplate that perhaps children's word learning is guided by their emerging domain-general socio-pragmatic skills, and argue that innate constraints or domain-specific cues are not necessary. Children are highly sensitive to the social and communicative nature of language use and can follow non-linguistic social cues when interacting with others. Infants from as young as 6 months can appreciate the communicative nature of language (Parise & Csibra, 2013). For instance, they expect speech to be directed at people (Augusti, Melinder, & Gredeback, 2010), and that speech can transmit information that non-communicative vocal sounds cannot (Vouloumanos, Martin, & Onishi, 2014). Also, infants from 9 months could follow adults' head turns, and from 10 months also eye gaze, to direct attention to objects (Brooks & Meltzoff, 2005). According to the socio-pragmatic account, children's sensitivity to communicative contexts and cues about speaker behaviours and speakers' state of knowledge and dispositions can help them work out the referential intentions of speakers, and, in turn, narrow down the possible meaning of a word. As children's word learning starts to take off at about the same time as their socio-cognitive skills come online, between 9 and 12 months of age (Tomasello, 2003), this account seems plausible.

Of note, two particular abilities allow young children to use socio-pragmatic cues to learn the meaning of words: the ability to establish joint attention, the coordination of mutual engagement with mutual focus on an entity, and intention reading, the ability to infer and understand a speaker's communicative intent. A series of studies by Baldwin (1991, 1993a, 1993b) have investigated children's word learning through joint attention. To illustrate, in one study, Baldwin (1993b) found that upon the establishment of joint attention between a child and an adult on a novel object, when a novel label was provided by the adult, 16- and 18-, but not 14-, month-olds could correctly identify the object in focus as the referent for the novel label. This suggests that children from 16 months of age could draw on joint attention to figure out the meaning of new words.

In the same study, Baldwin (1993b) also found that if joint attention was not established before the provision of the novel word, such that the adult and the child were focusing their attention on different unfamiliar objects when the adult uttered the novel word, only 18-month-olds, but not 14- and 16-month-olds, chose the object that was the focus of the adult's attention as the referent of the novel word. This shows that 18-month-olds are aware that it is the speaker's focus of attention, not their own, that matters when figuring out the meaning of a new word. This finding suggests that children from 18 months of age can work out the meaning of new words by monitoring the speaker's intentions. Other studies by Tomasello and colleagues (Akhtar & Tomasello, 1996; Tomasello & Barton, 1994) have provided support for children's use of intention reading skills to aid word learning. Akhtar and Tomasello showed that 2-year-olds would more readily map a novel word to an object that a speaker is searching for, but not to objects that have been rejected during searching, even though they had not seen the target object during the search. In addition, Tomasello and Barton demonstrated that 2-year-olds could rely on a speaker's affect (e.g., excitement and surprise) to infer the meaning of a novel word. Importantly, the children's performance in these studies could not be explained by strategies such as ME, as all objects at test were novel to the children – the children did not have a name for any of the objects prior to the task. These findings thus provide compelling evidence that children actively monitor speakers' intentions to discover the intended referents of new words.

To successfully monitor a speaker's intention, children also need to show sensitivity to a speaker's state of knowledge. Akhtar, Carpenter, and Tomasello

(1996) tested 2-year-olds on a referential selection task. An experimenter presented children and two adults with three novel objects to play with, and then introduced a fourth novel object to the children in the absence of the two adults. All four objects were then placed in a transparent box. When the two adults returned, they provided a novel word in exclamation: "Look, I see a (novel word)!". It was found that the children systematically selected the fourth object as the referent for the novel word. Akhtar et al. took this as evidence that the children were successful at interpreting the novel word as referring to the object that was novel to the speakers, showing that they were sensitive to speakers' state of knowledge and communicative intentions.

These socio-pragmatic skills could explain findings that support the lexical constraints account. For instance, ME, the tendency that children select an object without a known name as the referent for a novel word, as opposed to an object of which the name is known, could be explained by their intention reading skills. The socio-pragmatic explanation to this phenomenon is that children might reason that if a speaker had wanted the object of which the name is known, the speaker could refer to it by using the already-known name. The speaker's use of a new name would therefore likely indicate that an object without a name is intended (Clark, 1988, 1990). Provided that the socio-pragmatic account does not assume any innate, and sometimes misleading or useless, constraints, it would be a better account for word learning than the lexical constraints account.

However, the socio-pragmatic account also has some limitations. The two main sets of criticisms are as follows: first, word learning could take place in the absence of socio-pragmatic cues, and second, evidence for socio-pragmatic cues could be explained by other, more basic cognitive processes. The first set of criticisms suggests that socio-pragmatic cues alone are not sufficient in explaining word learning. For instance, children know words before they could use joint attention skills to learn words. In Baldwin's (1993b) study, 14-month-olds failed to learn words based on joint attention. Yet, children would have learned their first words by 12 months of age (Fenson et al., 1994). In fact, the average child would already understand over 30 words by 8 months of age (Bates et al., 1994). Therefore, some words are learned before socio-pragmatic cues are available, suggesting that there must be other means for children to acquire words. Similarly, children with autism spectrum disorder (ASD), who have difficulties interpreting socio-pragmatic cues, are still capable of learning words. In a study by Rourke and Tsatsanis (1996), they found that despite having severe difficulties in social understanding, children and adults with Asperger's syndrome demonstrated very few difficulties in word learning. In more recent work, Hartley, Bird, and Monaghan (2020) found that although children with ASD generally show delays in their language abilities, their word-learning mechanisms are not qualitatively different when compared with those of typically developing children. Again, these suggest that the socio-pragmatic account is not the whole story to word learning.

The other set of critics argue that it is unnecessary to posit high-level socio-pragmatic skills to explain word learning, as word learning could be explained by more basic cognitive mechanisms, such as attention and memory. For instance, Samuelson and Smith (1998) interpreted the results of Akhtar et al. (1996) in terms of attentional biases. They argued that the children were not mapping the novel word to the object that was new to the speakers; rather, the children were assigning the novel word to the object due to it being introduced in a different context – playing with three adults on the floor for the first three objects as opposed to playing at a table with one adult for the fourth object. Samuelson and Smith modified Akhtar et al.'s study, such that at the introduction of the fourth object, all adults were present, but the object was introduced in a different manner than the first three objects. It was found that the children still showed the same responses as in the original study, suggesting that it is not necessary to attribute word learning to socio-pragmatic skills.

In sum, it seems that neither the lexical constraints account nor the socio-pragmatic account is necessary or sufficient in explaining word learning in all situations.

1.3 Extrinsic Cues of Word Learning

In contrast to the endogenous biases of word learning discussed, some have argued that children's word learning could be attributed to properties of the external communicative situation. These learner-external cues include linguistic input and associative information. They highlight the importance of exposure to language in word learning without the need to posit multiple learner-internal mechanisms.

1.3.1 Linguistic Input

A vast amount of literature has looked into the links between linguistic input and child language development. They could be broadly categorised into two themes: quantity and quality of linguistic input. They affect the rate and manner of word learning in children.

A robust finding in the literature is that parents from high socio-economic status (SES) backgrounds generally speak more to their children, and these children would, in turn, have a larger vocabulary than their low SES counterparts (Hoff, 2006). A landmark study by Hart and Risley (1995) followed some American households for 2.5 years and observed the quantity of caregiver language use. They found that children from high SES families were exposed to 153,000 more words per week than those from families of low SES. By 3 years old, this projects to a 30 million word gap, difference in number of words, in the language experience of children from different SES backgrounds. In addition, Hart and Risley found that the children who were exposed to more language, in terms of number of word tokens, word types, and sentences, had a larger vocabulary. In a similar study, Huttenlocher, Haight, Bryk, Seltzer, and Lyons (1991) found that the frequency of a word in caregiver speech correlated with the timing of acquisition of the word in children, such that the more frequent a word is in the input, the earlier a child would acquire the word. This suggests that quantity of linguistic input plays an important role in word learning (Cartmill et al., 2013; Chang & Monaghan, 2019; Rowe, 2012).

Apart from quantity of input, quality of input has also been found to be related to children's word learning. To illustrate, in a longitudinal study, Newman, Rowe, and Ratner (2016) found that repetitiveness in maternal speech at 7 months of age significantly predicted 24-month-olds' vocabulary size. In another study by Rowe (2012), it was found that greater numbers of word types and rare words in caregiver speech at 30 months of age were associated with a larger vocabulary at 42 months of age. Similarly, Huttenlocher, Waterfall, Vasilyeva, Vevea, and Hedges (2010) also found that number of word types in caregiver linguistic input significantly predicted number of word types in later child speech. These findings suggest that lexical diversity is also crucial to early word learning. Other studies that explored the relations between quality of linguistic input and word learning have looked into the role of grammatical complexity: the use of questions and the use of language that is removed from the here-and-now (i.e., decontextualised talk; Snow, 1990). It was found that the use of *wh-* questions by fathers at 24 months of age and parents' use of decontextualised talk at 42 months of age were predictive of children's vocabulary size at 36 and 54 months of age respectively (Rowe, 2012; Rowe, Leech, & Cabrera, 2016). Taken together, these studies have shown that quality of linguistic input plays a critical role in children's word learning.

Further support that linguistic input shapes early word learning comes from research relating to the noun bias. Various studies (e.g., Gentner, 1978; Macnamara, 1972; Nelson, 1973) have found that children tend to learn nouns before other word classes, and the proportion of nouns is higher than that of other word classes in children's vocabulary. Gentner (1982) explained this phenomenon in terms of the high frequency of nouns, compared to other word classes, in the input and conceptual simplicity of nouns over other word classes. However, the noun bias is not universal. In some other languages, such as Mandarin (Tardif, 1996) and Korean (Choi & Gopnik, 1995), a verb bias has been observed. This cross-linguistic difference has been explained in terms of the syntactic rules of the individual languages. In many East Asian languages, the subject and object do not have to be overtly expressed, in other words they can be omitted, when it is clear from the context who or what the subject and object are. Therefore, many sentences in these languages come without nouns and children hear more verbs than nouns. In addition, these languages are often verb final, which means that the verb in most sentences is placed at a prominent position. These factors likely contribute to a verb, rather than noun, bias. This reinforces the notion that linguistic input shapes early word learning.

These studies have undeniably shown the importance of linguistic input on word learning. Yet, it is unclear whether and how input constrains the way children infer the meaning of new words. One possibility is that caregivers adapt the linguistic input to children and simplify the reference problem by providing children with multiple cues hinting at the meaning of words and relationships between words (Clark & Wong, 2002; Nelson, 1988). For example, caregivers have been found to use a great amount of basic-level count nouns (Callanan, 1985). This could potentially lead children to learn that words refer to categories, leading to behaviours akin to those that would be predicted by the taxonomic assumption. As another example, the way that caregivers label objects may lead children to develop expectations of one-to-one word-object mappings. Caregivers rarely name an object using multiple labels or, if such instances arise, they are qualified by clarifying expressions (Callanan & Sabbagh, 2004). Also, caregivers have a tendency to question children about names of familiar objects, but directly label novel objects (Masur, 1997). These patterns observed in the linguistic input could constrain children to map novel words to novel objects, which would produce behaviours in line with the ME bias.

Although linguistic input is integral to word learning, as word learning, and language acquisition in general, cannot happen in the absence of linguistic input, the linguistic input proposal still has its shortcomings. There are two main problems with this account. First, it does not seem to provide a clear answer as to how children learn their first words. More specifically, if it is about manipulating linguistic input based on children's existing knowledge about words, then children would need some other mechanisms in place to acquire their first words. Hence, linguistic input alone is not a sufficient solution to the reference problem. Second, as is true for the socio-pragmatic account, evidence for this account could be explained by general cognitive mechanisms. If it is possible to explain such evidence using general cognitive mechanisms, then it is unnecessary to posit domain-specific strategies or multiple constraints and biases.

1.3.2 Cross-Situational Statistical Learning

All the discussed word-learning accounts posit that young children rely on strategies or cues to limit the number of potential candidate referents in the environment for a word. Yet, constraining the problem space is not the only way to solve the reference problem. A domain-general mechanism that has been proposed to be a valuable contributor to word learning is cross-situational statistical learning (CSSL). CSSL concerns associative learning, which takes place when two cues co-occur in predictable ways, across multiple situations. In any given learning instance, the referent of a novel word might be ambiguous, but across multiple learning instances, children would be able to track the probability of the co-occurrence of the word and potential referents present in the environment, and map the word to the referent that it most reliably occurs with.

Smith and Yu (2008) tested whether young children could learn word-object pairs using CSSL. They presented 12- and 14-month-olds with a series of learning trials containing two unfamiliar objects and two novel words. Within each trial, there was no correspondence between the order of words and the location of objects on the computer screen, hence the word-object pairings were ambiguous. Yet, across trials, with the presentation of different combinations of novel words and their referring objects, the word-object pairings would become apparent. Hence, the children would be able to learn the word-object pairs if they were capable of tracking the co-occurrences of words and objects across learning instances. It was found that, at test, where only one word was presented, children in both age groups preferentially looked at the object that reliably occurred with the presented word. This suggests that children as young as 12 months of age can learn word-object mappings through CSSL.

Two theoretical accounts of learning mechanisms have been proposed for CSSL: Associative Learning (Frank, Goodman, & Tenenbaum, 2009; Yu & Smith, 2007) and Hypothesis Testing (Gleitman, Cassidy, Nappa, Papafragou, & Trueswell, 2005). According to the Associative Learning account, to learn words through CSSL, children have to make multiple hypotheses (i.e., word-referent mappings) on every learning instance, store them in memory, and compare across learning instances to select the best hypothesis. In other words, children have to make simple initial mappings between words and referents, and then strengthen or weaken the associations as they aggregate information from additional learning instances. Yet, it seems unrealistic to assume that young children can store all hypotheses across all learning instances in memory. In fact, Vlach and Johnson (2013) discovered that when some mappings were presented in immediate succession and some distributed across all learning instances, 16-month-olds could only learn the mappings presented in immediate succession, showing memory constraints on CSSL. In another study with adult language learners, Trueswell, Medina, Hafri, and Gleitman (2013) found that learners tended to track and test only a single hypothesis per word at a time. They proposed the Hypothesis Testing account of CSSL, whereby learners first select a random hypothesis in terms of the potential referent for a word, then verify the selected hypothesis in a subsequent learning instance. If the hypothesis is confirmed, the mapping would be remembered, but if the hypothesis is invalidated, the hypothesis would be discarded, and another random hypothesis would be selected for verification. To date, there is no definite answer as to which account is more plausible (Zhang, Chen, & Yu, 2019); there is even evidence suggesting that neither account is sufficient to account for CSSL data (Roembke & McMurray, 2016). More work is still needed to determine which account better explains CSSL. Yet, regardless of the exact underlying mechanism, it is clear that learners are capable of learning word-object mappings based on co-occurrence statistics in the input.

The CSSL account of word learning is simple – as there is no need for innate knowledge and multiple strategies – and powerful – as it seems to be in place very young. However, evidence comes from very simplified lab environments (i.e., seeing two objects and hearing two words at a time). It is unclear how well it can scale up to learning in the real world – it is rarely the case in real life that the visual scene contains only two objects, and not all objects in the scene would be mentioned by name in every language exchange. Another issue of CSSL is that it relies heavily on seeing the referent whilst hearing the word. How then could it account for the learning of abstract words? This suggests, as for the case of lexical constraints, socio-pragmatic cues, and linguistic input, that CSSL alone is not sufficient in explaining word learning.

1.4 Integrative Approaches to Word Learning

The word-learning field is rich with different theoretical approaches. Apart from the few theories discussed, there are also other accounts, including the developmental lexical principles framework – a set of acquired rules that are similar to lexical constraints, but more flexible (Golinkoff, Mervis, & Hirsh-Pasek, 1994); syntactic boostrapping – learning based on innate knowledge of the links between syntax and semantics (Naigles, 1990); and distributional learning – learning based on transitional probabilities (co-occurrence frequencies) between words (e.g., Monaghan & Mattock, 2012). These and the few theories discussed in this chapter try to isolate one or two mechanisms that might explain how children learn words. Yet, as discussed earlier, it seems that no one word-learning account can fully explain word learning. In reality, multiple mechanisms may be at play. It is possible that children use a combination of biases and cues in figuring out the meaning of words, and these strategies might come online at different stages of development. In other words, the different word-learning accounts do not necessarily contradict each other. Rather, they could be complementary to each other, in that children rely on the strategies that are optimal for learning depending on the learning situation. Some researchers have proposed integrated accounts that draw on multiple biases and cues. A prominent and detailed multiple-cues account is the Emergentist Coalition Model (ECM).

1.4.1 Emergentist Coalition Model

The ECM is a hybrid account that integrates multiple strategies that children use to learn words (Hollich, Hirsh-Pasek, & Golinkoff, 2000). There are three key ideas about the ECM: (1) children are sensitive to the full range of word-learning strategies, including cues from the social, perceptual, and linguistic domains; (2) children differentially weigh cues over others at different stages of development; and (3) children generally move from using immature, basic constraints to more mature, sophisticated ones as they develop and understand more about the word-learning process. Evidence for the ECM comes from a series of experiments by Hirsh-Pasek, Golinkoff and others (Hollich et al., 2000; Pruden, Hirsh-Pasek, Golinkoff, & Hennon, 2006). They investigated on what basis infants between the ages of 10 and 24 months map a novel word to an unfamiliar object. They presented the infants with two objects, an interesting object (brightly coloured with moving parts) and a boring object (dull colour with no moving parts). In one condition, a speaker focused their attention on the interesting object and provided a novel label. It was found that all infants were able to show preference for the interesting object when later asked to find the referent of the novel label. In another condition, the speaker focused their attention on the boring object when providing the novel label. In this case, the perceptual cue (brightly coloured attention-grabbing object) and the social cue (speaker's focus of attention) were in conflict. It was found that, with the conflicting cues, only 19- and

24-month-olds ignored the perceptual cue and relied on the social cue, with the 19-month-olds slightly more attracted to the perceptual cue. In contrast, 10-month-olds relied predominantly on the perceptual cue. These results show a developmental shift in early word learning, from relying more on perceptual cues to weighing social cues more heavily, and provided support for the ECM. In a broader sense, these findings suggest that children are sensitive to multiple cues when learning the meaning of words.

The ECM and other multiple-cues accounts are potentially capable of explaining any pattern of results from any studies on word learning, as they incorporate multiple mechanisms of word learning. However, some researchers (e.g., Akhtar & Tomasello, 2000; Smith, 2000) have criticised these multiple-cues accounts. A common criticism is that if the same work could be done by one single mechanism (e.g., CSSL), why would it be necessary to involve multiple mechanisms? For instance, Smith argued that the evidence in support of the ECM could also be explained by an associative/attentional learning model. Yet, there is evidence from computation modelling showing that multiple-cues models perform more similarly to infants and are more optimal than single-cue models on word-learning tasks (Yu & Ballard, 2007). More importantly, these models show that a pure associative learning model is often sub-optimal and does not tightly model infants' actual word-learning behaviour. Taken together, there is strong support for the multiple-cues account of word learning. A remaining question is how the different biases and cues interact with each other in guiding children's word learning. Studies with bilingual children may be able to elucidate how children learn to weigh and co-ordinate multiple cues.

1.5 Word Learning in Bilingual Children

The majority of infants in the world are bilingual, growing up learning more than one language. However, previous word learning research has focused mainly on monolingual infants. Unlike monolingual infants, bilingual infants have to accept lexical overlap, where two labels can refer to the same referent (i.e., many-to-one word-referent mappings). Therefore, bilingual infants are less likely to rely on the ME bias. This is supported by Byers-Heinlein and Werker's (2009) finding that bilingual 17- and 18-month-olds relied less on ME than their monolingual counterparts.

Kalashnikova et al. (2015) examined whether language experience – being monolingual or bilingual – affects the use and relaxation of ME and the ability to accept lexical overlap. They first presented 3- to 5-year-olds with two puppets labelling an unfamiliar object either with the same label, or each used a different label. Then, the children were given four labels and asked to select a referent each for each label from four objects – two familiar, one unlabelled unfamiliar, and the labelled unfamiliar object. In one condition (the exclusivity condition), the four labels corresponded to each of the four objects that the children could choose from; whereas in the other condition (the overlap condition), two of the labels referred to the same object – the labelled unfamiliar object – and the remaining two labels each referred to a familiar object. Kalashnikova et al. found that all children were able to apply ME and accept lexical overlap in learning the meaning of new words. Yet, bilingual experience boosted the children's ability to accept lexical overlap. In addition, it was also found that the monolingual children's reliance on ME (i.e., reluctance to accept lexical overlap) was shaped by their experience with language, such that children between 4 and 5 years of age were less likely than those between 3 and 4 years of age in accepting lexical overlap. Yet, in their study, Kalashnikova et al. used puppets that spoke the same language, and the pragmatic information that they manipulated was only speaker (puppet) identity. However, speakers of the same language rarely label an object in two different ways, provided that they tend to name objects with basic category labels (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). Hence, the design of Kalashnikova et al.'s study might not have truly reflected monolingual and bilingual children's use of ME and acceptance of lexical overlap.

Considering the language-learning experience of bilingual infants, socio-pragmatic and contextual cues may be particularly important, as they have to figure out, in each language exchange, which language is being spoken and who speaks which language. Therefore, young bilinguals' use (and relaxation) of ME could be influenced by socio-pragmatic and contextual information, in particular speaker identity, speaker knowledge, and language context. This notion is in line with the multiple-cues account. The question here is how ME interacts with socio-pragmatic and contextual cues in early word learning. Byers-Heinlein, Chen, and Xu (2014) investigated the influence of language context on monolingual and bilingual 2-year-olds' use of ME. The children were first provided with a novel name for an unfamiliar object, and later asked to select from the just-named and an unnamed unfamiliar object the referent of a new novel word, all in an English context. Following that, a speaker who spoke a different language asked the children to choose from two objects – the object that they were ostensively taught the name of and another unfamiliar object – the referent of a novel word presented in the different language. Byers-Heinlein et al. found that although both groups showed performance in line with the ME bias in the trial using English, only the monolingual children systematically used ME in the trial using a different language. This suggests that monolingual children assume that words are conventionally shared across speakers of all languages, whereas bilingual children are aware that speakers of one language are ignorant of words in another language. Similar studies by Henderson and Scott (2015) and Scott and Henderson (2013) also found that monolingual and bilingual infants show different expectations about how words map onto objects, such that monolingual infants are more likely to expect one-to-one mappings, mappings in line with ME, whereas bilingual infants were more flexible and open to two-to-one mappings, mappings that violate ME. Yet, although these studies have tested young children's adherence to ME, they did not directly test their acceptance of lexical overlap.

Taken together, to date, no studies have directly investigated how socio-pragmatic information relating to speaker language background (i.e., the language a speaker speaks) influences monolingual and bilingual children's word learning, and more specifically their use of ME and acceptance of lexical overlap. There are two possibilities. One is that bilingual children would be better at word learning from both the application of ME and acceptance of lexical overlap, due to their experience of multiple speakers labelling the same referents differently. Alternatively, the socio-pragmatic information about speaker language background would guide monolingual children to more readily accept lexical overlap. Both scenarios can inform us about how socio-pragmatic cues interact with lexical constraints in guiding young children's word learning.

The interaction of lexical constraints, such as ME, and socio-pragmatic cues may have implications for other word-learning strategies, for example CSSL. There is ample evidence in the literature that suggests that learners can learn one-to-one word-object mappings via CSSL (e.g., Fitneva & Christiansen, 2011; Monaghan & Mattock, 2012; Smith & Yu, 2008). Yet, as discussed earlier, word-object mapping does not always follow a one-to-one mapping rule. For instance, bilinguals have to accept lexical overlap and learn translation equivalents (many-to-one word-object mappings).

A study by Benitez, Yurovsky, and Smith (2016) tested monolingual and bilingual learners' learning of one-to-one and two-to-one word-object mappings. In an initial experiment, they found that both monolingual and bilingual learners performed similarly on the task, and both groups were able to learn the one-to-one and two-to-one mappings. In a follow-up experiment, they added a phonological cue to one of the labels of the two-to-one mappings, distinguishing the set of labels (or "language") to which a given word belonged. Benitez et al. found that with the added phonological cue, the bilingual learners were more likely to learn both words of the two-to-one mappings, suggesting that bilinguals, compared to monolinguals, are more sensitive to contextual information, here the linguistic cues, that hint at different languages being present in the language input.

In another study, Poepsel and Weiss (2014) varied the socio-pragmatic information available to monolingual learners in a CSSL task involving the learning of one-to-one and one-to-two word-object mappings. In one condition, all words were used by one speaker, whereas in another condition, two speakers of different gender were used, and they used the same word to refer to different objects. The manipulation of speaker identity in this condition was an implicit cue to two underlying language structures being involved in the task. It was found that varying socio-pragmatic information about speaker identity did not affect monolingual learners' acquisition of one-to-two word-object mappings. Yet, in multilingual environments, it is more usual for one object to be labelled differently by different speakers. Therefore, although an effect of speaker identity may not be observed for the learning of one-to-two word-object mappings, it is possible that speaker identity can influence the learning of two-to-one mappings.

Based on Benitez et al.'s (2016) findings, contextual information can promote bilingual learners' learning of two labels for one object in a CSSL task, what is unknown is whether varying socio-pragmatic and contextual cues on speaker identity and speaker language background would affect bilingual learners' cross-situational word learning, especially the learning of two-to-one word-object mappings. Looking at the dynamics of the interaction of ME, socio-pragmatic cues, and CSSL in monolingual and bilingual learners' word learning would allow the development of theoretical frameworks of language acquisition that are representative of learners from different linguistic backgrounds, including monolinguals and bilinguals, and clarify the complex interactions of learners' individual language experience, the language-learning environment, and the use of different word-learning strategies and cues. Understanding these complex interactions has important applied implications.

1.6 Learning an Additional Language at Preschool

In recent decades, language diversity within society has increased as a result of super-diversity, the phenomenon that people from multiple geographic origins live in our society (Vertovec, 2007). As a consequence of this super-diversity, young children in our society become more likely to speak a variety of different first languages that are not the majority language of society. Some of these children do not speak the majority language at home and often only use and learn the majority language as an additional language. Many of these children spend a significant amount of time in preschool. For instance, in the UK, the government provides 15 hours of free childcare per week for all children from 3 years of age, and for children from lower SES backgrounds from 2 years of age. In addition, for many of these children, preschool may be one of the few environments where they are exposed to and use the majority language. Some of these children may initially possess no or only minimal knowledge of the majority language. This poses great challenges to preschool teachers, as they struggle to communicate with these children. The preschool teachers also have to find ways to support these children in acquiring the majority language to integrate them into the preschool, and later school, environment.

1.6.1 Language Interventions for Children Learning Majority Language as Additional Language

Some successful interventions have been documented in the literature. Yet, many of them are context-specific (e.g., address a homogeneous group of children speaking the same first language). These intervention programmes often draw on strategies that are not practically viable for all settings or readily transferrable or easily adaptable for use in a different country. For example, some of the interventions require additional resources, such as preschool teachers running extra sessions with children learning the majority language as an additional language and their parents (e.g., Leyva & Skorb, 2017; Melzi, Schick, & Scarola, 2018). This would increase the workload of staff and demand in resources. Not all settings can manage to cope with all such demands. Some other interventions designed rely on teachers using the children's first language (e.g., Leacox & Jackson, 2014). Such programmes would be impractical for use in some countries, such as the UK, where preschoolers learning the majority as an additional language are often less homogeneous in terms of first language compared to those in the US who more usually speak the same first language (e.g., Oxley & de Cat, 2019).

Placing a child learning the majority language as an additional language in an environment where only the majority language is used, as is the case of such a child attending preschool that is run in the majority language, is similar to the idea of immersion. Immersion programmes have been found helpful for children learning a second language (e.g., Barik & Swain, 1978; Genesee, 1981; Lambert & Tucker, 1972). To illustrate, a recent study by Bergström, Klatte, Steinbrink, and Lachmann (2016) compared the effectiveness of immersion and conventional instruction (i.e., explicit teaching) for German preschoolers learning English. It was found that, over the 2.5 years that the children spent at preschool, although both groups showed an increase in their vocabulary scores, the immersion group showed greater improvement. Notwithstanding, the immersion programme reported in Bergström et al. was not a full immersion, in that a German-speaking teacher was also present in the classroom and all the children in the classroom spoke the same first language. It is therefore unclear how a full immersion in an additional language environment would impact on preschoolers' proficiency and development of that additional language.

Further, in previous immersion programme studies, the teachers were only instructed to speak and encourage the children to use the target language. There has not been any investigation that looks into how different linguistic features in the input relate to children's improvement in the target language. One of the first steps in acquiring a language is building a repertoire of words in that language. Taking into consideration the different word-learning biases and cues a learner draws on, linguistic input would be the cue that preschool teachers would have the most control on. Therefore, amidst the lack of a practical intervention that can be used widely across settings with varying constraints and in addressing the challenges faced by preschool teachers, it is important to understand the language environment of a preschool classroom and how preschool teacher language use affects children's language development, in particular lexical development. This would then help us identify strategies that preschool teachers can apply to support the language development of children learning the majority language as an additional language.

1.6.2 Effects of Preschool Teacher Talk on Children's Lexical Development

Numerous studies (e.g., Dickinson & Porche, 2011; Dickinson & Smith, 1994; McCartney, 1984; NICHD Early Child Care Research Network, 2000) have examined the relation between preschool teacher talk and monolingual children's language development. A common finding across these studies is that the quantity and quality of preschool teacher talk is correlated with monolingual preschoolers' lexical development. For example, McCartney observed a number of preschools and assessed the vocabulary knowledge of the children attending those settings. It was found that the children in settings with a greater amount of teacher talk, as measured in number of utterances, had higher vocabulary scores. Similarly, a large-scale US-based longitudinal study that followed a cohort of over 13,000 children in childcare found that teachers' self-assessed language quantity significantly correlated with preschoolers' language development, including lexical development. More recently, Dickinson and Porche (2011) looked at preschool teacher talk during free play and group time and how this relates to preschoolers' longer-term language development. They found that the preschool teachers' use of sophisticated vocabulary during free play and their attempts to correct the children's utterances during group time and analytic talks (i.e., utterances that explore cause-and-effect relationships or discuss word meanings) during booking reading significantly predicted the children's word recognition and receptive vocabulary respectively in fourth grade. These findings mirror those from studies investigating caregiver speech and young children's lexical development (e.g., Chang & Monaghan, 2019; Hart & Risley, 1995) and suggest that the quantity of preschool teacher talk contributes to preschoolers' lexical development.

Compared to the vast number of studies focusing on monolingual children, there are very few extant studies on language exposure of children learning the majority language as an additional language in preschool settings. One exception is a study by Bowers and Vasilyeva (2011), which compared the lexical development of monolingual English children and children learning English as an additional language (EAL) in relation to the linguistic input they receive from preschool teachers. Preschool teacher talk during selected routine sessions was recorded and transcribed for 10 classrooms. The children were tested on their receptive vocabulary twice, a year apart. The teacher talk was analysed for input quantity (number of word tokens), lexical diversity (number of word types), and syntactic complexity (mean length of utterances; MLU). It was found that although there was not a difference in the average growth of vocabulary scores between the monolingual English and EAL groups, the gain of vocabulary scores in the two language groups were based on different factors, such that the monolingual English children's vocabulary scores were predicted by lexical diversity, whereas those of the EAL children were predicted by input quantity and syntactic simplicity.

Bowers and Vasilyeva's (2011) findings suggest that the monolingual English and EAL children were at different stages of language learning, and different linguistic features in the linguistic input played a more important role in their lexical development at these different stages. For the EAL children, they may still be in early stages of lexical development, thus needed more exposure to the same high-frequency words in order to learn them. Also, shorter utterances may help them to deconstruct and comprehend the utterances more easily. In contrast, the monolingual English children may need exposure to words that are lower in frequency in order to learn new words, and utterances containing more diverse word types are more likely to contain such words, hence aiding lexical development. In sum, Bowers and Vasilyeva's findings clearly demonstrate the influence of linguistic input on children's lexical development, be it monolingual children or children learning the majority language as an additional language. Yet, they have only looked at a small subset of linguistic features in the input at one time point. A closer examination of a more extended set of linguistic features and how these vary across different stages of development is needed for a more comprehensive understanding on how linguistic input influences lexical development in children learning the majority language as an additional language.

1.7 Summary and Future Directions

In summary, this chapter has shown that word learning is a complex problem and researchers have proposed various accounts in relation to how children learn the meaning of words. Accounts that isolate one or two mechanisms do not seem sufficient in solving the reference problem, and there is compelling evidence to support accounts that integrate multiple cues. Yet, how exactly these cues interact to inform word learning is unclear. Studying word learning in bilingual children can not only offer insights into the dynamics of the interaction of different word-learning biases and cues, but also refine theoretical frameworks on word learning in monolingual children and extend them to explain word learning in bilingual children. Having a clear understanding of how monolingual and bilingual children utilise multiple cues in learning the meaning of words have important applied implications for how preschool teachers can support the language development of children learning the majority language as an additional language.

1.7.1 Outline of Thesis

Several gaps in the literature have been identified through this review. First, despite some evidence showing effects of speaker identity and contextual information about languages involved in a given situation on monolingual and bilingual learners' word learning, it is unclear how the different biases and cues interact with each other to guide word learning. Second, it is unclear how specific linguistic features of the input influence lexical development in children learning the majority language as an additional language at different stages of development. These translate into four specific research questions and each forms the basis of one of the four studies presented in this thesis.

The first two studies will empirically test the integration of lexical constraints, ME in particular, socio-pragmatic cues, and CSSL. The first study (Chapter 2) will examine the effect of socio-pragmatic information on word learning, looking into how information on speaker language background affects the use of ME and acceptance of lexical overlap in monolingual and bilingual children. Three- to 4-year-old monolingual and bilinguals will be taught names of novel objects under ME or lexical overlap conditions. There will be two language conditions, one where two speakers speak the same language and one where two speakers speak different languages. The children will be tested on a referent selections task immediately after learning the names of the objects and again after a 10-minute delay.

The second study (Chapter 3) will investigate the influence of varying socio-pragmatic information about speaker identity and referential ambiguity on the learning of one-to-one and two-to-one word-object mappings via CSSL. Socio-pragmatic cues (number of speakers – one vs. two – and presence of cue to speaker linguistic background) and referential ambiguity (number of distractors – one vs. three) will be varied across a series of experiments. Instead of testing preschoolers, this study will test adults in the first case, as there are no fundamental differences between statistical learning in children and adults (Weiss, Poepsel, & Gerfen, 2015) and previous cross-situational word learning studies were mostly done with adults (e.g., Benitez et al., 2016; Poepsel & Weiss, 2014, 2016; Yu & Smith, 2007).

The final two studies will assess the linguistic input monolingual children and children learning the majority language as an additional language receive in a preschool classroom through naturalistic observation and see whether and how specific linguistic features in the input influence language development of these two groups of children. Specifically, in the third study (Chapter 4), the general linguistic environment of a preschool classroom with a mix of monolingual and EAL children will be assessed, and the linguistic input that the two groups of children receive, in terms of quantity and quality, will be compared. This study will also examine whether preschool teachers adapt the way they speak to individual children's language proficiency.

The group of preschoolers studied in Chapter 4 will be followed longitudinally for 4.5 months for the fourth study (Chapter 5) in order to examine whether specific linguistic features and changes in their linguistic input could predict their language development. The language development of the two language groups will be compared, and any changes in the linguistic features of preschool teacher talk will be assessed. The relationship between these changes will be examined to determine if preschool teachers' changing language practice is in response to children's developing language capacity. Finally, potential predictors of monolingual English and EAL children's language development will be identified.

Together, the findings of all the studies presented in this thesis will provide insights into language interventions for fostering word learning in children learning the majority language as an additional language, which will be re-visited in the General Discussion chapter (Chapter 6).

Chapter 2: Flexible Use of Word Learning Strategies: Monolingual and Bilingual Children's Word Learning from Different Language Contexts

Despite some evidence in the literature showing effects of speaker identity and contextual information about languages involved in a given situation on monolingual and bilingual learners' word learning, it is unclear how the different word-learning biases and cues interact with each other to guide word learning. This chapter presents a study that examined the effect of socio-pragmatic information on word learning, looking into how information on speaker language background affects the use of mutual exclusivity and acceptance of lexical overlap in monolingual and bilingual preschoolers.

Statement of Author Contribution

In the chapter entitled "Flexible Use of Word Learning Strategies: Monolingual and Bilingual Children's Word Learning from Different Language Contexts", the authors agree to the following contributions:

Kin Chung Jacky Chan – 80% (Experimental design, data collection, data analysis, and writing)

Signed: Date: 19/6/2020

Padraic Monaghan – 20% (Experimental design and review)

Signed: Date: 24/6/2020

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Abstract

Mutual exclusivity (ME) guides young children to learn one-to-one word-referent mappings, and its effective use relates to vocabulary development in monolingual children. However, bilingual children also have to accept two-to-one word-referent mappings (lexical overlap, LO), and there is a bilingual advantage for LO when words are spoken in a single language. We investigated whether monolingual and bilingual preschool age children would apply ME or accept LO differently in a one-language and a two-language context. Twenty monolingual and 20 bilingual 4-year-old children were taught names of novel objects under ME or LO conditions, then tested immediately and after a 10-minute delay. Both language groups performed similarly for ME, both groups were more likely to accept LO in the two-language than one-language condition, and all children's performance was related to their vocabulary development. Monolingual and bilingual children can adapt their word learning strategies to cope with the demands of different linguistic contexts.

1. Introduction

Word learning is an immensely complex task. One difficulty is due to the presence of infinitely many possible referents in the environment for a word (Quine, 1960). To address this difficulty, several researchers (e.g., Markman, 1994; Markman & Hutchinson, 1984; Markman & Wachtel, 1988; Mervis & Bertrand, 1994; Waxman, 1989) have argued that young children possess operating principles to guide their word learning by constraining the number of potential referents for a word (Golinkoff, Mervis, & Hirsh-Pasek, 1994; Markman, 1990). One of the proposed constraints that children use to map words to their referents is mutual exclusivity (ME), a strategy that assigns a new word label to an unfamiliar rather than a familiar object, assuming that every object can only have one label (Kalashnikova, Mattock, & Monaghan, 2014; Markman & Wachtel, 1988). ME has been discovered in even very young children: studies with 10-month-olds (Mather & Plunkett, 2012) and 17-month-olds (Halberda, 2003) using looking time paradigms, and 17.5-month-olds (Mervis & Bertrand, 1994) and 2 years and older (Clark, 1990; Littschwager & Markman, 1994; Markman, Wasow & Hansen, 2003) using behavioural selection tasks.

These studies have focused on ME in monolingual children, but how bilingual children utilise ME is less clear. Unlike monolingual children, bilingual children have to accept lexical overlap (LO), where two labels can refer to the same object, in order to learn words in two different languages, thus are likely to be less dependent on ME strategies. Byers-Heinlein and Werker (2009) compared the use of ME in monolingual and bilingual 17- and 18-month-olds in a looking time study and found that bilingual children relied less on ME than monolinguals.

Extending this approach, Byers-Heinlein, Chen, and Xu (2014) investigated whether monolingual and bilingual children use ME to a different extent when provided with information about language context. In their study, an English speaker taught 2-year-olds a novel name for an unfamiliar object, then asked them to select from the just-named object and an unnamed unfamiliar object the referent of a new novel word. Later, a Chinese speaker asked the children to choose from two objects – the object that the children were ostensively taught the name of and an unfamiliar object different from that manipulated by the English speaker during test – the referent of a Chinese novel word. Note that the Chinese speaker only interacted with the children in Chinese, and Chinese was a language that was novel to both the monolingual and bilingual groups. It was found that both groups of children used ME in the English condition, whereas only the monolingual children systematically used ME in the Chinese condition. These results suggest that monolingual children assume that words are conventionally shared across speakers of all languages, while bilingual children are aware that speakers of one language are ignorant of words in another language.

Henderson and Scott (2015) tested 13-month-old bilingual children, who were introduced to two speakers, either both English or one English and the other French. Then they saw two unfamiliar objects and one of the speakers. The speaker uttered a novel word and picked up one of the objects. The infants then saw the other speaker utter another novel word and pick up either the same object that the first speaker manipulated or the object that had not been manipulated. It was found that the infants looked longer at the scene when the second speaker labelled the object consistently with the first speaker in the English-French condition, suggesting that they were surprised by the event. The results were compared with those of a similar study (Scott & Henderson, 2013) involving monolingual infants only, and it was found that the monolingual infants did not show increased looking towards the scene in the same situation. The studies by Byers-Heinlein et al. (2014) and Henderson and Scott (2015) have shown that monolingual and bilingual children use ME differently, in that monolinguals' use of ME is less flexible. Yet, they did not explicitly test whether the two groups of children accept LO.

Kalashnikova, Mattock, and Monaghan (2015) examined the effect of monolingual or bilingual language experience on how flexible ME could be used for word learning, testing not only referent selection from applying ME, but also children's ability to correctly identify referents from accepting LO. Two puppets either both used the same label, or each used a different label, for an unfamiliar object. Children were then given four labels sequentially and asked to select from four objects: two familiar objects, one unlabelled unfamiliar and the labelled unfamiliar object. In the exclusivity condition, the four labels corresponded to the four objects that the children could choose from; whereas in the overlap condition, two of the labels referred to the same object – the labelled unfamiliar object, and the remaining two labels each referred to a familiar object. All children were able to apply ME and accept LO, but bilingual experience increased the 3- to 5-year-olds' ability to accept LO. It was also found that linguistic experience shaped the children's use of ME, such that the monolingual children relied on ME on word learning more and accepted fewer LOs than their bilingual counterparts with increasing age from 3-4 years to 4-5 years. However, Kalashnikova et al. (2015) presented children with two puppets that spoke the same language, and the pragmatic information that differed between the interactions with the two puppets was only derived from (puppet) speaker identity. In natural language exchanges, however, it is unlikely for children to encounter two speakers of the same language labelling an object in two different ways, given they both tend to name the object with its basic category label (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). Hence, the design of Kalashnikova et al.'s study might not have truly reflected the abilities of the children to use ME and accept LO.

In an experiment based on the paradigm of Byers-Heinlein et al. (2014), Kalashnikova et al. (2016a) tested whether 4- to 5-year-old monolingual children could both apply ME and accept LO when two speakers labelled the same object with a different novel label. The children were then asked by both speakers to select from two objects, the one that was named with two different labels and an unnamed unfamiliar object, the referent of the words that the speakers have used. Critically, each speaker consistently used the same label during naming and test. The study also included an ME condition where the same children were introduced to a novel word for an unfamiliar object by a speaker and were asked to choose from the just-named object and an unnamed unfamiliar object the referent of another novel word. It was found that these monolingual children performed significantly better than chance level in both conditions, signifying their ability to use ME and accept LO for referent selection. The results were consistent with studies showing that children at around 3 to 4 years are able to accept two labels from the same language for one object, given the two labels are from different levels, for instance *rose* and *flower* can both refer to a rose (Au & Glusman, 1990; Waxman & Hatch, 1992).

However, these studies have not yet directly compared monolingual and bilingual children's ability to use speaker identity information to learn words from both ME and LO conditions. The first aim of our study was thus to assess young children's ability to learn words using ME and accepting LO, when information about speaker identity was available to children. One possibility is that bilingual children – due to their exposure to multiple speakers labelling the same referents differently – might be better at word learning from both ME and LO, when speaker identity is provided. Alternatively, monolingual children might be supported by pragmatic information about speaker identity, enabling them to accept LO for word learning to a similar degree as bilingual children. Classic inferential statistics do not enable us to gather evidence for similar behaviour between groups, however, Bayes Factor analyses do provide a means by which similar performance, as well as distinct performance, can be ascertained from data. Our analyses include both inferential statistical model building approaches, as well as Bayes Factor analyses of differences between the monolingual and the bilingual groups.

For studies examining ME, there has been substantial variability in evidence across studies in terms of eliciting reliable ME responses in young children, particularly up to the age of 18 months (Bion, Borovsky, & Fernald, 2013; Halberda, 2003; Mather & Plunkett, 2010). One possible explanation for these inconsistent results is that the use of ME is related to vocabulary size (Graham, Poulin-Dubois, & Baker, 1998; Mervis & Bertrand, 1994), as the use of ME requires children to have some vocabulary – knowing the name of the known object – and their experience with words may also lead them to be more proficient in using ME. Bion, Borovsky, and Fernald (2013) found that 24- and 30-month-olds' ME performance was positively correlated with their vocabulary knowledge, and Kalashnikova et al. (2016b) found that 17- to 19-month-olds' vocabulary knowledge significantly predicted their use of ME in a looking time task. Taken together, these results imply that children's ability to utilise ME is mediated by their vocabulary knowledge, but children from 2 years onwards are likely to systematically use ME when learning the meaning of new words. However, vocabulary knowledge may also relate to LO, with greater skill at linking words to referents supporting application not only of ME but also of multiple labels to the same referent. The second aim or our study was to relate vocabulary knowledge to acceptance of LO.

Previous studies of ME and LO tend to focus on referent selection tasks – where very soon after being exposed to labelling of an object, children are tested on their ability to distinguish between a set of objects from a similar or novel label. However, referent selection ability is not the same as word learning, and the latter can be measured by testing children's word learning after a delay. Using this method, Horst and Samuelson (2008) found that 24-month-old monolingual children show poor retention of words learned through the application of ME. Relatedly, Vlach and DeBrock (2019) showed that word retention is also poor from slow, associative cross-situational learning, and unreliable until children reach the age of approximately 46 months. Both studies tested children's learning of one-to-one word-object mappings. However, learning two-to-one word-object mappings (i.e., through accepting LO) presents a different and perhaps more complicated problem. Fitneva and Christiansen (2011) found that learners acquire word-object mappings better when their initial learning is difficult, and so it is possible that learning words from accepting LO may be more resilient to a delay than learning from applying ME. The third aim of our study was thus to test retention of learning from accepting LO.

In the current study, 3- to 4-year-old monolinguals and bilinguals were tested in an adaptation of Kalashnikova et al.'s (2016a) study. This age range was selected based on Kalashnikova et al.'s (2015) finding that 3- to 4-year-olds did not differ significantly in their use of ME and acceptance of LO. The present study aimed to investigate whether the additional cue of linguistic background of speakers would differentially affect the use of ME and acceptance of LO in monolingual and bilingual children of this age, when socio-pragmatic information about the linguistic backgrounds of the two speakers were provided. In one condition, both speakers spoke English, whereas in the other condition, the two speakers spoke English and Hungarian respectively. Additionally, children's vocabulary knowledge was tested to relate to their use of ME and acceptance of LO, and performance was measured not only in terms of referent selection ability, but also word learning after a delay following ME and LO training conditions.

2. Method

2.1 Participants

Twenty monolingual (M_{age} = 4.10 years, SD_{age} = 0.43, 12 females) and 20 bilingual children (M_{age} = 3.92 years, SD_{age} = 0.50, 12 females) took part in the present study. All monolingual children and four bilingual children were recruited from and tested at pre-schools and nurseries in the local area of Lancaster, UK. Due to recruitment difficulties, the remainder of the bilingual sample (n = 17) was recruited through and tested at Lancaster University Babylab. All children in the monolingual group only spoke English, and none had experience of Hungarian. The bilingual group consisted of children who spoke English and an additional language: Arabic (n = 1), Dutch (n = 1), French (n = 2), German (n = 5), Italian (n = 1), Malagasy (n = 1), Polish (n = 1), Russian (n = 1), Slovak (n = 1), and Spanish (n = 6). Three additional monolingual and three additional bilingual children were tested but excluded due to testing being done in a noisy classroom resulting in inability to follow the experiment instructions (n = 3), very low English proficiency raw scores that were not convertible to age-standardised scores (n = 2), or experimenter error (n = 1).

All children took part in two experimental conditions: English-English, where they saw video clips of two English speakers speaking and naming unfamiliar objects, and English-Hungarian, where one speaker in the video clips spoke English whilst the other spoke Hungarian. The two conditions were administered a week apart. Each condition contained two testing blocks: exclusivity and overlap, each of which consisted of four immediate test trials and eight delayed test trials.

2.2 Materials and Apparatus

2.2.1 Experimental stimuli. Eight images of familiar objects were selected from the TarrLab Object Databank (1996) for use in the familiarisation trials (see Appendix for a list of the stimuli used). The images of familiar objects were placed in four two-object sequences for familiarisation.

Thirty-two images of unfamiliar objects and novel words were selected from the Novel Object and Unusual Name (NOUN) Database (Horst & Hout, 2016) for the test trials. All selected novel words were phonotactically legal in both English and Hungarian, and pronunciations were aligned across English and Hungarian, such that the Hungarian version was matched to the phonology of the English version of the nonword. For the English-English condition, a male and a female English speaker were recorded. For the English-Hungarian condition, a male English speaker (different than the speaker in the English-English condition) and a female Hungarian speaker were recorded.

The images of the unfamiliar objects were ordered into 16 pairs, appearing on the screen with a video recording of one or two people. Four pairs were assigned to each testing block in each condition.

For the immediate test trials, two objects were shown on the screen, comprising the previously-named object and an unnamed unfamiliar object.

For the delayed test trials, four objects were shown on the screen. The four objects in a delayed test trial were all either objects of which the children were presented the label ostensively in the immediate test trials, or objects for which the children had been given the chance to learn the names through ME (during the immediate test trials).

All stimuli were presented on a Surface Pro 4 touchscreen using PsyScript 3 (Slavin, 2014), and children's responses were collected via touches on the screen. See Figure 1 for the experiment flow and screenshots of example trials in each testing block and phase.

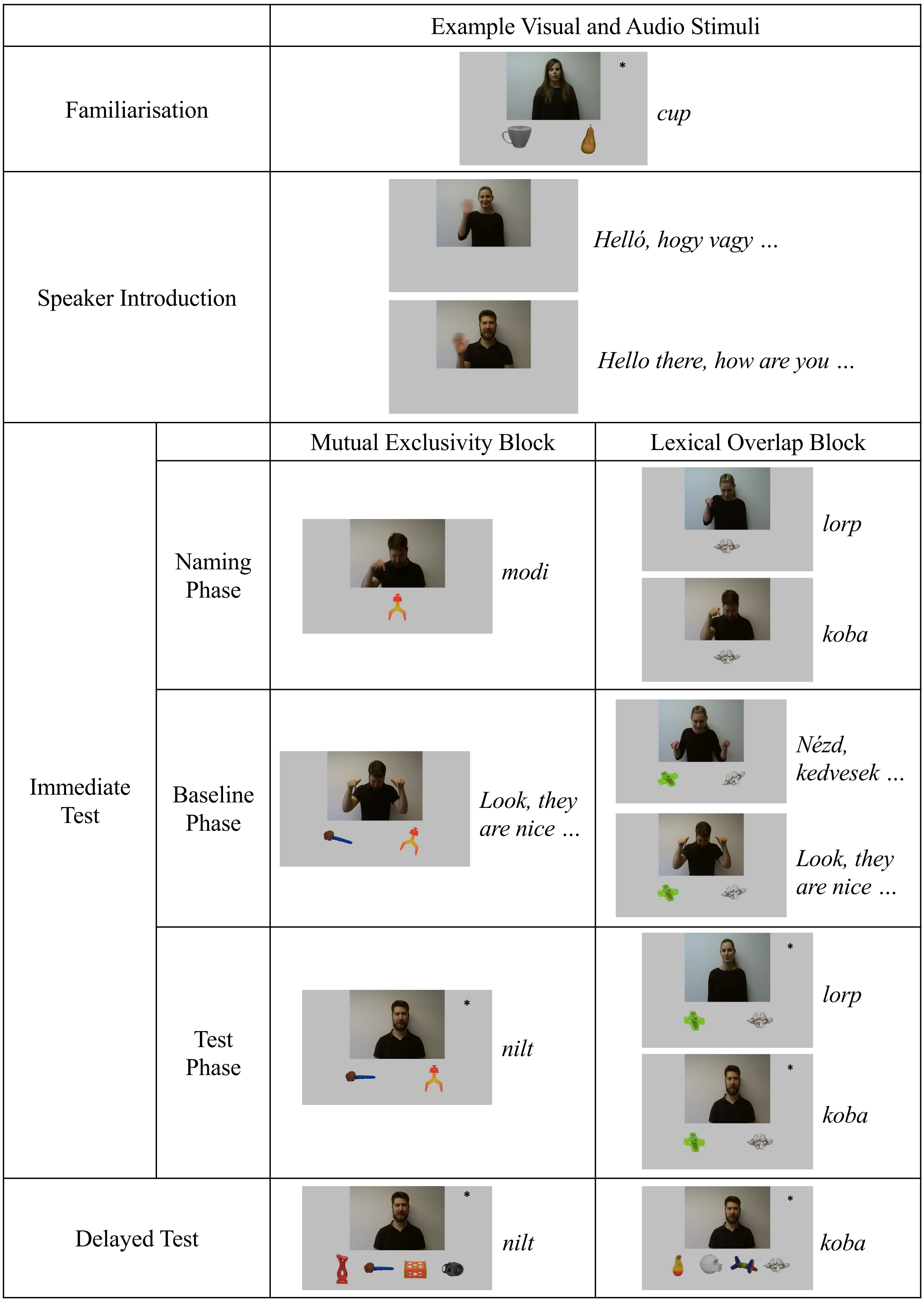

Figure 1. Example visual and audio stimuli for familiarisation, speaker introduction, and both the ME and LO blocks of the immediate and delayed tests.

2.2.2 Language proficiency. The British Picture Vocabulary Scale – Third Edition (BPVS III; Dunn, Dunn, Styles, & Sewell, 2009) was administered to all children immediately after the second experimental condition. The monolingual (M = 104.45, SD = 13.00) and bilingual groups (M = 98.85, SD = 8.98) did not differ significantly on their age standardised scores, $t(38) = 1.59$, $p = .121$, $d = 0.50$. Parents of all but one bilingual child (exposure to English since 2;2 years) reported that their child had been exposed to English since birth.

2.3 Procedure

For the children tested at preschools and nurseries, information sheets and consent forms were handed to parents by contacted preschools and nurseries. Visits to preschools and nurseries were arranged after obtaining parental consent. For the children tested at Lancaster University Babylab, parental consent was sought prior to the experiment on the first day of testing. The experiment took place on two separate days (one week apart), with one condition running on each day. The order of conditions was counterbalanced across participants. On the day of testing, the children were tested individually in a quiet area, under the supervision of a member of staff of the pre-school or nursery (a parent in the case of testing at the Babylab). The children were either sat at a table or on the floor.

The experimenter greeted the child by introducing his name and explaining what the child was expected to do, in terms of finding things for the people in the video. Then, the children completed the familiarisation trials. In each trial, pictures of two familiar objects were shown on the screen alongside a video clip featuring a female English speaker uttering a familiar word (e.g., *cup*). After hearing the label, the children were asked by the experimenter: “Which one is it?” and were encouraged to make their response by tapping an object on the screen. The target word was repeated if the touchscreen did not receive a response after 3.5 s. In the event of the touchscreen failing to register the children's touch, the experimenter provided assistance.

The study only proceeded if a child had provided correct answers to all four familiarisation trials (five children failed to provide the correct answer on one trial at the first instance, one failed on two trials at the first instance, but they all provided the correct answer on their second attempts). At this point, the experimenter repeated the instructions to the child. Children then took part in the English-English or the English-Hungarian condition and were then tested one week later on the other condition. The order of the language conditions was counterbalanced.

2.3.1 English-English condition. Children were first shown a short introductory video clip of a male and a female English speaker, featured one at a time, saying: "Hello there, how are you? We are going to play a game. Would you like to play a game with me?" This provided socio-pragmatic information about the speakers' linguistic backgrounds. The order of appearance of the speakers was counterbalanced across participants. There were then two testing blocks: ME and LO, with a short pause between the blocks. The order of testing blocks was counterbalanced across participants.

2.3.1.1 ME Block. All children completed two sets of test trials: four immediate test trials consisting of three phases (naming, baseline, and test, in order of presentation), and eight delayed test trials. In the immediate test trial set, each test trial featured only one speaker. The presentation of test trials featuring the two speakers was alternated, and the speaker featured in the first test trial was counterbalanced across participants.

2.3.1.1.1 Immediate test trials. In the naming phase, the speaker in the test trial labelled an unfamiliar object three times, each preceded by a short meaningless utterance (“oh”, “hmm”, or “ah”), while pointing at it and alternating gaze between the object and the children. In the baseline phase, two objects, the just-named object and an unnamed unfamiliar object, appeared on the screen and jittered to maintain the children’s attention. At the same time, the speaker said: “Look! They are nice! Wow! They are pretty!”, while pointing at both objects and alternating gaze between the objects and the children. This was to provide the children with an opportunity to view both objects that were going to be in the test phase to control for possible familiarity/novelty biases. The positions of the just-named and unnamed unfamiliar objects were randomised across test trials, but were the same in the baseline and test phases of a test trial. In the test phase, the speaker in the video looked at the children and uttered a novel label that was different from that in the naming phase. Then, the children were asked by the experimenter: “Which one is it?” The children were reminded to tap the screen if they only pointed to the object but did not touch the screen. Across the experiment, the children did not hear the label in the test phase more than two times. After all four trials, the children were told that they would be coming back to play some more of the game after 10 minutes.

2.3.1.1.2 Delayed test trials. On returning to the designated testing area, children were reminded of the instructions. They then saw four objects, the names of which either all occurred during ostensive teaching or all in the ME immediate test trials (i.e., they were either the targets in the naming or test phases of the ME immediate test trials). The objects appeared alongside a video clip of one of the two speakers uttering the name of one of the objects. The positions of the objects were randomised and were different across test trials. The speakers only uttered the labels that they used in the immediate test trials, in either a naming phase or a test phase.

2.3.1.2 LO Block. The procedure was identical to that of the ME block, with each child completing four immediate test trials and eight delayed test trials, with the exception that all video clips featured both speakers.

2.3.1.2.1 Immediate test trials. All phases were identical to those in the ME block with the following exceptions: (1) the video clips in all phases featured two speakers, one after another; (2) in the naming phase, the two speakers named the same object with different names; and (3) in the test phase, each of the speakers spoke the same name that they used during the naming phase, rather than a different novel word, which was the case in the ME block. The order of appearance of the speakers was counterbalanced across trials and remained the same for all the phases of the same trial. The first speaker of the naming phase was counterbalanced across participants.

2.3.1.2.2 Delayed test trials. The procedure was identical to that in the ME block with the exception that all four objects presented in any given trial were learned through exposure during the naming phase, as the children never had the opportunity to learn the names of the four unnamed objects that appeared in the immediate test trials.

2.3.2 English-Hungarian condition. The procedure was the same as that in the English-English condition, with the exception that whenever a video clip featured the Hungarian speaking the sentences were spoken in Hungarian using an equivalent translation to the English version.

3. Results

3.1 Accuracy Analyses

Children's responses to test trials were scored as correct if they pressed the picture that was intended to be the answer or incorrect if they pressed any other pictures.

In order to compare children's performance between the immediate and delayed tests (which differed in terms of the number of options available for selection), a likelihood score was computed for each child for their performance in each block of each condition in the immediate and delayed tests. Each score was an indication of the likelihood of a child's performance in a given block in a given condition not being due to chance (likelihood score): Score = $1 - nCx\ p^x(1-p)^{n-x}$, where n represents the number of trials, x the number of trials with a correct answer, and p the probability of success on each trial. See Table 1 and Figure 2 for means and standard deviations of the scores.

Table 1

Means (and standard deviations) of likelihood scores in the immediate and delayed tests by language group, condition, and block

	English-Hungarian		English-English	
	Monolingual	Bilingual	Monolingual	Bilingual
Immediate				
ME	.71 (.35)	.65 (.30)	.74 (.28)	.68 (.30)
LO	.62 (.21)	.61 (.29)	.64 (.16)	.64 (.16)
Delayed				
ME	.61 (.33)	.71 (.23)	.64 (.30)	.70 (.31)
LO	.78 (.20)	.56 (.32)	.69 (.30)	.69 (.70)

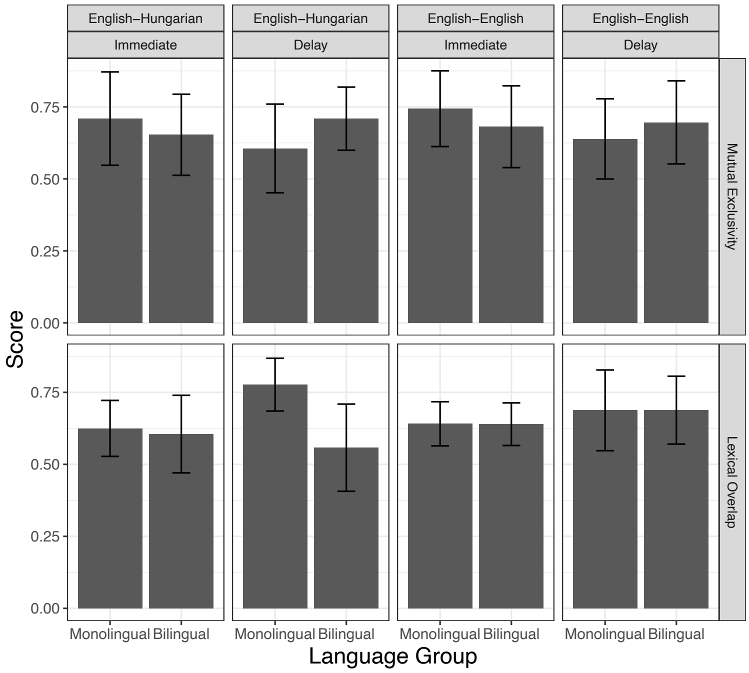

Figure 2. Children's likelihood scores in the immediate and delayed tests by language group, condition, and block. Error bars represent standard errors.

Linear mixed-effects (LME) modelling (Baayen, 2008) was used to determine the learning of both monolingual and bilingual children, whether this differed by language context (one or two languages), and whether there were differences in flexibility in applying ME and LO for these groups. We also compared performance on immediate and delayed testing to see if that differently reflected learning. We also tested the effect of children's BPVS III scores in order to determine if learning words from ME or LO varied according to language proficiency. The effect of age was also tested to see if language proficiency or chronological development related more closely to the observed learning.

The use of LME allows the investigation of both systematic and random individual differences (Jiang, 2007). There were a total of 320 observations. All likelihood scores were arcsine-root transformed prior to analysis to allow the bounded scores to be analysed using linear models, which assume dependent variables to be unbounded.

Intercorrelations between all predictor variables and the outcome variable (score) were examined and are shown in Table 2, note that many of the correlations are 0 due to the careful design of the study. Collinearity diagnostic indicated no possible risk of collinearity (condition number = 18, all $|r|$s $\leq .25$).

Table 2

Intercorrelations between all predictor and outcome variables for immediate and delayed tests

	1.	2.	3.	4.	5.	6.
1. Score	-					
2. Delay (immediate vs. delayed)	.02	-				
3. Language group (mono. vs. bi.)	-.05	.00	-			
4. Age	.05	.00	-.19***	-		
5. BPVS III score	-.08	.00	-.25***	.20***	-	
6. Condition (Eng-Hung vs. Eng-Eng)	.04	.00	.00	.00	.00	-
7. Block (ME vs. LO)	-.05	.00	.00	.00	.00	.00

* $p < .05$; ** $p < .01$.; *** $p < .001$.

A series of LME models were fitted using the lmer function in the lme4 package in R, in order to determine the effect of block (LO or ME), language condition, one- versus two-speakers, immediate and delayed testing, and the role of vocabulary on performance. In all models, all predictors were entered simultaneously. First, assuming the same random effects of participants on intercepts, the following models differing in fixed effects, fitted using the *REML = FALSE* setting in lmer, were compared:

1. A model with just the intercept.
2. The final model obtained through the following backwards elimination steps: (a) A model with all participant and item attributes and additional predictor (extraneous) variables, including setting and gender of child, order of block (ME first vs. LO first), day of testing (day 1 vs. day 2), and which speaker appeared first in the introductory video clip. The drop1 function (test = “Chisq”) was used to remove variables until the removal of all variables yielded a significant result from the likelihood ratio test. This was to ensure that the extraneous variables did not influence children’s performance, and if any of these extraneous variables did influence children’s performance, they were identified and included as a predictor in subsequent models. The final model was an empty model without any fixed effects.
3. The final model obtained through the following backwards elimination steps: (a) The most complex model with all six predictor variables and all interactions among them was first fitted to the data. (b) Then, the drop1 function (test = “Chisq”) was used to determine whether dropping the highest order fixed effect would fit the data better. (c) The highest order fixed effect with the highest likelihood ratio test p-value once dropped was then removed from the model, and a model with the identified fixed effect removed was then fitted to the data. (d) Steps (b) to (c) were then repeated until all likelihood ratio test p-values between a more complex model and

all simpler models with one of the highest order fixed effects removed from the complex model was smaller than .05 to obtain the final model.

The final model was the model with the following fixed effects: block, delay, BPVS III score; the two-way interactions of (a) delay and block, (b) BPVS III score and delay, and (c) BPVS III score and block; and the three-way interaction of BPVS III score, delay and block. Comparing a model with versus without the fixed effects was significant, $\chi^2(7) = 16.28$, $p = .022$.

To determine the random effects structure, the final model was then compared to the most preferred model (based on likelihood ratio tests) that included random effects of participants on the slopes of the fixed effects of delay, block, and/or the interaction of delay and block using the *REML = TRUE* setting in lmer. It was found that the inclusion of random effects of participants on the slopes of all the named fixed effects was not justified, $\chi^2(3) = 0.33$, $p = .953$, and so these slopes were not included. The final model is reported in Table 3.

Table 3

Summary of final model

Fixed Effects	Estimated Coefficient	SE	Wald Confidence Intervals 2.50%	97.50%	*t*	*p*r(>|*t*|)
(Intercept)	1.0555	0.0352	0.9864	1.1245	29.956	< .0001
Block (ME vs. LO)	-0.1326	0.0498	-0.2303	-0.0350	-2.662	.0082**
Delay (immediate vs.	-0.0694	0.0498	-0.1671	0.0282	-1.394	.1644

delay)						
BPVS III score	-0.0011	0.0031	-0.0073	0.0050	-0.364	.7162
Delay × Block	0.1449	0.0705	0.0068	0.2830	2.057	.0405*
BPVS III score × Delay	-0.0072	0.0044	-0.0159	0.0015	-1.632	.1037
BPVS III score × Block	-0.0021	0.0044	-0.0108	0.0065	-0.483	.6298
BPVS III score × Delay × Block	0.0139	0.0063	0.0016	0.0262	2.221	.0271*
Random effects	Name	Variance	*SD*			
Subject	(Intercept)	0	0			
	AIC	BIC	logLik	Deviance		
	189.1	226.8	-84.5	169.1		

Note. R syntax of the model is as follows: glmer (Accuracy ~ (Block + BPVS + Delay) ^ 3 + (1 | Subject), family = binomial)

The significant main effect of block showed that the children's performance in the LO block was 1.14 times poorer than their performance in the ME block, so performance over immediate and delayed testing was better for the ME than the LO learning conditions. However, the significant interaction of delay and block showed that the children's performance in the ME block had a tendency to worsen after the delay, whereas their performance in the LO block had a tendency to improve after the delay (see Figure 3). So, immediate performance versus retention of learning varied according to the initial manner in which the word is learned – a difference observed between ME and LO in an immediate referent selection task resolves to similar performance after a delay.

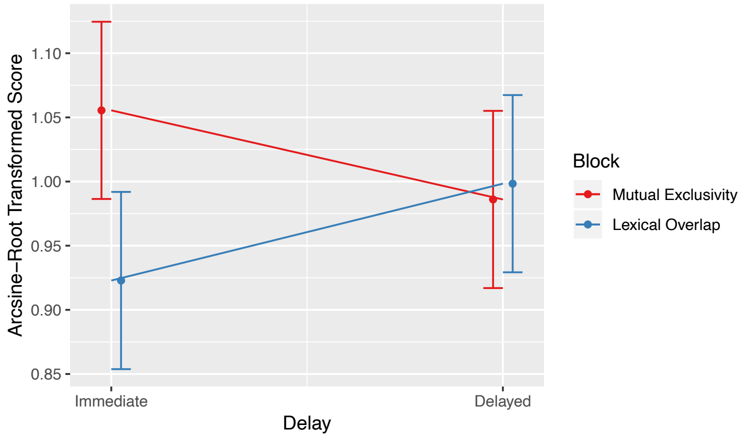

Figure 3. The interaction of delay and block on children's scores. Error bars represent standard errors.

The three-way interaction of BPVS III score, delay and block was also significant: In the ME block, the children's performance on both the immediate and delayed tests had a tendency to worsen with increasing English proficiency level, with their performance on the delayed test being affected more by their English proficiency. In contrast, in the LO block, whilst the children's performance on the immediate test had a tendency to worsen with increasing English proficiency level, their performance on the delayed test had a tendency to become better with increasing English proficiency (see Figure 4). Thus, the relation between language proficiency and word learning from ME or LO conditions varies according to whether testing is immediate – a referent selection task – or after a delay, which reflects word learning performance.

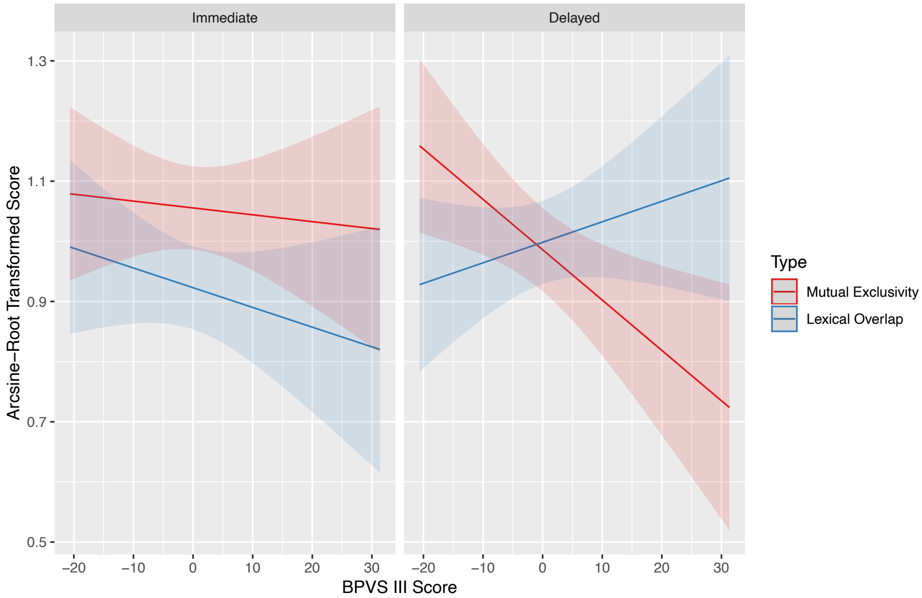

Figure 4. The interaction of BPVS III score, delay, and block on children's scores. Shaded areas represent standard errors.

3.2 Acceptance of LO Analysis

The above LME modelling based on transformed response accuracies provided information on whether the children were more accurate on ME or LO trials, however, it did not perfectly measure the children's acceptance of LO – accepting two labels for one object. To illustrate, if a child scored four out of eight in an LO block of the immediate test, it could be that they had chosen the target on one of each pair trial (i.e., always selecting different objects in the two test trials in the same test phase), or they had chosen the target in both trials in two test phases but the other object in the remaining trials (i.e., always selecting the same object in the two test trials in the same test phase). To address this, the children's responses in the LO blocks of the immediate test were coded as whether they picked the same object twice in the two test trials in the same test phase – when they were requested with different labels – which signifies acceptance of LO. All scores were then arcsine-root transformed for analysis.

Table 4 shows LO acceptance for each language group (monolingual vs. bilingual) and condition (chance level is 0.50).

Table 4

Means (and standard deviations) of untransformed tendency of accepting LO in the immediate LO test trials by language group and condition

	English-Hungarian	English-English
Monolingual	.14 (.20)	.11 (.21)
Bilingual	.23 (.23)	.21 (.28)

To examine the children's tendency of accepting LO, generalised linear mixed-effects (GLM) models were fitted to the LO scores. The data for GLM modelling consisted of the participants' acceptance of LO on each trial pair – whether different labels were linked to the same or to different objects – giving a total of 320 observations. Two observations were excluded due to the children being distracted during the trial, and two other observations were excluded due to the children not providing any responses, resulting in 316 observations for analysis.

The same variables were included in the mixed effects model as for the analysis of accuracy (with the additional variable of trial number and its interactions with other variables), and model construction and selection were also conducted in the same way.

It was found that the inclusion of random effects of participants on the slopes of all the fixed effects was not justified, $\chi^2(3) = 0.44$, $p = .93$. As a result, no random slopes were included in the model. A summary of the final model is reported in Table 5.

Table 5

Summary of model of tendency to accept LO

Fixed effects	Estimated coefficient	SE	Wald confidence intervals 2.50%	97.50%	*z*	*pr*(>|*z*|)
(Intercept)	0.2352	0.5868	-0.9148	1.3852	0.401	.6885
Order (ME first vs. LO first)	-1.8060	0.4913	-2.7690	-0.8430	-3.676	.0002***
Condition (Eng-Hung vs. Eng-Eng)	-1.8307	0.8118	-3.4217	-0.2396	-2.255	.0241*
Trial number	-0.4605	0.2095	-0.8711	-0.0498	-2.198	.0280*
Trial number × Condition	0.5954	0.3015	0.0045	1.1863	1.975	.0483*
Random effects	Name	Variance	*SD*			
Subject	(Intercept)	0.9166	0.9574			
	AIC	BIC	logLik	Deviance		
	271.0	293.6	-129.5	259.0		

Note. R syntax of the model is as follows: glmer (Tendency ~ (Condition + Trial) ^ 2 + Order + (1 | Subject), family = binomial)

The following fixed effects significantly predicted whether a child accepted LO: order of block, the children who took part in the ME trials first were more likely, by odds of 16%, to accept LO in the LO trials; condition, with the children being more likely to accept LO in the English-Hungarian than the English-English condition; trial number, indicating that the children were decreasingly likely to accept LO as the study proceeded; and the interaction of trial number and condition, showing that the children became less likely to accept LO across trials in the English-Hungarian condition, while becoming marginally more likely to accept LO across trials in the English-English condition (see Figure 5).

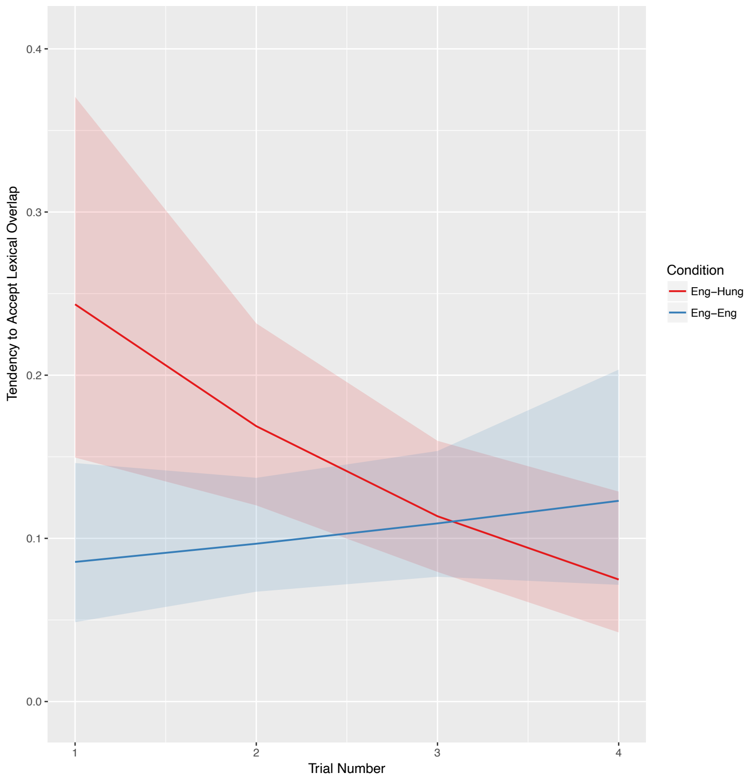

Figure 5. The interaction of trial number and condition on children's tendency to accept LO in the LO blocks. Shaded areas represent standard errors.

3.3 Bayes Analyses on the Effects of Language Group

The results of the mixed-effects analyses showed that monolingual and bilingual children did not perform significantly differently in the immediate and delayed tests in all blocks in all conditions. However, in order to determine whether there was positive evidence that language group did *not* have any influence on the children's performance, Bayes Factors were computed for all blocks in all conditions of both the immediate and delayed tests. Bayes Factor is an indicator of whether the data support the research hypothesis, the null hypothesis, or neither. A value of 3 or higher indicates noticeable support for the research hypothesis, and a value of 1/3 or less indicates noticeable support for the null hypothesis (Dienes, 2014; Jeffreys, 1936/1961). Intermediate values between 3 and 1/3 indicate no substantial evidence for a difference or for no difference. For the present study, Bayes Factors were computed based on arcsine-root transformed response accuracies. Bayes Factors relating to the immediate test were computed with bounds of the difference being [0, 0.785], as the differences could range from no different from chance based on the null hypothesis (i.e., 0) to the maximum difference based on the research hypothesis: the difference between performance at chance level (.50; 0.785 when arcsine-root transformed) and 100% accuracy (1.00; 1.571 when arcsine-root transformed). By contrast, Bayes Factors relating to the delayed test were computed with bounds of the difference being [0, 1.047], due to the chance level of the delayed test being .25 (0.524 when arcsine-root transformed). Additional Bayes Factors based on arcsine-root transformed tendencies of accepting LO were computed for the LO blocks of the immediate test. The bounds of the difference for these Bayes Factors were [0, 1.571], as the differences could range from not accepting LO at all (i.e., 0) to accepting LO for all pair trials (i.e., 1.00; 1.571 when arcsine-root transformed). When computing the Bayes Factors, a uniform distribution was used, as the maximum plausible difference in all cases is known. No priors were drawn from previous studies as the manipulations of the present study differed substantially with those of previous studies (e.g., different number of distractors in a trial and inclusion of a two-language context). All computed Bayes Factors are shown in Table 6.

Table 6

Bayes Factors comparing response accuracies of monolingual and bilingual children in all blocks in all conditions of the immediate and delayed tests

					Likelihood		
Test	Condition	Block	*M* difference	Difference *SE*	(data | difference)	(data | no difference)	Bayes Factor
Immediate	Eng-Hung	ME	.065	.135	0.871	2.632	0.33*
		LO	.009	.060	0.710	6.575	0.11*
	Eng-Eng	ME	.052	.130	0.833	2.833	0.29*
		LO	.004	.026	0.710	15.163	0.05*
Delayed	Eng-Hung	ME	.073	.073	1.070	3.315	0.32*
		LO	.194	.069	1.270	0.111	11.43**
	Eng-Eng	ME	.037	.078	0.867	4.570	0.19*
		LO	.028	.064	0.850	5.665	0.15*

* notable evidence for no difference between language groups; ** notable evidence for difference between language groups.

The Bayes Factors based on response accuracies demonstrate that the children's performance in all blocks in all conditions, except for the LO block in the English-Hungarian condition, provided evidence for the null hypothesis (i.e., evidence for no difference between the two language groups). In contrast, the monolingual and bilingual children performed differently on items in the LO block in the English-Hungarian condition in the delayed test. Interestingly, by examining the mean response accuracies of the LO block in the English-Hungarian condition of the delayed test, it was found that the monolingual children were better than the bilingual children at remembering word-object pairs that violate ME in a two-language context.

4. Discussion

There were three key aims of the current study. First, we explored how monolingual and bilingual children learned from both ME and LO conditions, when words were spoken either by speakers of the same language or of different languages. Previous studies of LO, where an object is named with two names or a familiar object is named with a novel name, have tended to show a bilingual advantage – bilingual children are more likely to accept LO than monolingual children (Byers-Heinlein & Werker, 2009; Kalashnikova et al., 2015). However, in the only study that has directly tested children's acceptance of LO, speakers of the names for objects spoke the same language (Kalashnikova et al., 2015). We considered what would happen if the speakers of two labels for the same object are evidently speakers of different languages – could this reduce the bilingual advantage, converting monolinguals to also accept LO? The results of our study suggest that this is the case. There was no significant effect of monolingual versus bilingual language background on learning from ME or from LO, and furthermore the Bayes Factor values indicate that there is evidence for similar performance between these language groups. Thus, monolingual and bilingual children are both able to accept LO during word learning.

Indeed, if anything there was evidence of an advantage for the monolingual speakers in the two-language condition of the study: after a delay, monolingual children were more likely than bilingual children to have retained two labels for an object named in two languages. Thus, children aged around 4 years old are able to learn words when they are given one or two labels. Intuitively, the results could be anticipated to be in the opposite direction, as bilingual children should be more familiar with the idea that different languages can have different words for an object. However, it was possible that the monolingual children were particularly attentive to the socio-pragmatic cue in the LO block of the English-Hungarian condition, as this was a situation which they were not used to (i.e., having to learn different names from different languages for an object). Alternatively, it was possible that, similar to Fitneva and Christiansen's (2011) finding that retention might not be optimal when the learning task is simple, the complexity of accepting LO and the presence of a novel language as socio-pragmatic information posed challenges to the monolingual children, which in turn boosted their retention performance.

The second aim of our study was to investigate whether children could retain words as well as being able to select referents after being exposed to word-object mappings. Previous studies of ME and LO have tended to investigate only immediate referent selection, yet the ability to retain mappings has been shown to be much more vulnerable in word learning studies (Horst & Samuelson, 2008). We thus investigated immediate and delayed learning from ME and LO conditions.

The finding that both groups of children were more accurate in the ME than the LO block was not surprising. It has previously been documented that monolingual and bilingual language learners are better at learning word-object mappings that adhere to ME (e.g., Benitez, Yurovsky, & Smith, 2016; Kachergis, Yu, & Smith, 2009; Poepsel & Weiss, 2016). Although much of this evidence came from adult language learners, the results of Kalashnikova et al.'s (2015) study have provided support for this in young children. Kalashnikova et al. analysed cases whereby monolingual and bilingual children failed to learn two-to-one word-object mappings in their study and found that in those situations, the children reasoned the referent of a word by applying ME. This suggests that bilingual children also rely on ME to some extent when learning the meaning of words, which is sensible, as bilingual children, like monolingual children, also need some strategies to help them reduce the number of potential referents for a word when learning the meaning of a new word. Moreover, the results in the LO block of the present study showed that the children were more likely to accept LO in the two-language condition. This finding is in line with that in a study by Samara, Smith, Brown, and Wonnacott (2017), which showed that young children (and adults) are able to benefit from socio-pragmatic cues in learning linguistic structures. Together, these findings imply that monolingual and bilingual children are sensitive to the socio-pragmatic information present in their environment and can adjust their learning strategies – in the context of this study, relax ME and accept LO – to accommodate the demands of different learning contexts.

Though, overall, learning from ME was easier than learning from LO, we found that this was affected by whether the testing was immediate or delayed. For immediate referent selection, the children were better able to identify word-object mappings when initial exposure was under ME conditions than LO. Hence, LO was more difficult a task for all the children in the study. However, the difference between ME and LO disappeared after a delay: now, the children were similar in their learning of words under ME and LO conditions. Thus, the ME constraint – assuming a one-to-one mapping – was most evident as a referent selection advantage and dissipated after a delay in a measure of performance that more closely approximates children's word learning ability (Horst & Samuelson, 2008).

The third aim of our study was to determine if learning from LO is related to vocabulary development in a similar way to ME. Previous studies of application of ME have shown that, even for very young children, it appears to be related to vocabulary development (Bion, Borovsky, & Fernald, 2013; Kalashnikova et al., 2016b). Here, the results were complex. There was a significant three-way interaction of vocabulary knowledge, whether the test was immediate or delayed, and testing block (ME or LO). In the delayed test, the higher a child's language proficiency score, the better they were at remembering the words learned in the LO block, but worse at remembering those learned in the ME block.

This contrasting pattern could be explained in two ways. The higher-level explanation is that, in line with the Emergentist Coalition Model of word learning, older children have a tendency to focus more on socio-pragmatic cues (e.g., eye gaze) when learning the meaning of new words and less on basic constraints, such as ME (Hirsh-Pasek, Golinkoff, & Hennon, 2006; Hollich, Hirsh-Pasek, & Golinkoff, 2000). In the present study, the children's age and language proficiency score were significantly and positively correlated. Therefore, the contrasting pattern relating to language proficiency score and block in the delayed test could be due to the children's use of socio-pragmatic cues, in this case pointing and eye gaze, rather than ME to guide their learning of word-object mappings. A lower-level explanation relates to the design of the present study. For the words in the LO block, the children had the chance to hear each of them at least four times (three times during the naming phase, once or twice during the test phase) during the immediate test, whereas for words in the ME block, the children only had the chance to hear half of them three times during the naming phase and the other half of them once or twice during the test phase. This had provided different number of learning instances and evidence (i.e., co-occurrences of novel words and their referring objects) to guide their word learning through cross-situational statistics or associative information, which could have given rise to the result that words in the LO block being better learned. A study that more carefully control for the number of learning instances for all words would be able to provide stronger evidence for the higher-level explanation.

In contrast, the children's performance in both the ME and LO blocks in the immediate test worsened with increasing language proficiency. A possible explanation for this is that learning did not just take place during fast mapping, but also during the delayed test via cross-situational statistical learning or associative learning, and that this learning was driven by the children's knowledge of or experience with the mapping between words and referents. This suggests that the children who were more proficient in English relied more on cross-situation statistical learning or associative learning, whereas the children who were less proficient in English relied more on ME. Note that these explanations are not inconsistent with the finding that the ME block was easier than the LO block for the children, as the children's performance in the ME block, averaged across the immediate and delayed tests, was still better than their performance in the LO block.

A limitation of the current study was that performance was not highly accurate in any condition. The Bayes Factor analyses indicate that the null effects due to the different conditions were not due to noise or high error rates: there is positive evidence that language background had no effect under nearly all conditions. However, repeating the study with older children, or with live rather than videoed presentations of word learning conditions might increase children's attention further and enhance learning. Kalashnikova et al. (2015) presented their stimuli in a live puppet presentation, whereas in the present study, the presentation of stimuli was through a computer screen. The live presentation in Kalashnikova et al.'s (2015) study might be more effective in attracting and sustaining children's attention and focus on the task. For instance, the children in Kalashnikova et al.'s study were allowed to explore the objects in the task, whereas the children in the present study did not have the opportunity to do the same. In fact, in both the ME (based on likelihood scores) and LO (based on tendency to accept LO) blocks in the present study, the children's performance became more deviated from the expected performance as the experiment progressed, showing a fatigue effect.

In Kalashnikova et al.'s (2016a) study, a similar computerised paradigm was used, and it was found that monolingual children were able to apply ME and accept LO to greater accuracy than the children in the present study. Yet, the children in the present study were younger than those in Kalashnikova et al.'s (2016a) study, who were between 4 and 5 years old. In Kalashnikova et al.'s (2015) study, when the children were divided into a younger and an older group, it was found that the performance of the younger group was significantly worse than that of the older group. Therefore, it was possible that repeating the study with older children might increase further the learning effects from ME and LO.

A further limitation of the present study is that owing to Hungarian being a language that was unknown to all the children, the prompt to invite children to provide a response could not be provided by the speakers in the task. In the present study, the prompt was provided by the experimenter, and the prompt was always in English. This could have an impact on the children's performance when the language in focus was Hungarian, as the prompt in English could have distracted them from concentrating on Hungarian being the language in focus. This could have reduced the sensitivity of the task in detecting whether monolingual and bilingual children would apply ME and accept LO differently in the two-language condition. Future studies could train children to provide a response upon a presentation of a visual cue on the screen, so that language would not be involved in the prompt for response. The similarity in performance of monolingual and bilingual children also contrasts with evidence for differences in LO between children according to their language background in immediate referent selection tasks (Byers-Heinlein & Werker, 2009). In Byers-Heinlein and Werker's (2009) study, it was found that the expected difference between language groups could be observed even in 17- to 18-month-olds. Byers-Heinlein and Werker's (2009) study measured performance using eye-tracking, whereas our study (as well as that of Kalashnikova et al., 2015) relied on behavioural measures. Repeating the study with an implicit rather than explicit behavioural measure may reveal processing differences between groups.

In conclusion, the results of the present study showed that monolingual and bilingual preschoolers are sensitive to the socio-pragmatic cues in their linguistic input and could alter their word learning strategies, for example relax ME, with respect to their linguistic environment when learning the meanings of new words. In addition, there is also evidence that children have a tendency to become more reliant on socio-pragmatic cues when learning the meanings of new words when they grow, providing support for the Emergentist Coalition Model of word learning. Further studies that employ a more sensitive measure, such as eye-tracking, may be able to show a clearer picture of how monolingual and bilingual children use ME and accept LO in different situations. Nonetheless, although cross-situational statistical learning and associative learning was not directly investigated in the present study, there is evidence that the children also used cross-situational statistics or associative information to aid their learning of new words. Future research could look at whether the two language groups use ME and cross-situational statistics or associative information to guide their word learning differently, and whether and how specific features in the linguist input influence the two groups' reliance on ME and cross-situational statistical learning or associative learning.

References

Au, T. K., & Glusman, M. (1990). The principle of mutual exclusivity in word learning: To honor or not to honor?, *Child Development*, *61*, 1474-1490. doi: 10.1111/j.1467-8624.1990.tb02876.x

Baayen, R. H. (2008). *Analyzing linguistic data*. Cambridge, UK: Cambridge University Press.

Benitez, V. L., Yurovsky, D., & Smith, L. B. (2016). Competition between multiple words for a referent in cross-situational word learning. *Journal of Memory and Language*, *90*, 31-48. doi: 10.1016/j.jml.2016.03.004

Bion, R. A. H., Borovsky, A., & Fernald, A. (2013). Fast mapping, slow learning: Disambiguation of novel word – object mappings in relation to vocabulary learning at 18, 24, and 30 months. *Cognition*, *126*, 39-53. doi: 10.1016/j.cognition.2012.08.008

Bloom, P. (2000). *How children learn the meanings of words*. Cambridge, MA: MIT Press.

Byers-Heinlein, K., Chen, K. H., & Xu, F. (2014). Surmounting the Tower of Babel: Monolingual and bilingual 2-year-olds' understanding of the nature of foreign language words. *Journal of Experimental Child Psychology*, *119*, 87-100. doi: 10.1016/j.jecp.2013.09.011

Byers-Heinlein, K., & Werker, J. F. (2009). Monolingual, bilingual, trilingual: Infants' language experience influences the development of a word-learning heuristic. *Developmental Science*, *12*, 815-823. doi: 10.1111/j.1467-7687.2009.00902.x

Clark, E. V. (1990). On the pragmatics of contrast. *Journal of Child Language*, *17*, 417-431. doi: 10.1017/S0305000900013842

Dienes, Z. (2014). Using Bayes to get the most out of non-significant results. *Frontiers in Psychology*, *5*, 781. doi: 10.3389/fpsyg.2014.00781

Dunn, L. M., Dunn, D. M., Styles, B., & Sewell, J. (2009). *British picture vocabulary scale III*. Winsor, UK: NFER-Nelson.

Fenson, L., Dale, P., Reznick, J., Bates, E., Thai, D., Pethick, S., … Stiles, J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development*, *59*, I-185. doi: 10.2307/1166093

Fitneva, S. A., & Christiansen, M. H. (2011). Looking in the wrong direction correlates with more accurate word learning. *Cognitive Science*, *35*, 367–380. doi:10.1111/j.1551-6709.2010.01156.x

Graham, S. A., Poulin-Dubois, D., & Baker, R. K. (1998). Infants' disambiguation of novel object words. *First Language*, *18*, 149-164. doi: 10.1177/014272379801805302

Golinkoff, R. M., Mervis, C. B., & Hirsh-Pasek, K. (1994). Early object labels: The case for a developmental lexical principles framework. *Journal of Child Language*, *21*, 125-155. doi: 10.1017/S0305000900008692

Halberda, J. (2003). The development of a word-learning strategy. *Cognition*, *87*, B23-B34. doi: 10.1016/S0010-0277(02)00186-5

Henderson, A. M. E., & Scott, J. C. (2015). She called that thing a mido, but should you call it a mido too? Linguistic experience influences infants' expectations of conventionality. *Frontiers in Psychology*, *6*, 332. doi: 10.3389/fpsyg.2015.00332

Hollich, G. J., Hirsh-Pasek, K., & Golinkoff, R. M. (2000). Breaking the language barrier: An Emergentist Coalition Model for the origins of word learning.

Monographs of the Society for Research in Child Development, *65* (3, Serial No. 262). Retrieved from http://www.jstor.org/stable/3181533

Horst, J. S., & Hout, M. C. (2016). The Novel Object and Unusual Name (NOUN) Database: A collection of novel images for use in experimental research. *Unpublished manuscript*.

Horst, J. S., & Samuelson, L. K. (2008). Fast mapping but poor retention by 24-month-old infants. *Infancy*, *13*, 128-157. doi: 10.1080/15250000701795598

Jeffreys, H. (1939/1961). *The Theory of Probability*, (1st/3rd ed.). Oxford, UK: Oxford University Press.

Jiang, J. (2007). *Linear and generalized linear mixed models and their applications*. New York, NY: Springer.

Kachergis, G., Yu, C., & Shiffrin, R. M. (2009). Frequency and contextual diversity effects in cross-situational word learning. In N. Taatgen & H. van Rijn (Eds.), *Proceedings of the 31st Annual Meeting of the Cognitive Science Society* (pp. 2220-2225). Austin, TX: Cognitive Science Society.

Kalashnikova, M., Mattock, K., & Monaghan, P. (2014). Disambiguation of novel labels and referential facts: A developmental perspective. *First Language*, *34*, 125-135. doi: 10.1177/0142723714525946

Kalashnikova, M., Mattock, K., & Monaghan, P. (2015). The effects of linguistic experience on the flexible use of mutual exclusivity in word learning. *Bilingualism: Language and Cognition*, *18*, 626-638. doi: 10.1017/S1366728914000364

Kalashnikova, M., Mattock, K., & Monaghan, P. (2016a). Flexible use of mutual exclusivity in word learning. *Language Learning and Development*, *12*, 79-91. doi: 10.1080/15475441.2015.1023443

Kalashnikova, M., Mattock, K., & Monaghan, P. (2016b). Mutual exclusivity develops as a consequence of abstract rather than particular vocabulary knowledge. *First Language*, *36*, 451-464. doi: 10.1177/0142723716648850

Littschwager, J. C., & Markman, E. M. (1994). Sixteen- and 24-month-olds' use of mutual exclusivity as a default assumption in second-label learning. *Developmental Psychology*, *30*, 955-968. doi: 10.1037/0012-1649.30.6.955

Markman, E. M. (1990). Constraints children place on word meanings. *Cognitive Science*, *14*, 57-77. doi: 10.1207/s15516709cog1401_4

Markman, E. M. (1994). Constraints on word meaning in early language acquisition. *Lingua*, *92*, 199-227. doi: 10.1016/0024-3841(94)90342-5

Markman, E. M., & Hutchinson, J. E. (1984). Children's sensitivity to constraints on word meaning: Taxonomic versus thematic relations. *Cognitive Psychology*, *16*, 1-27. doi: 10.1016/0010-0285(84)90002-1

Markman, E. M., & Wachtel, G. F. (1988). Children's use of mutual exclusivity to constrain the meanings of words. *Cognitive Psychology*, *20*, 121-157. doi: 10.1016/0010-0285(88)90017-5

Markman, E. M., Wasow, J. L., & Hansen, M. B. (2003). Use of the mutual exclusivity assumption by young word learners. *Cognitive Psychology*, *47*, 241-275. doi: 10.1016/S0010-0285(03)00034-3

Mather, E., & Plunkett, K. (2010). Novel labels support 10-month-olds' attention to novel objects. *Journal of Experimental Child Psychology*, *105*, 232-242. doi: 10.1016/j.jecp.2009.11.004

Mervis, C. B., & Bertrand, J. (1994). Acquisition of the Novel Name-Nameless Category (N3C) Principle. *Child Development*, *65*, 1646-1662. doi: 10.2307/1131285

Pearson, B., Fernandez, S., & Oller, D. K. (1993). Lexical development in bilingual infants and toddlers: Comparison to monolingual norms. *Language Learning*, *43*, 93-120. doi: 10.1111/j.1467-1770.1993.tb00174.x

Poepsel, T. J., & Weiss, D. J. (2016). The influence of bilingualism on statistical word learning. *Cognition*, *152*, 9-19. doi: 10.1016/j.cognition.2016.03.001

Pruden, S. M., Hirsh-Pasek, K., Golinkoff, R. M., & Hennon, E. A. (2006). The birth of words: Ten-month-olds learn words through perceptual salience. *Child Development*, *77*, 266-280. doi: 10.1111/j.1467-8642.2006.00869.x

Quine, W. V. O. (1960). *Word and object*. Cambridge, MA: MIT Press.

Rosch, E., Mervis, C. B., Gray, W. D., Johnson, D. M., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology*, *8*, 382-439. doi: 10.1016/0010-0285(76)90013-X

Samara, A., Smith, K., Brown, H., & Wonnacott, E. (2017). Acquiring variation in an artificial language: Children and adults are sensitive to socially conditioned linguistic variation. *Cognitive Psychology*, *94*, 85-114. doi: 10.1016/j.cogpsych.2017.02.004

Slavin, S. (2014). PsyScript 3 (Version 3.2.1) [Computer software]. Lancaster University. Retrieved from: http://www.lancaster.ac.uk/psychology/research/research-software/psyscript3

Smith, L., & Yu, C. (2008). Infants rapidly learn word-referent mappings via cross-situational statistics. *Cognition*, *106*, 1558-1568. doi: 10.1016/j.cognition.2007.06.010

The Object Databank [Computer software]. (1996). Carnegie Mellon University. Retrieved from: http://wiki.cnbc.cmu.edu/Objects

Twomey, K. E., Ma, L., & Westermann, G. (2018). All the right noises: Background variability helps early word learning. *Cognitive Science*, *42*, 413-438. doi: 10.1111cogs.12539

Vlach, H. A., & DeBrock, C. A. (2019). Statistics learned are statistics forgotten: Children's retention and retrieval of cross-situational word learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *45*, 711-711. doi: 10.1037/xlm0000611

Vlach, H. A., & Sandhofer, C. M. (2011). Developmental differences in children's context-dependent word learning. *Journal of Experimental Child Psychology*, *108*, 394-401. doi: 10.1016/j.jecp.2010.09.011

Waxman, S. R. (1989). Linking language and conceptual development: Linguistic cues and the construction of conceptual hierarchies. *Genetic Epistemologist*, *17*, 13-19. Retrieved from: http://groups.psych.northwestern.edu/waxman/linkinglangandconceptualdev.pdf

Waxman, S. R., & Hatch, T. (1992). Beyond the basics: Preschool children label objects flexibly at multiple hierarchical levels. *Journal of Child Psychology*, *19*, 153-166. doi: 10.1017/S0305000900013672

Appendix

Stimuli

Words

Familiar

bed	chair	flower	hat
carrot	cup	fork	pear

Novel – from the NOUN Database

adet /ædɛt/	fiffin / fɪfɪn/	lorp /lɔp/	slint /slɪnt/
bem /bɛm/	fimp /fɪmp/	modi /məʊdi/	tand /tænd/
bink /bɪŋk/	gip /gɪp/	nilt /nɪlt/	tannin /tænin/
biss /bɪs/	glark /glak/	poip /pɔɪp/	teebu /tibu/
blap /blæp/	kita /kitə/	posk /pɒsk/	toma /təʊmə/
dand /dænd/	kiv /kɪv/	pru /pru/	vab /væb/
darg /dag/	koba /kəʊbə/	rel /rɛl/	yosp /yɒsp/
doff /dɒf/	lep /lɛp/	sarl /sal/	zav /zæv/

Objects

Familiar – from the TarrLab Object Databank

BED	CHAR4	SFLWR	HAT2
CARO2	CUP2	FORK	PEAR

Unfamiliar – from the NOUN Database

2001	2005	2011	2016
2002	2006	2013	2018

2019	2027	2040	2054
2021	2028	2044	2055
2022	2029	2045	2056
2023	2033	2048	2058
2025	2035	2049	2063
2026	2039	2050	2064

Chapter 3: Simulating Bilingual Word Learning: Monolingual and Bilingual Adults' Use of Cross-Situational Statistics

Although there is evidence in Chapter 2 showing that both monolingual and bilingual language learners rely on cross-situational statistics / associative information when learning the meaning of words, how socio-pragmatic cues and lexical constraints interact with statistical / associative learning remains a question to address. Thus, this chapter presents a series of experiments that investigated the influence of varying socio-pragmatic information about speaker identity (number of speakers – one vs. two – and presence of cue to speaker linguistic background) and referential ambiguity (number of distractors – one vs. three) on the learning of one-to-one and two-to-one word-object mappings via cross-situational statistical learning. This study tested adults, based on the assumption that there are no fundamental differences between statistical learning in children and adults (Weiss, Poepsel, & Gerfen, 2015) and the fact that many previous cross-situational word learning studies were done with adults (e.g., Benitez, Yurovsky, & Smith, 2016; Poepsel & Weiss, 2014, 2016; Yu & Smith, 2007).

Statement of Author Contribution

In the chapter entitled "Simulating Bilingual Word Learning: Monolingual and Bilingual Adults' Use of Cross-Situational Statistics", the authors agree to the following contributions:

Kin Chung Jacky Chan – 80% (Experimental design, data collection, data analysis, and writing)

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Abstract

Previous research has shown that adults can learn one-to-one and two-to-one word-object mappings via cross-situational statistical learning (CSSL), and that socio-pragmatic cues may differentially influence monolingual and bilingual language learners' learning of such mappings. We first examined the influence of socio-pragmatic information on speaker identity (speaker number in Experiment 1 and speaker language background across Experiments 1 and 2) on monolingual and bilingual adults' learning of one-to-one and two-to-one word-object pairs. We successfully replicated previous studies that found that both monolinguals and bilinguals could learn both types of mappings via CSSL. We also found that towards the start of the task, the monolinguals showed a preference for the one-to-one mappings, whereas the bilinguals were more open to learning the two-to-one mappings; and socio-pragmatic cues on speaker identity reduced such discrepancies between language groups. We then increased task complexity by introducing more distractors per learning instance in Experiment 3 to assess whether a potential ceiling effect has influenced our findings. Our results show that this was not the case, and learning was poorer when more noise was introduced to the learning environment. Together, these findings suggest that word-object mappings are acquired in a complex manner and language experience and learning context both play an important role.

1. Introduction

The learning of the mapping between a word and its referent is profoundly difficult, as there are infinitely many potential referents in the environment for a spoken word. This uncertainty is referred to as the “Gavagai” problem (Quine, 1960). The uncertainty is increased still further when children grow up in multilingual environments, as this means there are also multiple words for a particular referent. The present study aims to investigate how speaker identity, as a socio-pragmatic cue, impacts on language learning under such conditions of referential and reference uncertainty.

A prominent suggestion as to how language learners overcome the “Gavagai” problem has been that language learners make use of constraints on which mappings can be formed. For instance, the mutual exclusivity (ME) constraint suggests that language learners tend to assign only one word to a referent (Markman & Wachtel, 1988). When language learners hear a novel word and see a familiar object, of which they already know the name, and an unfamiliar object, they would, based on ME, pair the novel word with the unfamiliar object. Other constraints include the whole-object assumption and the taxonomic assumption (Markman, 1991; Markman & Hutchinson, 1984; Markman & Wachtel, 1988). Another account of word learning is that children use socio-pragmatic constraints, which suggests that language learners’ word learning is guided by their socio-cognitive skills and the social cues available in communicative contexts (Tomasello, 2000). This account explains word learning in terms of language learners’ ability to actively monitor others’ attention (Akhtar & Tomasello, 1996) and intention (Tomasello & Barton, 1994) to discover intended referents of novel words. In general, both of these accounts posit that language learners make use of certain strategies to limit the number of potential referents for a word to help solve the “Gavagai” problem. Yet, constraining the problem space is not the only way to solve the word-learning problem.

Recently, cross-situational statistical learning (CSSL) ability has been proposed as a valuable contributor to word learning. Though the referent of a novel word might be ambiguous within the context of a single learning instance, across multiple learning instances, learners would be able to track the co-occurrences of the novel word and its referent, with which it reliably occurs. This statistical information can then help learners to disambiguate which words refer to which referents. Yu and Smith (2007) presented adults with a series of trials containing two to four unfamiliar objects and novel words. Within each trial, the word-object pairings were ambiguous (i.e., novel words were presented in a random order in all trials and there was no correspondence between the order of words and the location of objects on the computer screen), but across trials, with the presentation of different combinations of novel words and their referring objects, the word-object pairings could become apparent. Hence, learners would be able to learn the word-object pairs if they were capable of tracking the co-occurrences of words and objects across different situations. Yu and Smith found that adults could learn the meanings of words via CSSL. This finding has been replicated in various similar studies (e.g., Fitneva & Christiansen, 2011; Hamrick & Rebuschat, 2012; Monaghan & Mattock, 2012; Vouloumanos, 2008).

In these studies, only one-to-one word-object pairs were used. Yet, although learners favour ME (i.e., one-to-one word-referent mappings) when learning the meaning of words, overcoming ME is important for learning category labels, as well as synonyms (e.g., Markman & Wachtel, 1988). It is also particularly important for bilinguals as they have to learn translation equivalents – forming many-to-one word-referent mappings (e.g., both “apple” in English and “manzana” in Spanish refer to a particular fruit) – and interlingual homographs – forming one-to-many word-referent mappings (e.g., “tuna” refers to a kind of fish in English but prickly pear in Spanish) – in order to be proficient in all the languages they speak.

Ichinco, Frank, and Saxe (2009) tested whether two-to-one and one-to-two word-object pairs could be learned by adults (i.e., relaxing ME) during a CSSL task. They familiarised and then tested adults on a set of one-to-one word-object pairs. Then, the participants were familiarised to a second set of one-to-one word-object pairs. Some of the pairs in the second set required the remapping of objects or words. Thus, although each set consisted of one-to-one word-object pairs, across the two sets, there was a combination of one-to-one, two-to-one, and one-to-two word-object pairs. It was found that the participants were successful in learning the one-to-one word-object pairs and the first mapping of the two-to-one and one-to-two word-object pairs. By contrast, they failed to learn the second mapping of the two-to-one and one-to-two word-object pairs. Ichinco et al. took the results of their study as evidence against a simple associative learning account of word learning and evidence of use of ME.

Yet, Kachergis, Yu, and Shiffrin (2009) argued that the results of Ichinco et al.’s (2009) study could be due to a blocking effect, giving rise to the participants favouring the first mapping learned. Using a similar paradigm to that in Ichinco et al.’s study, Kachergis et al. manipulated the number of occurrences of the second mapping of the word-object pairs. It was found that the extent to which the participants relaxed ME – in other words, success at learning the second mapping of the word-object pairs – was associated with the number of times they had been exposed to the pairs, such that the participants were more likely to relax ME when there was more evidence (i.e., exposure) in the input for the second mapping.

These CSSL studies examined CSSL in a monolingual population. Only a few studies have looked at CSSL in a bilingual population. A study similar to that of Yu and Smith's (2007) by Escudero, Mulak, Fu, and Singh (2016) showed that bilingual adults could not only learn one-to-one word-object pairs via CSSL, but also outperform their monolingual counterparts. Another study by Poepsel and Weiss (2016) investigated whether bilingual adults would learn one-to-two word-object pairs better than monolingual adults do, owing to them encountering more instances in their natural language usage where they have to relax ME in order to learn new words. They tested the participants' learning of the first and second word-object mappings of the one-to-two word-object pairs in separate testing blocks after the first and second block of learning trials respectively, and tested all word-object mappings in the final testing block after the third learning block. Consistent with Poepsel and Weiss' prediction, it was found that the bilingual adults were quicker than the monolingual adults at learning and showed higher proficiency in learning the one-to-two word-object pairs.

Further, Benitez, Yurovsky, and Smith (2016) familiarised monolingual and bilingual adults with a set of one-to-one and two-to-one word-object pairs and tested their learning of the word-object mappings. They manipulated whether there was a phonological cue distinguishing the set of labels to which the word belonged. They found that the monolingual and bilingual adults performed similarly on the task overall. Both groups showed learning of both the one-to-one and two-to-one word-object pairs, but both groups were better at learning the one-to-one pairs. This was perhaps because monolinguals, who have been exposed to synonyms in their one language, are also experienced in learning two-to-one word-object mappings. However, when the phonological cue distinguished the sets of labels, the bilingual adults were more likely to learn both words of the two-to-one pairs. This suggests that bilingual adults are more sensitive to the linguistic cues that hint at different languages being present in the linguistic input. Taken together, there is evidence that bilingual adults are better than their monolingual counterparts when it comes to learning word-object pairs that violate ME via CSSL.

Other studies have investigated whether socio-pragmatic cues, such as speaker identity, in the linguistic input would affect learners' cross-situational word learning (e.g., Metzing & Brennan, 2003; Trude & Brown-Schmidt, 2012). Poepsel and Weiss (2014) manipulated the socio-pragmatic information available to participants in a one-to-two label-object CSSL task. In one condition, all words were uttered by the same speaker. In another condition, a male and a female speaker were used, and the two speakers used the same word to refer to a different object. This socio-pragmatic cue on speaker identity could be seen as an implicit cue that there could be two different language structures involved in the task. It was found that the manipulation of socio-pragmatic information did not affect the monolingual adults' performance on learning one-to-two word-object pairs. Yet, in multilingual environments it is more usual for one object to be labelled differently by distinct speakers. We know that language information can promote learning two labels for one object in a two-to-one label-object CSSL task (Benitez et al., 2016), but whether varying *speaker* identity would affect bilingual adults' cross-situational word learning, and whether speaker identity can influence learning of two-to-one mappings is as yet unknown.

The aim of the present study was to examine whether socio-pragmatic information on speaker identity would differentially affect monolingual and bilingual adults' performance on a CSSL task that involved the learning of one-to-one and two-to-one word-object pairs. In a series of experiments, we varied the socio-pragmatic information on speaker identity and task complexity of a CSSL task. In Experiment 1, we investigated whether monolingual and bilingual adults' learning of word-referent mappings would be influenced by the number of speakers in the task. We included two conditions – one where there was a single speaker labelling objects in two ways, and one where two speakers labelled objects in two different ways. In Experiment 2, we repeated the two-speaker condition of Experiment 1, but adapted it by providing more explicit information about speaker identity by having the two speakers in the task each introduce themselves in a different language prior to the CSSL task. In Experiment 3, we, again, repeated the two-speaker condition of Experiment 1, but this time increased the number of distractors appearing in each trial from one to three, making the task more complex and closer in informational content to Benitez et al. (2016). The present study employed a CSSL paradigm similar to that in Monaghan and Mattock's (2012) study, which is slightly different from many of the CSSL paradigms used in other studies. The crucial difference is that the CSSL paradigm used in the present study did not distinguish between familiarisation and test trials – participants were required to make a forced choice response, without feedback, in all trials. This allowed an online measure of how quickly and reliably participants form one-to-one and two-to-one word-object mappings as learning progresses. In order to determine whether successful learning of two-to-one word-object pairs was due to successful tracking of two structures in the linguistic input or a general tendency to relax ME, an additional ME block was administered at the end of the CSSL training, to determine how strictly ME was being applied by the participant.

2. Experiment 1

There were two conditions in this initial experiment with varying number of speakers. In one condition, only one speaker was involved in labelling all the objects;

whereas in the other condition, two speakers each used a unique label to name the objects with two names (i.e., objects of two-to-one word-object mapping type). It was predicted that bilingual adults would be quicker and more accurate at learning two-to-one word-object pairs than monolingual adults. Also, it was predicted that the cue on speaker identity would further benefit bilingual adults' learning of two-to-one word-object pairs due to them being more experienced than monolingual adults in integrating socio-pragmatic information when tracking multiple structures in their linguistic input.

2.1 Method

2.1.1 Participants. Forty monolingual (M_{age} = 22.80, *SD* = 4.56, 4 male) and forty bilingual (M_{age} = 23.58, *SD* = 3.71, 10 male) participants were recruited through the departmental online recruitment system and advertisements on social networking websites. Half the participants in each language group were randomly assigned to the one-speaker condition, and the other half the two-speaker condition. Nine additional participants were tested but excluded due to technical difficulties (*n* = 8) and experimenter error (*n* = 1).

Participants rated their language proficiency on a 10-point Likert scale from 1 (limited knowledge) to 10 (highly proficient). Monolinguals rated their English proficiency at an average of 9.95 (*SD* = 0.22). Ten monolingual participants indicated exposure to additional languages, but were considered functionally monolingual, as all additional language proficiency ratings were below 4 (*M* = 2.23, *SD* = 0.93), a similar cut-off to that used in Poepsel and Weiss (2016). The bilingual group rated the proficiency of their first language at an average of 9.85 (*SD* = 0.43) and that of their additional languages at an average of 7.36 (*SD* = 2.01).

2.1.2 Materials and apparatus. Fourteen images of unfamiliar objects and 20 novel words were selected from the Novel Object and Unusual Name (NOUN) Database (Horst & Hout, 2016; see Appendix A). Sound files of the novel words were generated using the system voices Kate (female voice) and Daniel (male voice) on Macintosh computers. Pictures were randomly paired with the novel words for each participant, such that there were eight one-to-one word-object pairs and six two-to-one word-object pairs.

In the one-speaker condition, all words were uttered by the same speaker. The gender of the speaker was counterbalanced across participants assigned to the one-speaker condition. In the two-speaker condition, half the words were uttered by a male, and the other half by a female. For words in the two-to-one word-object pairs, the two words referring to the same object were uttered by voices of different gender. The gender of speaker of each word was counterbalanced across participants assigned to the two-speaker condition.

In addition, eight images of familiar objects were selected from the TarrLab Object Databank (1996) for use in the familiarisation trials (see Appendix A). Sound files of the familiar words were generated using the system voice Allison (female voice) on a Macintosh computer. Note that this was a different voice from those used in the main experiment trials. The pictures and audio files of words were presented on a Macintosh computer using PsychoPy (Peirce, 2009).

2.1.3 Procedure. The experiment took place in a quiet room. Participants were tested in groups of less than five people. After receiving an information sheet and signing informed consent, each participant was asked to complete the experiment on a Macintosh computer. Participants were asked to put on headphones for the experiment.

For each trial, the participants saw two pictures presented on the screen, one of which was the target for the word and the other was a foil (but a target for one of the other words in the set). After 500 ms, they heard a word. The target and foil were randomised for screen position (left vs. right) across trials. The participants were instructed to press the right arrow key if they thought the word presented refers to the object on the right and press the left arrow key if they thought the word presented refers to the object on the left. The participants were also instructed to make a guess if they did not know the answer.

The participants first took part in a familiarisation block, in which they were presented with four trials containing known words and objects. This was to familiarise the participants with the experimental procedure.

For the main experiment, the participants first took part in eight CSSL blocks of 40 test trials each whereby they were exposed to four one-to-one and six two-to-one word-object mappings (i.e., 16 different words and 10 different objects). Within each of the CSSL blocks, each object occurred four times as the target and four times as the foil. The screen position of the target and foil were pseudo-randomised, such that the target appeared an equal number of times as the left and as the right object. Words in the one-to-one word-object pairs occurred four times within a block, whereas those in the two-to-one word-object pairs occurred only two times within a block, so that the frequency of each target object was equalised over the two-to-one and one-to-one trials. The order of trials within each block was pseudo-randomised, such that none of the objects appeared in two consecutive trials. The participants were not provided with any information on the number of languages involved in the main experiment – the only socio-pragmatic cue available to them was the number of speakers in the task. The participants were allowed to take a short break after every two blocks. After all eight blocks, the participants were exposed to each one-to-one word-object pair 32 times and each two-to-one word-object pairs 16 times.

Immediately after the eighth CSSL block, the participants took part in an ME block containing eight test trials. The first four were familiarisation trials. The final four were ME test trials. Each trial featured one of the objects from the one-to-one pairs from the CSSL blocks and a new unfamiliar object. As in the CSSL blocks, the screen positions of the target and foil were pseudo-randomised. For each of the first four trials, the participants heard a word that they had just had the opportunity to learn during the CSSL blocks. These four trials served the purpose of familiarising the participants with the new unfamiliar objects and to control for a possible novelty bias during later trials, where the new unfamiliar objects were the target. Responses on these four trials were not included in our analyses. For each of the final four trials, the participants heard a new novel word, which was spoken by the speaker who spoke the word for the foil in the same trial. If a participant was relying on ME, they would be more likely to choose the familiar object in the first four trials and the less familiar objects in the last four trials. However, if a participant was relaxing ME, their performance would be closer to chance level – choosing either object as the answer in any given trial.

Upon completing the ME block, all participants were given a full debrief and received £3.50 for taking part in the experiment. Each testing session lasted less than 30 minutes.

2.2 Results

2.2.1 Learning over the training blocks. Data from six participants, one from the monolingual group and five from the bilingual group were excluded from analysis, due to them not demonstrating learning across training blocks (i.e., average proportion correct across first two blocks > average proportion correct across final two blocks).

To compare whether number of speakers had influenced the monolingual and bilingual adults' learning of the two types of mappings, generalised linear mixed-effects (GLM) modelling was used to predict the adults' response accuracy. See the first two panels from the left in Figure 1 for mean response accuracy by mapping type of target, condition, and language group. The data for GLM modelling consisted of the response accuracy from each participant on each trial, giving a total of 23680 observations.

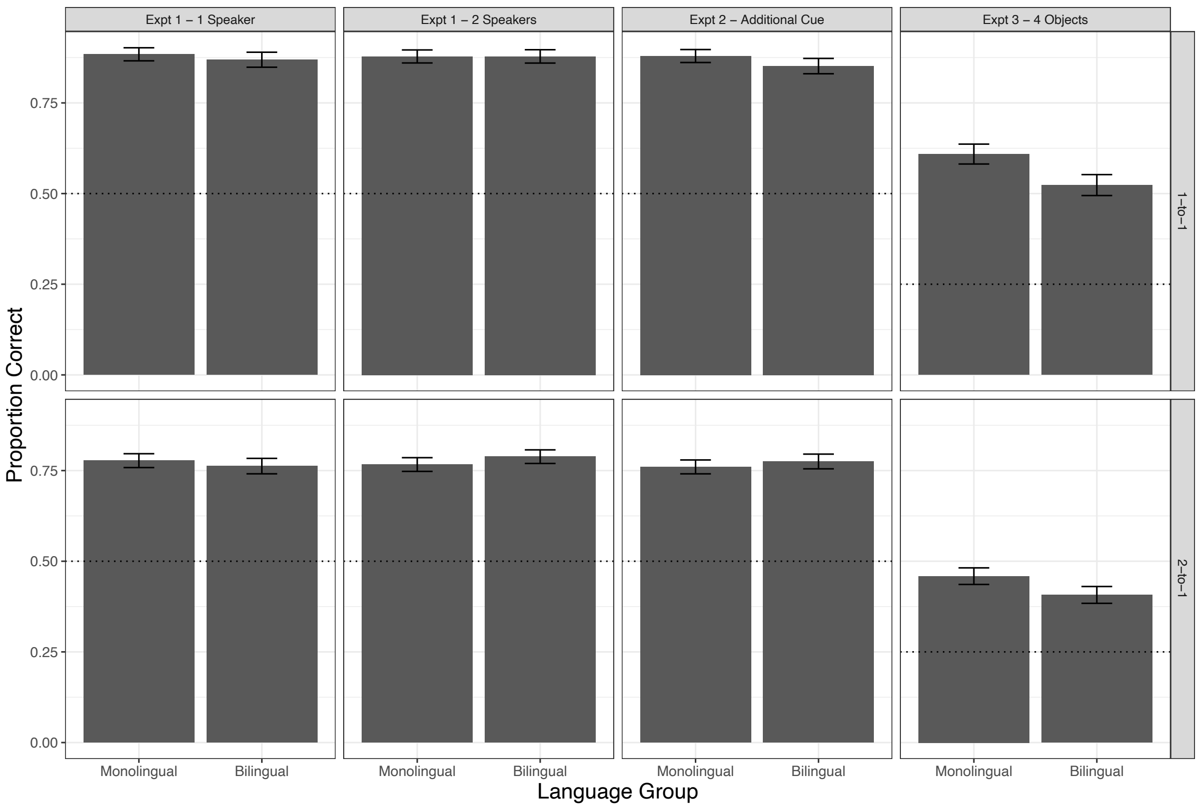

Figure 1. Response accuracies of participants on both mapping types by condition and language group in CSSL blocks. Error bars represent standard errors. Dotted lines represent chance performance.

A series of GLM models were fitted using the glmer function (family = binomial) in the lme 4 package in R. Intercorrelations between all predictor variables and the outcome variable (response accuracy) were examined; and collinearity diagnostics indicated no possible risk of collinearity (condition number = 23.87, all $|r|$s $\leq .20$). In all models, all predictors were entered simultaneously. A backwards elimination approach was used, entering as fixed factors: language group, speaker number, block, and mapping type of the target (whether it had one or two labels), and their interactions. Extraneous variables, including participant gender and speaker gender were also included in the model selection process to ensure that they did not influence the participants' performance.

First, assuming the same random effects of participants, words, and target objects on intercepts, we fitted a series of models differing in fixed effects. The most complex model with all four predictor variables and all interactions among them, alongside the extraneous variables, was first fitted to the data. Then, the drop1 function (test = "Chisq") was used to determine whether dropping the highest order fixed effect would increase fit to the data. The highest order fixed effect with the highest likelihood ratio test p-value once dropped was then removed from the model, and a model with the identified fixed effect removed was then fitted to the data. These steps were then repeated until the likelihood ratio test p-values between a more complex model and all simpler models with one of the highest order fixed effects removed from the complex model were smaller than .05 to obtain a final model.

The final model was the model with the following fixed effects: the three-way interaction, all two-way interactions, and main effects of block, language group, and target mapping. Comparing this model with an empty model with just the intercept was significant, $\chi^2(7) = 1258.20$, $p < .001$.

To determine the random effects structure, a series of models with the random effects of participants, target objects, and words on the slopes of the fixed effects were fitted. The best model was the model containing the following random intercepts: subject, target object, and word; and the following random slopes: block and target mapping on subject and language group on both target object and word. This model was compared to the model with just the fixed effects. It was found that the inclusion of the random effects was justified, $\chi^2(9) = 138.36$, $p < .001$. The final model (AIC = 20028.6, BIC = 20190.0, logLik = -9994.3, deviance = 19988.6) is reported in Table 1.

Table 1

Summary of model comparing one-speaker and two-speaker conditions in Experiment 1

			Wald Confidence Intervals			
Fixed Effects	Estimated Coefficient	SE	2.50%	97.50%	*z*	*pr*(>|*z*|)
(Intercept)	1.0179	0.1746	0.6757	1.3599	5.831	< .001
Block	0.3629	0.0309	0.3023	0.4235	11.742	< .001
Language group (mono vs. bi)	-0.2859	0.2100	-0.6975	0.1257	-1.361	.1734
Target mapping (1-to-1 vs. 2-to-1)	-0.7726	0.1387	-1.0445	-0.5007	-5.570	< .001
Block × Language group	0.0542	0.0445	-0.0330	0.1414	1.218	.2233
Block × Target	-0.1019	0.0262	-0.1534	-0.0505	-3.884	< .001

mapping						
Language group × Target mapping	0.4790	0.1966	0.0937	0.8644	2.436	.0148
Block × Language group × Target mapping	-0.0837	0.0378	-0.1578	-0.0096	-2.214	.0268
Random effects	Name		Variance	*SD*	Corr	
Subject	(Intercept)		0.4234	0.6507		
	Block		0.0154	0.1240	.47	
	Target mapping		0.2245	0.4738	-.85	-.71
Word	(Intercept)		0.1127	0.3357		
	Language group		0.0169	0.1299	.26	
Target	(Intercept)		0.0309	0.1758		
	Language group		0.0182	0.1349	.40	
	AIC	BIC	logLik	Deviance		
	20028.6	20190.0	-9994.3	19988.6		

Note. R syntax of the model is as follows: glmer (Accuracy ~ (Block + LanguageGroup + Mapping) ^ 3 + (Block + Mapping + 1 | Subject) + (LanguageGroup + 1 | Target) + (LanguageGroup + 1 | Word), family = binomial)

There was a significant effect of block, suggesting that, in general, performance improved across training blocks. The main effect of target mapping was also significant, suggesting that the participants were better at learning the one-to-one than two-to-one mappings.

In addition, there was a significant three-way interaction of block, language group, and target mapping (see Figure 2). The three-way interaction suggests that the two language groups performed differently towards the start of the task. In the beginning, the bilinguals' performance on both mapping types was more similar than that of the monolinguals – the bilinguals' learning, when compared to that of the monolinguals, was better for the two-to-one mappings, but worse for the one-to-one mappings. The performance of the two groups on both types of mapping became increasingly similar across blocks.

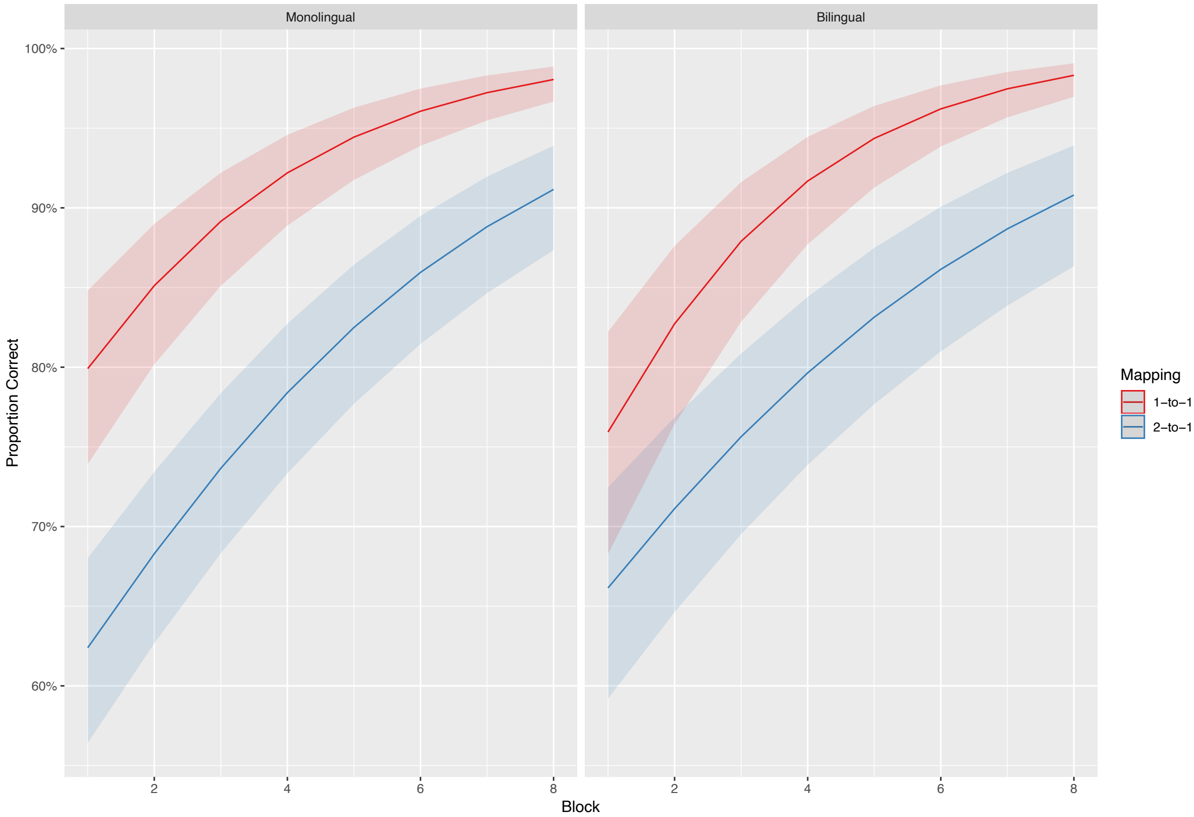

Figure 2. Three-way interaction of block, language group, and target mapping. Shaded areas represent standard errors.

Moreover, the interaction of block and target mapping was also significant (see Figure 3), showing a convergence of the participants' performance in learning the two mapping types across blocks, such that although their learning of the one-to-one mappings was better than that of the two-to-one mappings across blocks, their learning rate for the two-to-one mappings was steeper.

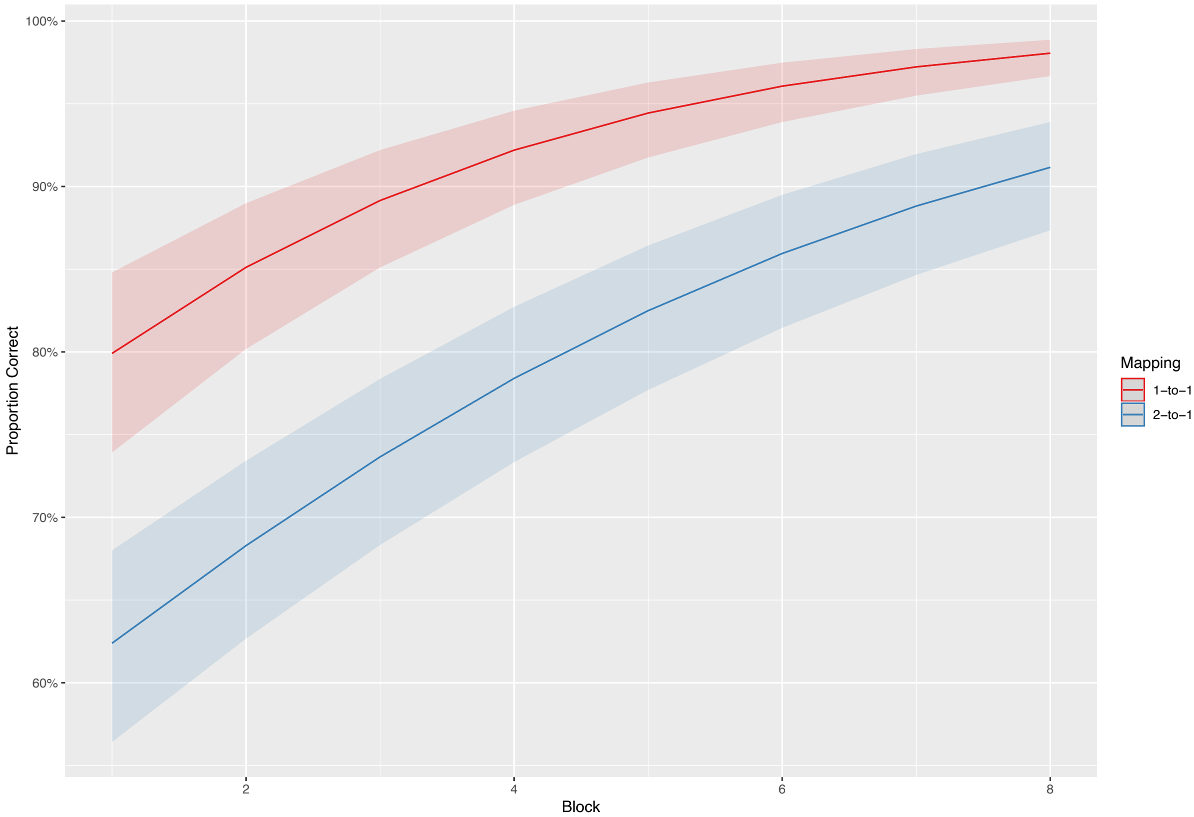

Figure 3. Interaction of block and target mapping. Shaded areas represent standard errors.

Further, although there was not a significant main effect of language group, the interaction of language group and target mapping was significant (see Figure 4), indicating that although both language groups were better at learning the one-to-one mappings, the monolingual group's performance difference between the two mapping types was greater than that of the bilingual group. In light of the significant three-way interaction of block, language group, and target mapping, this significant interaction was driven by the participants' performance in the first two training blocks.

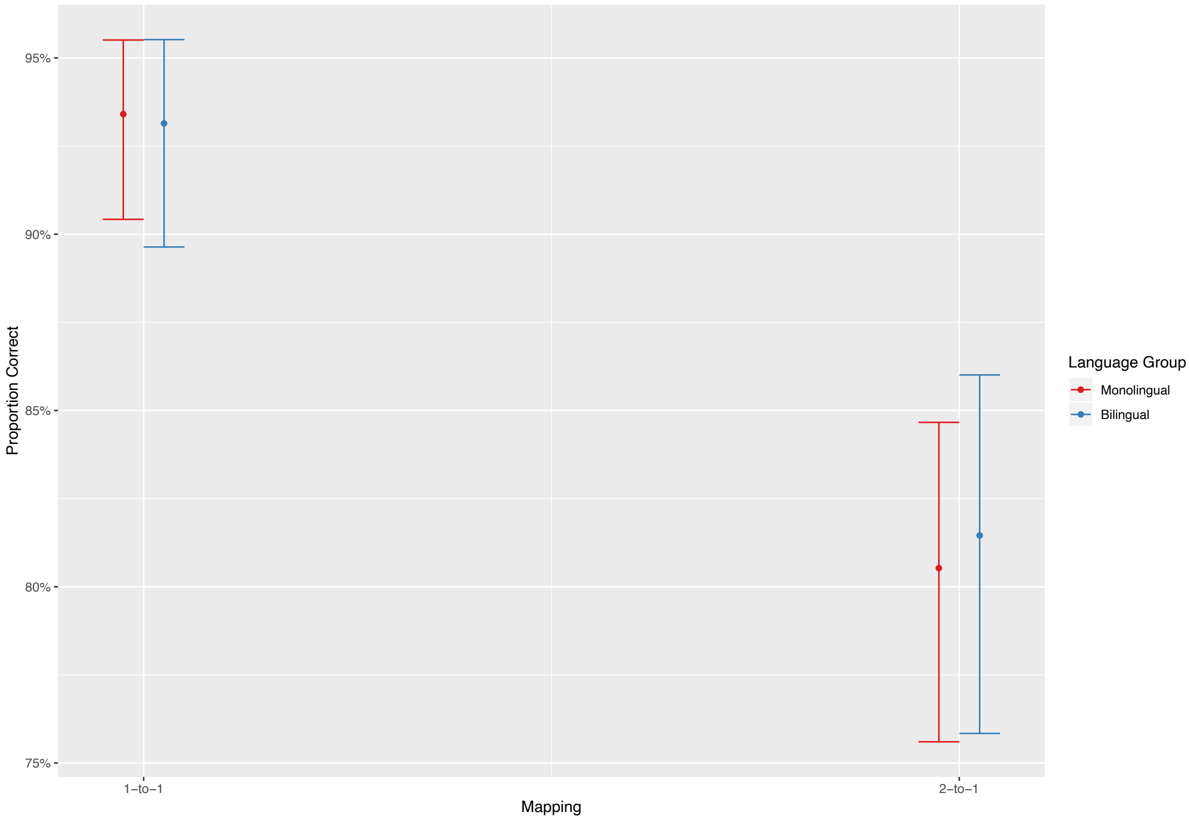

Figure 4. Interaction of language group and target mapping. Error bars represent standard errors.

2.2.2 Performance on the ME task. Though the analysis of training trials demonstrated that there were no significant main effect or interactions with number of speakers in the task, it was possible that the monolingual and bilingual participants relied on different strategies – either relaxing ME or successfully tracking two labels in the linguistic input would produce a similar pattern of results. In order to determine whether the two language groups relied on similar strategies, their performance on the final four trials in the ME block was analysed. In any given trial, if a participant picked the object that was in line with the application of ME, they scored 1, otherwise they scored 0. Mean scores in the ME block are shown in the first two panels from the left in Figure 5.

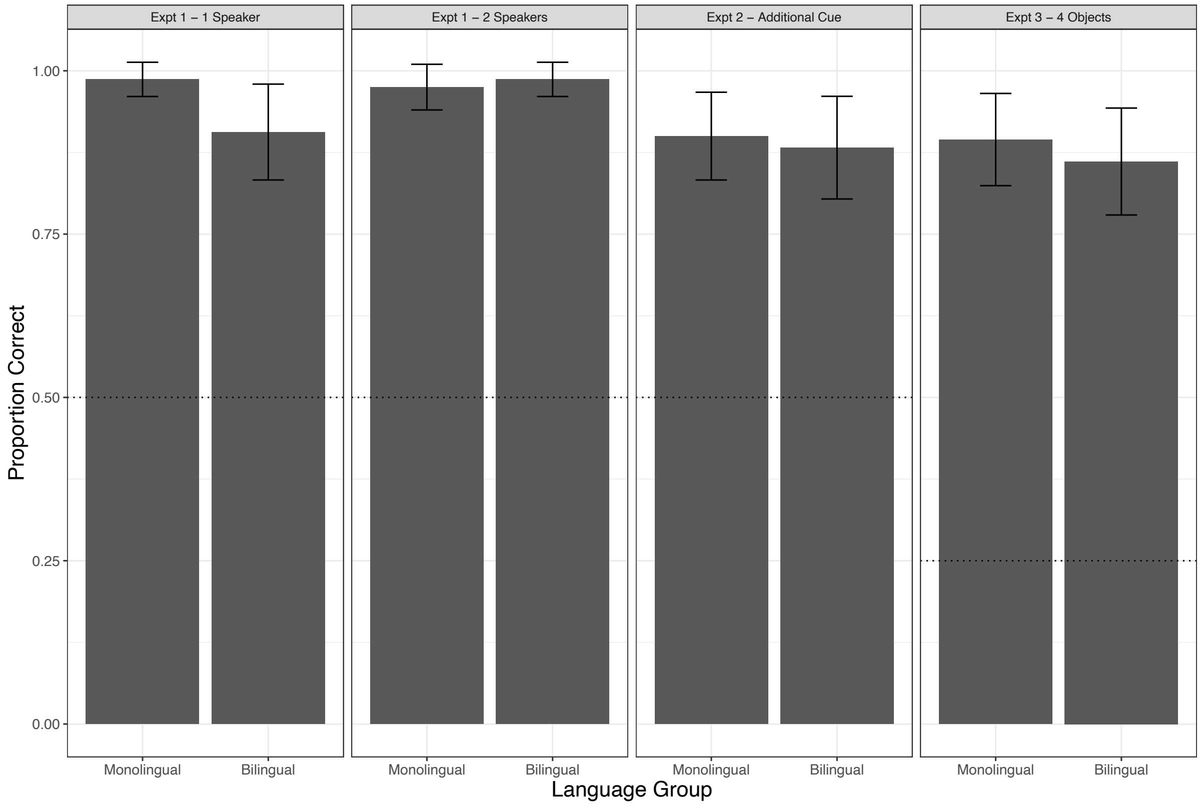

Figure 5. Response accuracies of participants by condition and language group in ME block. Error bars represent standard errors. Dotted lines represent chance performance.

Similar to the treatment of the data from the CSSL blocks, GLM models were fitted to participants' scores on each trial (296 observations). Collinearity diagnostics indicated no possible risk of collinearity (condition number = 16.41, all $|r|$s $\leq$ .20). Predictor variables of the GLM models were language group, speaker number, and average response accuracy of the distractor during the CSSL blocks. The inclusion of the average response accuracy of the distractor was to access whether the participants' reliance on ME was influenced by how well they have learned the name of the distractor. Extraneous variables, including participant gender and speaker gender, did not influence the participants' performance. The best model (AIC = 80.0, BIC = 87.4, logLik = -38.0, deviance = 76.0) given the data was the model with only the intercept and a random intercept of subject. Thus, there was no statistically significant difference in application of ME for the language groups nor due to number of speakers during training.

2.3 Discussion

The overall findings from Experiment 1 suggest that, consistent with Benitez et al. (2016) and Poepsel and Weiss (2016), both monolinguals and bilinguals are capable of learning one-to-one and two-to-one word-object mappings. Yet, although the one-to-one mappings were easier to learn for both language groups, there was evidence that the learning of the two types of mapping was more similar for the bilinguals. This was possibly due to the experience of and expectations on the mapping between words and objects of each language group, leading to a preference for the one-to-one rather than two-to-one mappings for the monolinguals, whereas the bilinguals being more open to two-to-one mappings. This difference between the two language groups was particularly strong in the first training blocks, indicating the biases that the two language groups brought to the study. This is in line with previous findings that monolinguals and bilinguals tend to hold different expectations for how words map onto objects (e.g., Byers-Heinlein, Chen, & Xu, 2014; Henderson & Scott, 2015) and, more specifically, bilingual experience would lead to more flexible use of ME, exhibited by higher tendency to accept lexical overlap (i.e., two-to-one word-object mapping; Kalashnikova, Mattock, & Monaghan, 2015). Although the biases were eroded during the course of the study, we note that this might be due to a potential ceiling effect, especially on the learning of the one-to-one mappings.

Interestingly, in Benitez et al.'s study, there was only a distinction in performance between the monolingual and bilingual groups when a linguistic cue distinguished the two labels of the two-to-one mappings, which was not the case in the present experiment. This could have arisen from the way training occurred. In Benitez et al.'s study, participants were presented with four objects and four words at a time during training, whereas the participants in the present experiment were only presented with two objects and one word at a time. In addition, whereas Benitez et al. controlled for the frequency of co-occurrences of words and objects (i.e., ensuring all target word-object mappings occurred the same number of times during training), the present experiment controlled for the frequency of occurrences of each object, hence the participants were presented with fewer tokens of the two-to-one mappings. Our experiment was likely to have more closely mimicked actual word-learning experiences than Benitez et al.'s task – in naturalistic settings, it is unlikely that all objects at sight are labelled, and language input is likely split between the two languages that bilinguals are exposed to. However, as the number of objects per trial during training was different between Benitez et al.'s and our study, further experiments increasing the number of distractors per trial of our CSSL task are needed to determine which experimental task better resembles natural language learning.

Our manipulation of speaker identity did not influence the participants' learning of one-to-one and two-to-one word-object mappings. It was possible that our two-speaker condition did not sufficiently simulate the experience of a bilingual learner, in that there were no reliable cues signalling what languages the speakers in the task spoke. As all our stimuli were phonotactically legal in English, it was possible that the participants assumed that both speakers in the two-speaker condition were speakers of English. A condition with more socio-pragmatic cues about the language backgrounds of the speakers might better simulate the bilingual experience.

Further, we did not find any significant differences in the monolingual and bilingual groups' performance in the ME block in both conditions. This could be due to their remarkable performance on the one-to-one mappings in the CSSL blocks, as indicated by a potential ceiling effect towards the end of training. Since most of the participants had learned the one-to-one mappings well, it was possible that their performance in the ME block was influenced by their confidence in their knowledge of the one-to-one mappings, driving them to map the new novel nameless object to the novel name, leading to performance that was in line with ME.

To explore this further, we carried out two follow-up experiments: Experiment 2 introduced additional socio-pragmatic information that could better simulate a bilingual environment to determine if that additional language background information affected learning of one-to-one and two-to-one mappings differently, and Experiment 3 increased the complexity of the task to reduce the influence of the ceiling effect at the end of training on performance.

3. Experiment 2

In Experiment 1, our manipulation of number of speakers in a CSSL task that involved learning one-to-one and two-to-one word-object mapping types did not affect the performance of either the monolingual or bilingual participants. In this follow-up experiment, we aimed to see whether providing additional socio-pragmatic information about the language background of the speakers (i.e., information on what language each of the speakers involved in the task speaks) would influence monolingual and bilingual adults' performance differentially.

Our main prediction was that additional socio-pragmatic information relating to speakers' language background would benefit both language groups' learning of two-to-one mappings, but more so for the bilinguals, such that they would show higher accuracies and/or a steeper learning rate for two-to-one mappings over one-to-one mappings. We also predicted that the additional socio-pragmatic information would make both language groups more flexible in applying ME, and the influence would be stronger for the bilingual group. Based on the results in Experiment 1, it was expected that both language groups would be able to learn both types of mappings across CSSL training blocks, with better learning of the one-to-one mappings. We also predicted that the bilinguals' performance on both types of mappings would be more similar compared to that of their monolingual counterparts.

3.1 Method

3.1.1 Participants. Twenty monolingual (M_{age} = 19.60, *SD* = 1.18, 5 male) and twenty bilingual (M_{age} = 20.43, *SD* = 2.06, 5 male) participants were recruited through the department online recruitment system and advertisements on social networking websites. Four additional participants were tested but excluded due to technical difficulties (*n* = 3) and experimenter error (*n* = 1).

Monolinguals rated their English proficiency at an average of 9.85 (*SD* = 0.49). Three monolingual participants indicated exposure to additional languages, but were considered functionally monolingual, as all such proficiency ratings were below 4 (*M* = 2.33, *SD* = 0.58). The bilingual group rated the proficiency of their first language at an average of 9.85 (*SD* = 0.37) and that of their additional languages at an average of 6.90 (*SD* = 2.45).

3.1.2 Materials and apparatus. All test images were the same as those used in Experiment 1. However, as the language background of the speakers in the task was the main manipulation, in addition to the original system voices on Macintosh computers – Kate and Daniel – two Turkish voices – Yelda (female voice) and Cem (male voice) – were also used. Additional scenes featuring generic pictures of a male and a female were used to provide information about the language backgrounds of the speakers. An introduction scene was shown to participants after the familiarisation block. The scene started with two static images, one male and one female, being shown on the screen. When the speakers introduced themselves (one in English and the other in Turkish), a speech bubble pointing towards the gender-corresponding image would appear on the screen. The speakers took turn to say their names and repeat the task instructions. After each inserted break (after every two blocks of the CSSL task), a scene similar to the introduction scene was shown as a reinforcement of the socio-pragmatic manipulation of the task.

3.1.3 Procedure. The procedure was identical to the two-speaker condition of Experiment 1 with the following exceptions: 1. the two speakers in the task spoke different languages (the gender of the speaker of each language was counterbalanced across participants); and 2. introduction and reinforcement scenes were added after the familiarisation block and after every inserted break.

3.2 Results

We first report results of this experiment alone, followed by a comparison with the two-speaker condition in Experiment 1.

3.2.1 Learning over the training blocks. Data from three bilingual participants were excluded from analysis for not demonstrating learning across training blocks.

To determine whether socio-pragmatic information on language backgrounds of speakers (i.e., what language a speaker speaks) had influenced the monolingual and bilingual adults' learning of the two types of mappings, GLM modelling was used to predict response accuracy. See the third panel from the left in Figure 1 for mean response accuracy by target mapping and language group. The data for GLM modelling consisted of the response accuracy from each participant on each trial, giving a total of 11840 observations.

As in Experiment 1, a series of GLM models were fitted using the glmer function (family = binomial) in the lme 4 package in R. Intercorrelations between all predictor variables and the outcome variable (response accuracy) were examined; and collinearity diagnostic indicated no possible risk of collinearity (condition number = 18.07, all $|r|$s $\leq .02$). In all models, all predictors were entered simultaneously. A backwards elimination approach was used, entering as fixed factors: language group, block, and mapping type of the target. Participant gender and speaker gender were included in our model selection process to ensure that these extraneous variables did not influence the participants' performance. Assuming the same random effects of participants, words, and target objects on intercepts and varying the fixed effects, the best model was the model with the following fixed effects: the two-way interaction and main effects of block and target mapping and those of language group and target mapping. This model was significantly better than a model with just the intercept, $\chi^2(5) = 1237.30$, $p < .001$.

A series of models with the random effects of participants, target objects, and words on the slopes of the fixed effects were then fitted. The best model was the model containing the following random intercepts: subject, target object, and word; and the following random slopes: block and target mapping on subject and target mapping on word. Comparing this best model with the best model with just the fixed effects, the inclusion of the random effects was justified, $\chi^2(5) = 201.62$, $p < .001$. The interaction of language group and target mapping was no longer significant after the inclusion of the random slopes and was therefore dropped from the best model. The main effect of language group was also non-significant and dropped. The removal of these two fixed effects was justified because model fit was not significantly worse when omitting them, $\chi^2(2) = 3.88$, $p = .143$. The final model (AIC = 10391.5, BIC = 10494.8, logLik = -5181.8, deviance = 10363.5) is reported in Table 2.

Table 2

Summary of model of Experiment 2 alone

			Wald Confidence Intervals			
Fixed Effects	Estimated Coefficient	SE	2.50%	97.50%	*z*	*p*r(>|*z*|)
(Intercept)	0.7706	0.1775	0.4228	1.1184	4.343	< .001
Block	0.3640	0.0337	0.2979	0.4302	10.790	< .001
Target mapping (1-to-1 vs. 2-to-1)	-0.4728	0.1984	-0.8616	-0.0839	-2.383	.0172
Block × Target mapping	-0.1249	0.0262	-0.1761	-0.0736	-4.774	< .001
Random effects	Name		Variance	*SD*	Corr	
Subject	(Intercept)		0.4531	0.6731		
	Block		0.0217	0.1472	.18	
	Target mapping		0.3496	0.5912	-.87	-.53
Word	(Intercept)		0.0709	0.2662		
	Target mapping		0.1950	0.4416	-.33	
Target	(Intercept)		0.0117	0.1082		

AIC	BIC	logLik	Deviance
10391.5	10494.8	-5181.8	10363.5

Note. R syntax of the model is as follows: glmer (Accuracy ~ (Block + Mapping) ^ 2 + (Block + Mapping + 1 | Subject) + (1 | Target) + (Mapping + 1 | Word), family = binomial)

As expected, there was a significant effect of block, showing that the participants were becoming more accurate at identifying the word-object mappings across blocks. As in Experiment 1, a significant main effect of target mapping was found, suggesting that the participants were better at learning the one-to-one than two-to-one mappings. Further, the interaction of block and target mapping was also significant (see Figure 6). This significant interaction, again, showed a convergence of the participants' performance in learning the two mapping types across blocks, despite initially being better at learning the one-to-one mappings. Notably, there was not a significant main effect of language group or any significant interactions involving language group.

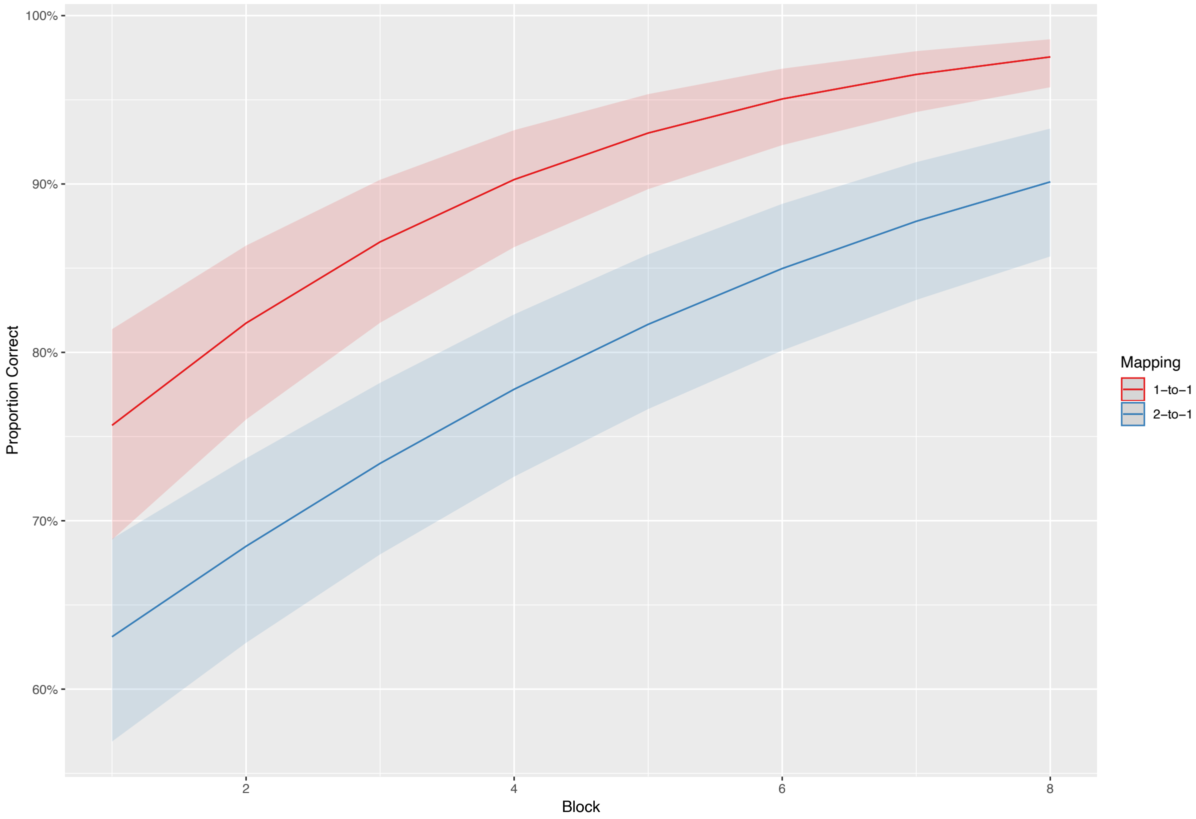

Figure 6. Interaction of block and target mapping. Shaded areas represent standard errors.

The data from this experiment were then compared to those from the two-speaker condition of Experiment 1 to determine whether the added socio-pragmatic cue (i.e., speaker language background in addition to speaker identity) had influenced the participants' performance. Again, GLM modelling was used to predict response accuracy. The data for GLM modelling consisted of the response accuracy from each participant on each trial, giving a total of 24320 observations.

A series of GLM models were, again, fitted using the glmer function (family = binomial). Collinearity diagnostic indicated no possible risk of collinearity (condition number = 25.47, all $|r|$s $\leq .08$). Predictors were, again, entered simultaneously, and a backwards elimination approach used. We included the following fixed factors: language group, block, target mapping type, and condition (no speaker language background vs. language background provided about speaker). Participant gender and speaker gender were included in our model selection process to ensure that these extraneous variables did not influence the participants' performance. Assuming the same random effects of participants, words, and target objects on intercepts and varying the fixed effects, the best model was the model with the following fixed effects: the two-way interaction and main effects of block and target mapping and those of language group and target mapping. This model was significantly better than a model with just the intercept, $\chi^2(5) = 933.29$, $p < .001$.

The best model after fitting a series of models with the random effects of participants, target objects, and words on the slopes of the fixed effects was the model containing the following random intercepts: subject, target object, and word; and the following random slopes: block and target mapping on subject. Comparing this model with the best model with just the fixed effects, the inclusion of the random effects was justified, $\chi^2(5) = 368.31$, $p < .001$. Again, the interaction of language group and target mapping became non-significant after the addition of the random slopes, and was thus dropped. The main effect of language group was also dropped for not being significant. The dropping of these fixed effects was justified, $\chi^2(2) = 2.39$, $p = .303$. The final model (AIC = 20878.4, BIC = 20975.6, logLik = -10427.2, deviance = 20854.4) is reported in Table 3.

Table 3

Summary of model comparing two-speaker conditions in Experiments 1 and 2

Fixed Effects	Estimated Coefficient	SE	Wald Confidence Intervals 2.50%	Wald Confidence Intervals 97.50%	*z*	*p*r(>|*z*|)

(Intercept)	0.8662	0.1494	0.5735	1.1590	5.800	< .001
Block	0.3708	0.0222	0.3274	0.4143	16.722	< .001
Target mapping (1-to-1 vs. 2-to-1)	-0.5536	0.1004	-0.7503	-0.3569	-5.516	< .001
Block × Target mapping	-0.1248	0.0186	-0.1612	-0.0883	-6.710	< .001
Random effects	Name		Variance	*SD*	Corr	
Subject	(Intercept)		0.3467	0.5888		
	Block		0.0159	0.1263	.42	
	Target mapping		0.2214	0.4705	-.84	-.67
Word	(Intercept)		0.1395	0.3735		
Target	(Intercept)		0.0416	0.2041		
	AIC	BIC	logLik	Deviance		
	20878.4	20975.6	-10427.2	20854.4		

Note. R syntax of the model is as follows: glmer (Accuracy ~ (Block + Mapping) ^ 2 + (Block + Mapping + 1 | Subject) + (1 | Target) + (1 | Word), family = binomial)

The same significant main effects and interaction as in the analysis of the data of this experiment alone were observed, and these significant fixed effects were in the same direction in both final models. Notably, there was not a significant main effect of language group or any significant interactions involving language group.

3.2.2 Performance on the ME task. As in Experiment 1, the participants' performance on the final four trials in the ME block was analysed. The same scoring scheme was used, with response in compliance to ME awarded a score of 1, otherwise a score of 0. See the third panel from the left in Figure 5 for mean scores.

We first analysed only the data from Experiment 2. Similar to the treatment in Experiment 1, GLM models were fitted to participants' scores on each trial (148 observations). Collinearity diagnostic indicated no possible risk of collinearity (condition number = 13.60, all $|r|$s $\leq .02$). Predictor variables of the GLM models were language group and average response accuracy of the distractor during the CSSL blocks. Extraneous variables, including participant gender and speaker gender were also included in the model selection process. Using the same backwards elimination approach, the best model (AIC = 91.0, BIC = 100.0, logLik = -42.5, deviance = 85.0) given the data was the model with only the intercept and the random intercepts of subject and target.

We then compared the data from this experiment to those from the two-speaker condition of Experiment 1 (304 observations). The same backwards elimination approach on GLM models, with the fixed effects involving condition, was used. Collinearity diagnostic indicated no possible risk of collinearity (condition number = 20.71, all $|r|$s $\leq .08$). The best model (AIC = 124.6, BIC = 135.7, logLik = -59.3, deviance = 118.6) given the data was the model with only the intercept and the random intercepts of subject and target.

3.3 Discussion

Our analyses of the data from Experiment 2 alone and those combining the two-speaker conditions of both Experiments 1 and 2 yielded similar results. As in Experiment 1, in the CSSL blocks, the participants showed improved learning of both types of mapping across blocks and that their performance on the one-to-one mappings was better. Notably, no significant main effects or interactions involving language group were found. This suggests that the significant two-way interaction of language group and target mapping and the three-way interaction of block, language group, and target mapping in Experiment 1 were mainly driven by the participants' performance in the one-speaker condition. A possible interpretation is that having two, rather than one, speakers had exerted subtle effects on the monolinguals' CSSL involving two types of mapping, and this effect was enhanced by additional socio-pragmatic information about the language backgrounds of the speakers. In other words, the higher the resemblance of the input to a natural bilingual environment, the more the monolinguals perform like the bilinguals.

The significant interaction of block and target mapping observed in both analyses of the CSSL blocks, and the lack of significant predictors in the analyses of the ME block, may have been influenced by a potential ceiling effect. In Experiment 3, we increased the difficulty of our task in order to obtain a clearer picture of the interplay between socio-pragmatic cues and cross-situational statistics in word learning.

4. Experiment 3

In this follow-up experiment, we aimed to see whether using a more difficult task – by increasing the number of objects on each trial from two to four, as in the training phase of Benitez et al.'s (2016) study – would provide us with a clearer picture of how socio-pragmatic information (i.e., speaker identity) influences monolingual and bilingual adults' learning of one-to-one and two-to-one word-object mappings in a CSSL task.

Experiment 3 was a replication of the two-speaker condition of Experiment 1, with the exception that each trial contained four, rather than two, objects. It was expected, as in Experiments 1 and 2, that both the monolingual and bilingual groups would be able to learn both types of mappings across CSSL training blocks. We also expected a main effect of condition, where the overall performance in the two-speaker condition of Experiment 1 would be better, as there were fewer distractors per training trial, making the task easier. Further, it was hypothesised that bilingual adults would be better initially at learning the two-to-one mappings, and this would be indicated by higher accuracy across training blocks. It was also hypothesised that bilingual adults will be more flexible in applying ME.

4.1 Method

4.1.1 Participants. Twenty monolingual (M_{age} = 21.30, *SD* = 4.30, 3 male) and twenty bilingual (M_{age} = 23.54, *SD* = 3.47, 3 male) participants were recruited through the department online recruitment system and advertisements on social networking websites. Three additional participants were tested but excluded due to technical difficulties ($n = 2$) and self-reported to be dyslexic ($n = 1$).

Monolinguals rated their English proficiency at an average of 10 (*SD* = 0.00). One monolingual participant indicated exposure to additional languages, but were considered functionally monolingual, as all such proficiency ratings were below 4 (*M* = 1.50, *SD* = 0.71). The bilingual group rated the proficiency of their first language at an average of 9.70 (*SD* = 0.80) and that of their additional languages at an average of 7.46 (*SD* = 2.12).

4.1.2 Materials and apparatus. All stimuli were the same as those in Experiment 1.

4.1.3 Procedure. The procedure was identical to that of the two-speaker condition in Experiment 1 with one exception: each trial consisted of four, rather than two, objects – one target and three distractors – presented in a single row. For the CSSL blocks, each object appeared four times as the target and twelve times as a distractor within each CSSL block. The position of the target was counterbalanced, such that each object was the target in each position once. As in Experiments 1 and 2, no objects appeared in any two consecutive trials in the CSSL block.

For the ME block, the two additional distractors on each trial were all objects from the one-to-one mappings in the CSSL blocks. Due to the limited number of such objects, some of them appeared in consecutive trials. The position of the target was counterbalanced, such that the target was in each position once for the first four trials, where the target was from the CSSL block, and for the last four trials, where the target was a new novel object. Critically, the task in Experiment 3 was created by adding two additional distractors on each trial of the two-speaker condition of Experiment 2 (ensuring no objects appeared in two consecutive trials), keeping the presentation orders of target and original foil the same. This allows a direct comparison with the data of Experiment 3 with those from the two-speaker condition in Experiment 1.

4.2 Results

As with Experiment 2, we first report results of this experiment analysed alone, followed by a comparison with the two-speaker condition in Experiment 1.

4.2.1 Learning over the training blocks. Data from one monolingual and two bilingual participants were excluded from analysis for not showing learning across training blocks.

To determine whether speaker identity had influenced the monolingual and bilingual adults' learning of the two types of mappings in this more difficult CSSL task, GLM modelling was used to predict response accuracy. See the rightmost panel in Figure 1 for mean response accuracy by target mapping and language group. The data for GLM modelling were based on the response accuracy from each participant on each trial, giving a total of 11840 observations.

As in Experiments 1 and 2, a series of GLM models were fitted using the glmer function (family = binomial) in the lme 4 package in R. Intercorrelations between all predictor variables and the outcome variable (response accuracy) were examined; and collinearity diagnostic indicated no possible risk of collinearity (condition number = 21.00, all $|r|$s $\leq .07$). In all models, all predictors were entered simultaneously. Again, a backwards elimination approach was used, entering as fixed factors: language group, block, and target mapping. Participant gender and speaker gender were also included in our model selection process. Assuming the same random effects of participants, words, and target objects on intercepts and varying the fixed effects, the best model was the model with the following fixed effects: the two-way interaction and main effects of block and language group and those of language group and target mapping. This model was significantly better than a model with just the intercept, $\chi^2(5) = 411.80$, $p < .001$.

A series of models with the random effects of participants, target objects, and words on the slopes of the fixed effects were then fitted. The best model was the model containing the following random intercepts: subject, target object, and word; and the following random slopes: language group on target and word. Comparing this model with the best model with just the fixed effects, the inclusion of the random effects was justified, $\chi^2(4) = 45.53$, $p < .001$. The interaction of language group and target mapping was then dropped, as it was not significant after the inclusion of the random slopes, and the removal of this interaction was justified, $\chi^2(1) = 3.45$, $p = .063$. The final model (AIC = 14785.8, BIC = 14874.4, logLik = -7380.9, deviance = 14761.8) is reported in Table 4.

Table 4

Summary of model of Experiment 3 alone

Fixed Effects	Estimated Coefficient	SE	Wald Confidence Intervals 2.50%	97.50%	*z*	*pr*(>|*z*|)
(Intercept)	-0.4188	0.2270	-0.8637	0.0260	-1.845	.0650
Block	0.1804	0.0124	0.1561	0.2046	14.563	< .001
Language group (mono vs. bi)	-0.1086	0.2610	-0.6201	0.4028	-0.416	.677
Target mapping (1-to-1 vs. 2-to-1)	-0.5061	0.0609	-0.6254	-0.3867	-8.308	< .001
Block × Language group	-0.0415	0.0177	-0.0760	-0.0069	-2.349	.0188
Random effects	**Name**		**Variance**	***SD***	**Corr**	
Subject	(Intercept)		0.4081	0.6388		
Word	(Intercept)		0.1727	0.4155		
	Language group		0.1067	0.3266	-.49	
Target	(Intercept)		0.1376	0.3709		
	Language group		0.0917	0.3028	-.63	
	AIC	**BIC**	**logLik**	**Deviance**		
	14785.8	14874.4	-7380.9	14761.8		

Note. R syntax of the model is as follows: glmer (Accuracy ~ (Block + LanguageGroup + Mapping) ^ 2 - Block:Mapping - LanguageGroup:Mapping + (1 | Subject) + (LanguageGroup + 1 | Target) + (LanguageGroup + 1 | Word), family = binomial)

As predicted, there were significant main effects of block and target mapping, showing that the participants became better at identifying the word-object mappings across blocks and were better at learning the one-to-one mappings. Although there was not a significant main effect of language group, the significant interaction of block and language group revealed that, surprisingly, the monolinguals' learning rate was steeper than that of the bilinguals (see Figure 7).

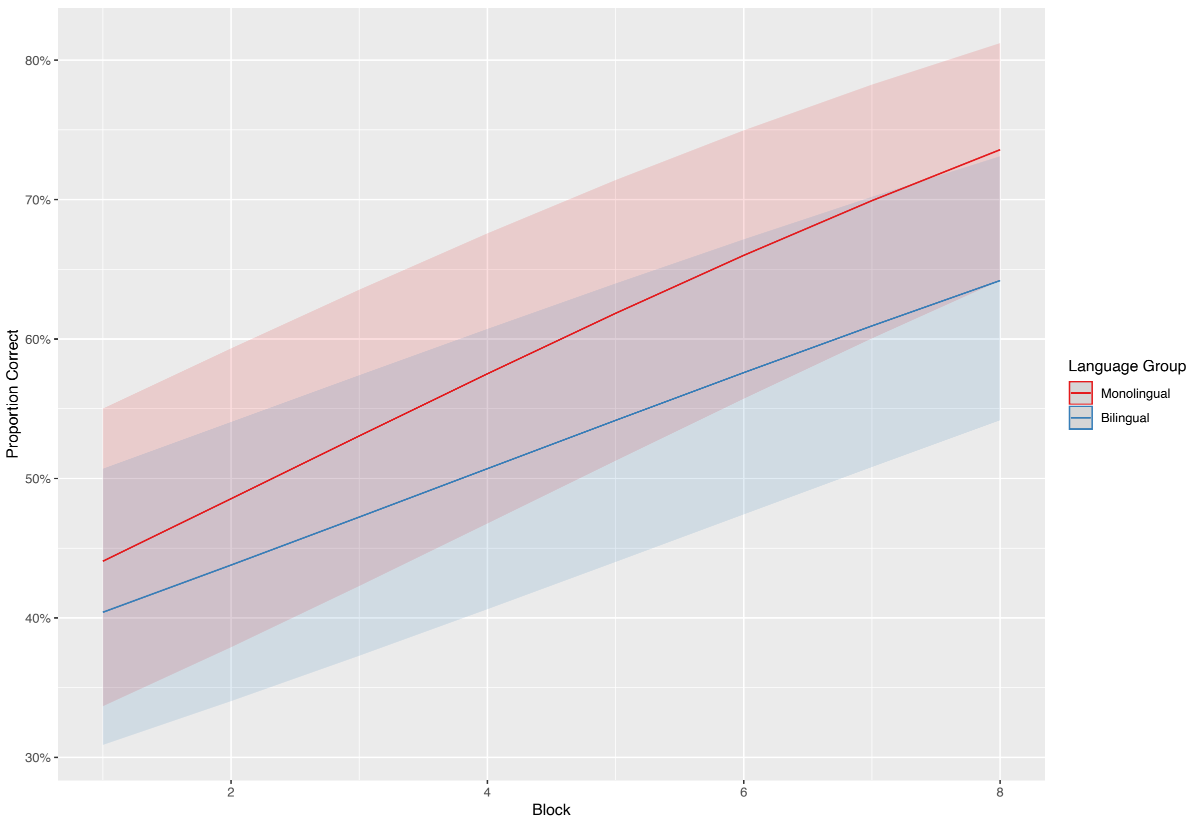

Figure 7. Interaction of block and language group. Shaded areas represent standard errors.

We then compared the data from this experiment to those from the two-speaker condition of Experiment 1 to determine whether task difficulty had impacted on the participants' performance. Again, GLM modelling was used to predict response accuracy. The data for GLM modelling consisted of 23680 observations.

A series of GLM models were, again, fitted using the glmer function (family = binomial). Collinearity diagnostic indicated no possible risk of collinearity (condition number = 22.77, all $|r|$s $\leq .06$). Predictors were, again, entered simultaneously, and a backwards elimination approach used. We included the following fixed factors: language group, block, target mapping, and condition (two objects per training trial vs. four objects per training trial). Participant gender and speaker gender were included in our model selection process to check if they had influenced the participants' performance. Assuming the same random effects of participants, words, and target objects on intercepts and varying the fixed effects, the best model was the model with the following fixed effects: the three-way interaction of block, condition, and target mapping, the two-way interaction of language group and target mapping, the two-way interaction of block and language group, and all the lower order interactions and main effects of these interactions. This model was significantly better than a model with just the intercept, $\chi^2(10) = 1141.90$, $p < .001$.

The best model after fitting a series of models with the random effects of participants, target objects, and words on the slopes of the fixed effects was the model containing the following random intercepts: subject, target object, and word; and the following random slopes: block and target mapping on word and language group on target. Comparing this model with the best model with just the fixed effects, the inclusion of the random effects was justified, $\chi^2(7) = 386.48$, $p < .001$. The two-way interaction of language group and target mapping and that of block and language group, as well as the main effect of language group, became non-significant after the inclusion of the random slopes and were thus dropped. The dropping of these fixed effects was justified, $\chi^2(3) = 1.39$, $p = .708$. The final model (AIC = 25081.1, BIC = 25226.9, logLik = -12522.5, deviance = 25045.1) is reported in Table 5.

Table 5

Summary of model comparing two-speaker conditions in Experiments 1 and 3

Fixed Effects	Estimated Coefficient	SE	Wald Confidence Intervals 2.50%	Wald Confidence Intervals 97.50%	*z*	*p*r(>|*z*|)
(Intercept)	0.6948	0.2181	0.2674	1.1222	3.186	.0014
Block	0.3807	0.0283	0.3252	0.4362	13.447	< .001
Condition (2 vs. 4 objects)	-1.2839	0.1725	-1.6219	-0.9458	-7.444	< .001
Target mapping (1-to-1 vs. 2-to-1)	-0.3053	0.2558	-0.8066	0.1961	-1.193	.2327
Block × Condition	-0.1974	0.0360	-0.2679	-0.1269	-5.488	< .001
Block × Target mapping	-0.1255	0.0262	-0.1769	-0.0742	-4.789	< .001
Condition × Target mapping	-0.0358	0.1843	-0.3970	0.3253	-0.194	.8458
Block × Condition × Target mapping	0.1008	0.0320	0.0381	0.1636	3.152	.0016

Random effects	Name	Variance	*SD*	Corr
Subject	(Intercept)	0.3203	0.5660	
	Block	0.0104	0.1018	.75

	Target mapping	0.2738	0.5233	-.87	-.67
Word	(Intercept)	0.1597	0.3996		
	Target mapping	0.5963	0.7722	-.72	
Target	(Intercept)	0.1200	0.3464		

AIC	BIC	logLik	Deviance
25081.1	25226.9	-12522.5	25045.1

Note. R syntax of the model is as follows: glmer (Accuracy ~ (Block + Condition+ Mapping)^3 + (Block + Mapping + 1 | Subject) + (1 | Target) + (Mapping + 1 | Word), family = binomial)

In line with our prediction, there was a significant main effect of block, showing that the participants became increasingly better at identifying the word-object mappings. The significant main effect of condition showed that, in line with our prediction, the participants performed better in the two- compared to four-object condition.

In addition, the three-way interaction of block, condition, and language group yielded statistical significance, showing that towards the final training blocks, the participants in the two-object condition performed better on the one-to-one mappings, whereas the same advantage with regards to the one-to-one mappings was not observed in the four-object condition (see Figure 8).

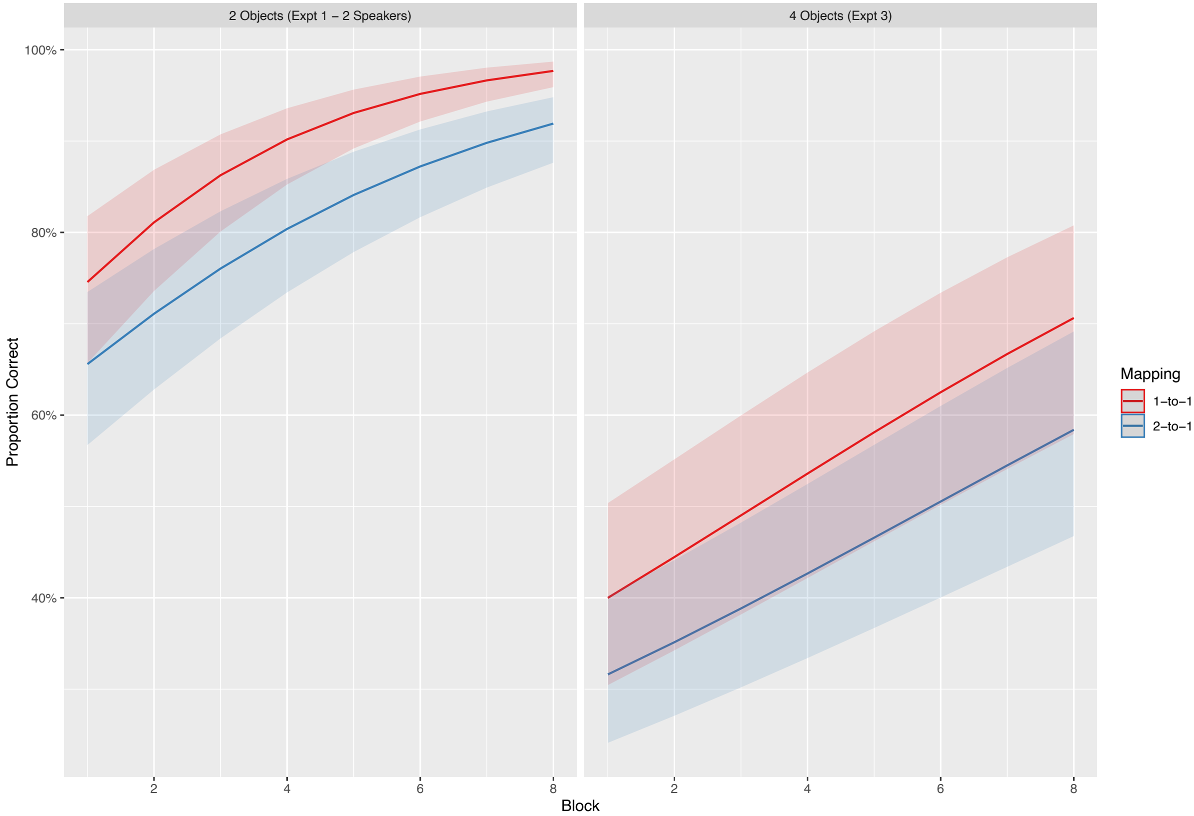

Figure 8. Three-way interaction of block, condition, and target mapping. Shaded areas represent standard errors.

Further, there were two significant two-way interactions. The significant interaction of block and target mapping indicated that although performance on both types of mapping were similar towards the start of the training, the participants were better at identifying the one-to-one than two-to-one mappings towards the end of training (see Figure 9). In light of the significant three-way interaction of block, condition, and target mapping, this significant two-way interaction was likely driven by the performance in the two-object condition. The significant interaction of block and condition showed that the performance in the four-object condition kept improving, whereas that in the two-object condition plateaued towards the end of training (see Figure 10).

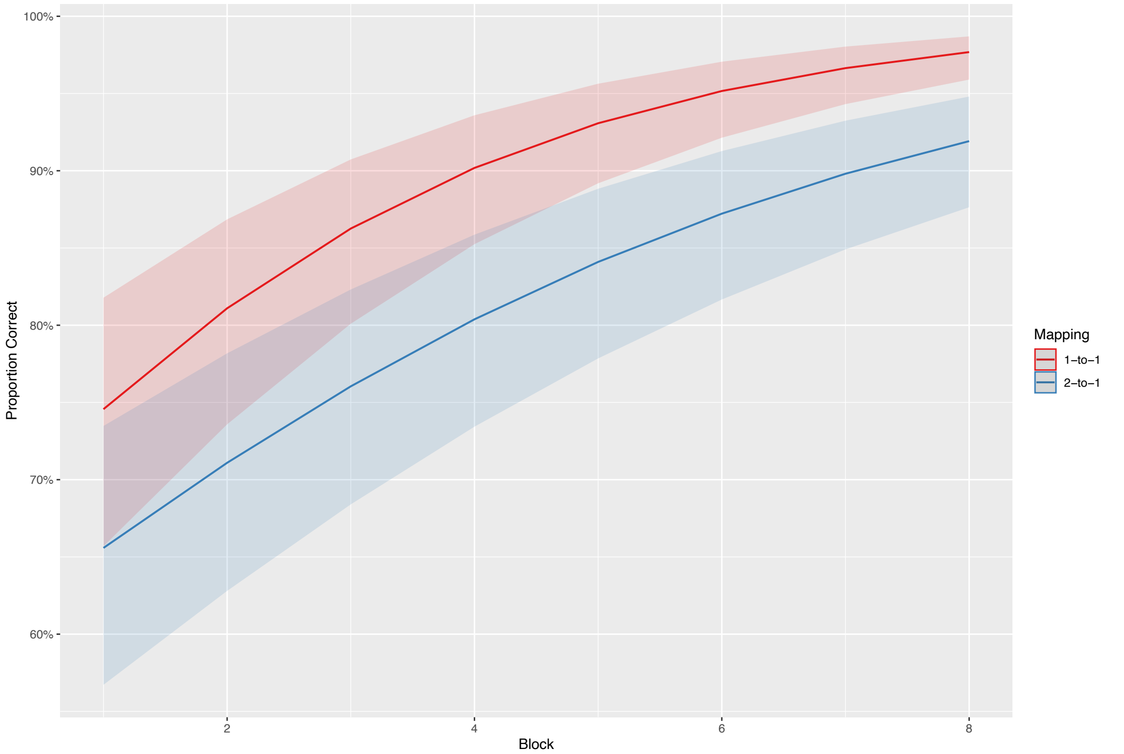

Figure 9. Interaction of block and target mapping. Shaded areas represent standard errors.

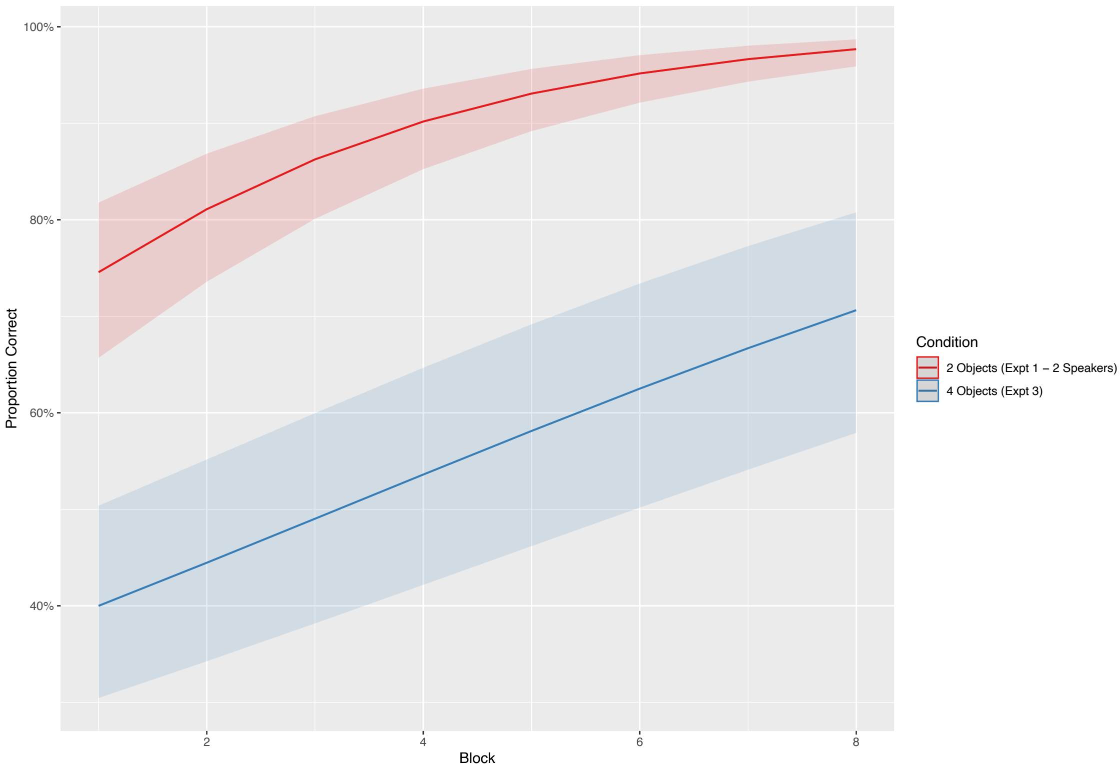

Figure 10. Interaction of block and condition. Shaded areas represent standard errors.

4.2.2 Performance on the ME task. As in Experiments 1 and 2, the participants' performance on the final four trials in the ME block was analysed. The same scoring scheme was used, with response in compliance to ME awarded a score of 1, otherwise a score of 0. Mean scores can be examined in the rightmost panel in Figure 5.

We first analysed only the data from Experiment 3. Similar to the treatment in Experiments 1 and 2, GLM models were fitted to participants' scores on each trial (148 observations). Collinearity diagnostic indicated no possible risk of collinearity (condition number = 16.42, all $|r|$s $\leq .07$). Predictor variables of the GLM models were language group and average response accuracy of the distractor during the CSSL blocks. Note that as there were three distractors instead of one, the average response accuracy used was the average of all three distractors. Participant gender and speaker gender were also included in the model selection process. Using the same backwards elimination approach, the best model (AIC = 113.6, BIC = 119.5, logLik = -54.8, deviance = 109.6) given the data was the model with only the intercept and the random intercepts of subject and target.

We then compared the data from this experiment to those from the two-speaker condition of Experiment 1 (304 observations). The same backwards elimination approach on GLM models, with additional fixed effects involving condition, was used. Collinearity diagnostic indicated no possible risk of collinearity (condition number = 15.54, all $|r|$s $\leq .06$). Assuming the same random effects of participants, words, and target objects on intercepts and varying the fixed effects, the best model was the model with the main effect of condition. This model was significantly better than a model with just the intercept, $\chi^2(1) = 12.67$, $p < .001$.

A series of models with the random effects of participants, target objects, and words on the slopes of the main effect of condition were then fitted. The best model was the model containing the random slope intercept of target objects. The exclusion of the random intercepts of participants and words was justified, $\chi^2(2) = 0.00$, $p = 1.00$. The final model (AIC = 145.2, BIC = 156.3, logLik = -69.6, deviance = 139.2) is reported in Table 6. The effect of condition means that accuracy in the ME task was higher in the presence of two rather than four objects.

Table 6

Summary of model comparing ME blocks of the two-speaker conditions in Experiments 1 and 3

Fixed Effects	Estimated Coefficient	SE	Wald Confidence Intervals 2.50%	97.50%	*z*	*pr*(>|*z*|)
(Intercept)	3.9434	0.5937	2.7797	5.1070	6.642	< .001
Condition (2 vs. 4 objects)	-1.9571	0.6352	-3.2020	-0.7122	-3.081	.0021
Random effects	Name		Variance	*SD*		
Target	(Intercept)		0.0241	0.1553		
	AIC	BIC	logLik	Deviance		
	145.2	156.3	-69.6	139.2		

Note. R syntax of the model is as follows: glmer (Accuracy ~ Condition + (1 | Target), family = binomial)

4.3 Discussion

In Experiment 3, we successfully replicated the main effects of block and target mapping from Experiments 1 and 2. To our surprise, increasing the number of distractors has led to an unanticipated language group difference, such that there was a monolingual advantage towards the end of the CSSL blocks. Although similar studies tend to find that both monolinguals and bilinguals perform comparably or bilinguals perform better (see Weiss, Schwob, & Lebkuecher, 2020 for a review), a monolingual advantage has been documented in Poepsel and Weiss (2016). However, Poepsel and Weiss noted that the observed monolingual advantage was likely due to their language stimuli being more similar to the language that the monolinguals spoke. The same also applies to our results. All of the novel words used in our experiments were phonotactically legal in English, which was the first language of our monolingual participants. Our bilingual participants spoke a range of different first languages (e.g., Chinese and German), which vary in terms of phonological similarity with English. The bilingual participants in our experiments were, therefore, likely to be less familiar with the phonology of the novel words used, making the learning task more difficult for them. This difference may not be observable in an easy task, as was the case for the two-object conditions in the present study, but would be pronounced in a more difficult task, as was the case for the four-object condition in Experiment 3. Future experiments could recruit bilingual participants who speak the same languages and more carefully manipulate the phonology of the test stimuli, such that they conform to or violate the native phonology of all participants, to further elucidate the source of this observed difference.

When comparing data from Experiment 3 to those from the two-speaker condition of Experiment 1, we observed the same significant main effect of block. Also, as expected, increasing the number of distractors made the task more difficult for the participants. Amid this increased task complexity, the potential ceiling effect we observed in Experiment 1 was no longer present in the four-object condition, as evident in the significant three-way interaction of block, condition, and target mapping. This suggests that the more complex task used in this experiment could better capture the variability in performance of language learners. The significant interaction of block and target mapping was likely driven by the potential ceiling effect discussed in relation to the two-object condition, as the same significant effect was not observed when analysing the data from Experiment 3 alone.

Further, the participants' performance in the ME block was different across the two conditions, with better performance in the two-object condition. This suggests that the participants use of ME was contingent on how well they have learned the one-to-one mappings in the CSSL training blocks, such that the better they knew the names of the objects of the one-to-one mappings, the more likely they would pick the new novel object as the referent of a new word. Although the average response accuracies of the distractor during the CSSL blocks did not predict the participants' application of ME, we note that the average response accuracies in the two conditions represented different quantities of information. In the two-object condition, it represents the knowledge of a particular one-to-one mapping, whereas in the four-object condition, it represents the knowledge of three one-to-one mappings, which the participants might have learned to varying extents. More importantly, there was not a difference between the performance of the two language groups, which was the same as in Experiments 1 and 2.

5. General Discussion

Across a series of experiments using a CSSL paradigm, we investigated whether varying socio-pragmatic information on speaker identity – number of speakers (Experiment 1) and speaker language background (Experiments 1 and 2) – and task complexity – number of distractors per learning instance (Experiments 1 and 3) – would impact on monolingual and bilingual adults' cross-situational word learning. Across all three experiments, our results showed that, in line with previous research (e.g., Benitez et al., 2016), both monolingual and bilingual adults are capable of learning one-to-one and two-to-one word-object mappings through CSSL. In Experiment 1, where we manipulated speaker identity (one speaker vs. two speakers), we found that the monolinguals showed a preference for learning one-to-one mappings, whereas bilinguals were initially open to learning both one-to-one and two-to-one mappings. This suggests that the monolinguals and bilinguals brought different biases in relation to how words map onto objects to the CSSL tasks. In line with previous findings (e.g., Byers-Heinlein et al., 2014; Henderson & Scott, 2015; Kalashnikova et al., 2015), based on their language experience, monolinguals expect word-object mappings to adhere to ME (i.e., one-to-one mapping), whereas bilinguals are more flexible and are more likely to relax ME and accept lexical overlap (i.e., two-to-one mappings). Interestingly, when we introduced more socio-pragmatic cues on speaker language background in Experiment 2, the difference between the two language groups reduced, suggesting that the difference observed in Experiment 1 was driven by the one-speaker condition. This implies that in situations without any contextual information, bilinguals are more likely than monolinguals to accept lexical overlap, whereas in situations where there are cues, in this case socio-pragmatic information on speaker identity, hinting at multiple language structures at play, monolinguals could also relax ME. This is seemingly inconsistent with the results of Poepsel and Weiss (2014) that showed no effect of speaker identity on the performance of monolinguals in a CSSL task that involved the learning of word-object mappings that violate ME. Yet, Poepsel and Weiss tested the learning of one-to-two word-object mappings, whereas we tested the learning of two-to-one word-object mappings. Between languages, there are usually more translation equivalents (i.e., two-to-one word-object mappings) than false cognates (i.e., one-to-two word-object mappings). The learning of two-to-one word-object mappings in the present study is thus arguably closer to learning in an actual bilingual environment.

Our finding that speaker identity, with and without additional information on speaker language background, only exerted subtle effects on monolinguals' cross-situational word learning coupled with the result of Benitez et al.'s (2016) study that bilinguals were better than monolinguals at learning two-to-one mappings in the presence of a linguistic cue suggest that language experience plays a role in the application of different word-learning strategies and could potentially add to the emergentist account of word learning. The emergentist account of word learning suggests that language learners draw on a range of available cues to learn the meaning of new words and that the weightings of these different cues change as the learner matures (Hollich, Hirsh-Pasek, & Golinkoff, 2000; Pruden, Hirsh-Pasek, Golinkoff, & Hennon, 2006). For example, language learners first rely on basic constraints (e.g., attentional bias or ME) to guide their learning of word meanings, then move on to rely more on socio-pragmatic cues when they mature and realise that socio-pragmatic cues are more reliable than basic constraints in determining the meaning of new words.

Our finding and that of Benitez et al. (2016) suggest that monolinguals and bilinguals may weigh ME, socio-pragmatic cues on speaker identity, and linguistic cues differently. Monolinguals may weigh ME more heavily when the situation is ambiguous. However, in an environment with multiple languages, learners have to quickly discriminate the different structures (Gebhart, Aslin, & Newport, 2009).

Previous studies (e.g., Qian, Jaeger, & Aslin, 2012) have shown that socio-pragmatic cues, such as a voice change, can help learners focus on the syntactic structures available in the input. Therefore, when socio-pragmatic information is available, as in our two-speaker conditions, they would weigh such information more heavily than ME in determining the meaning of new words. For bilinguals, they do not show heavy reliance on ME and are open to learning word-object mappings that are inconsistent with ME (e.g., Byers-Heinlein & Werker, 2009; Kalashnikova et al., 2015), although they might still show better learning for one-to-one mappings as they are more consistent and reliable in the input. Socio-pragmatic information on speaker identity may not influence bilingual's learning of two-to-one mappings, as speaker identity is not always a sufficiently reliable cue to signpost a switch in language – a speaker can speak different languages and different speakers can speak the same language. Compared to socio-pragmatic cue on speaker identity, linguistic cues would be more consistent and reliable in determining whether there is a switch between languages for bilinguals. A sensitivity to language-internal over speaker-associated cues could arise from the language experience of bilingual learners, with bilingual experience highlighting to them that language structures pertain to the language a speaker is speaking, not who the speaker is. Such language experience would build openness to the idea that a speaker can speak more than one language into bilingual learners' socio-pragmatic machinery, leading them to look to other, more reliable cues to language structure – the language itself (e.g., phonology). The same may not apply to monolinguals, as they are less experienced in and therefore arguably less sensitive in detecting speaker-language inconsistencies, thus speaker-associated cues (e.g., speaker identity) might be sufficient to index a switch in language.

In Experiments 1 and 2, where we presented the participants with two objects per training trial, we observed a potential ceiling effect towards the end of training, especially for the one-to-one mappings. This could have potentially influenced some of our results, resulting in a reduced effect of language group or of number of speakers on learning. Yet, note that the difference between the two language groups on the learning of the two mapping types observed towards the first training blocks in Experiment 1 could not have been influenced by the potential ceiling effect, as it occurred early in the task. When we increased task complexity by introducing more distractors per training trial in Experiment 3, the suspected ceiling effect disappeared. When there was only one distractor per training trial, the one-to-one mappings were easier to learn, and the participants' learning rate levelled towards the end of training. Yet, when there were three distractors per training trial, although the one-to-one mappings were still easier to learn, the learning rates of one-to-one and two-to-one mappings were comparable. This suggests that the learning of word-object is dependent, to a certain extent, on how noisy the environment is. Curiously, the increased complexity also brought about an unexpected advantage of the monolingual group, in that their overall learning rate was steeper than that of the bilingual group. We acknowledged that a similar monolingual advantage was also observed in Poepsel and Weiss (2016), which could be influenced by how familiar the participants were with the phonology of the novel words used in the task. We suggested that further studies could test a more homogenous group of bilinguals and carefully manipulate the phonology of the test stimuli.

In line with Benitez et al.'s main finding, we consistently found that both groups of participants in the present study were better at learning the one-to-one than two-to-one word-object mappings. Yet, the main effect of mapping type could be attributed to different factors. In our study, the participants were provided with more instances of the co-occurrence of the one-to-one mappings compared to each side of the two-to-one mappings, thus the better performance on the one-to-one mappings likely reflected the amount of exposure to word-object pairs. In Benitez et al.'s study, the number of co-occurrences of each corresponding word-object pair was the same for both mapping types, the difference between the two mapping types was the spurious co-occurrences of unpaired word-object mappings, which was higher for the two-to-one mappings. Therefore, the same effect in their study likely reflected the less noisy input for the one-to-one mappings. On a related note, the design of our CSSL task required participants to make a decision about a pairing on every trial, unlike in Benitez et al.'s (2016) study and other previous studies (e.g., Poepsel & Weiss, 2014, 2016) where participants went through a familiarisation phase and then a test phase. This requirement to respond could have made the participants' learning of the word-object mappings more explicit and highlighted to the participants that there were two-to-one mappings to learn, by forcing them to choose a referent for words. Also, as noted earlier, our CSSL task and Benitez et al.'s task also differed in terms of the number of word-object pairs provided per training trial. In Benitez et al.'s task, everything on every trial was named, whereas in our task, only one object was named on each trial. Although, ultimately, our findings were comparable, the underlying mechanisms that guided the observed responses might be different. Determining the extent of referential ambiguity and the relative occurrence of two-to-one versus one-to-one mappings in the language learner's experience will enable us to determine more closely which experimental task better resembles natural language learning and help us better understand CSSL in a naturalistic environment.

The results of the ME blocks of all three experiments showed no difference between language groups, and suggest that their learning of two-to-one mappings was based on successful tracking of the two language structures rather than a general relaxation of ME. However, towards the end of the CSSL blocks, the participants were reasonably accurate at identifying the one-to-one mappings (close to 100% accuracy in the two-object conditions and above 70% accuracy in the four-object condition), it was possible that this high familiarity influenced their performance, biasing them to map the new novel nameless object to the novel name. Hence, the ME test may not have truly probed the word-learning strategies used by the participants throughout the CSSL blocks. It is suggested that future studies could include additional ME blocks, for instance after the first CSSL block, or intersperse ME trials in the CSSL blocks to test whether the participants' word-learning strategies and expectations of how words map onto objects have changed throughout the task.

In summary, we replicated previous studies that found that language learners are adept at accepting multiple labels for the same object. Participants' language background exerted subtle effects on this ability, with the monolinguals showing a preference for one-to-one word-object mappings and the bilinguals more open to learning two-to-one word-object mappings when no contextual information was available. In addition, our manipulation of speaker identity exerted subtle effects on the monolinguals and bilinguals' performance, suggesting that language experience plays a role in the application of different word-learning strategies. Further, we found that language learners' learning of word-object mappings is also affected by task complexity, in our case indicated by how noisy the learning environment is and, potentially also how familiar the learner is with the phonology of the new words. These results show that the parameters determining how word-object mappings are acquired and the role of language experience in driving this learning are complex and varied. In a broader sense, the results of the present study have demonstrated that language learners can flexibly use multiple word-learning strategies to learn different language structures in solving the “Gavagai” problem. Nevertheless, the results of the present study, in terms of trajectory of learning on the CSSL task, suggest that the extent to which a word-learning strategy is relied upon depends in part on an individual learner’s previous experience with languages and the learning context. These results begin to give us some insights into how language experience, contextual cues, and task design contribute to shaping learners’ use of different word-learning strategies. Of note, this study provides the first evidence that CSSL of one-to-one and two-to-one word-object mappings is dependent on whether a learner is monolingual or bilingual and the presence of socio-pragmatic cues on speaker identity in a given learning context.

References

Akhtar, N., & Tomasello, M. (1996). Two-year-olds learn words for absent objects and actions. *Developmental Psychology*, *14*, 79-93. doi: 10.1111/j.2044-835X.1996.tb00695.x

Benitez, V. L., Yurovsky, D., & Smith, L. B. (2016). Competition between multiple words for a referent in corss-situational word learning. *Journal of Memory and Language*, *90*, 31-48. doi: 10.1016/j.jml.2016.03.004

Byers-Heinlein, K., Chen, K. H., & Xu, F. (2014). Surmounting the Tower of Babel: Monolingual and bilingual 2-year-olds' understanding of the nature of foreign language words. *Journal of Experimental Child Psychology*, *119*, 87-100. doi: 10.1016/j.jecp.2013.09.011

Byers-Heinlein, K., & Werker, J. F. (2009). Monolingual, bilingual, trilingual: Infants' language experience influences the development of a word-learning heuristic. *Developmental Science*, *12*, 815-823. doi: 10.1111/j.1467-7687.2009.00902.x

Escudero, P., Mulak, K. E., Fu, C. S. L., & Singh, L. (2016). More limitations to monolingualism: Bilinguals outperform monolinguals in implicit word learning. *Frontiers in Psychology, 7*, 1218. doi: 10.3389/fpsyg.2016.01218

Fitneva, S. A., & Christiansen, M. H. (2011). Looking in the wrong direction correlates with more accurate word learning. *Cognitive Science*, *35*, 367-380. doi: 10.1111/j.1551-6709.2010.01156.x

Gebhart, A. L., Aslin, R. N., & Newport, E. L. (2009). Changing structures in midstream: Learning along the statistical garden path. *Cognitive Science*, *33*, 1087-1116. doi: 10.1111/j.1551-6709.2009.01041.x

Hamrick, P., & Rebuschat, P. (2012). How implicit is statistical learning?. In P. Rebuschat & J. N. Williams (Eds.), *Statistical learning and language acquisition* (pp. 365-382). Berlin: de Gruyter Mouton.

Henderson, A. M. E., & Scott, J. C. (2015). She called that thing a mido, but should you call it a mido too? Linguistic experience influences infants' expectations of conventionality. *Frontiers in Psychology*, *6*, 332. doi: 10.3389/fpsyg.2015.00332

Hollich, G. J., Hirsh-Pasek, K., & Golinkoff, R. M. (2000). Breaking the language barrier: An Emergentist Coalition Model for the origins of word learning. *Monographs of the Society for Research in Child Development*, *65* (3, Serial No. 262). Retrieved from http://www.jstor.org/stable/3181533

Horst, J. S., & Hout, M. C. (2016). The Novel Object and Unusual Name (NOUN) Database: A collection of novel images for use in experimental research. *Unpublished manuscript*.

Ichinco, D., Frank, M., & Saxe, R. (2009). Cross-situational word learning respects mutual exclusivity. In N. Taatgen & H. van Rijn (Eds.), *Proceedings of the 31st Annual Meeting of the Cognitive Science Society* (pp. 2214-2219). Austin, TX: Cognitive Science Society.

Kachergis, G., Yu, C., & Shiffrin, R. M. (2009). Frequency and contextual diversity effects in cross-situational word learning. In N. Taatgen & H. van Rijn (Eds.), *Proceedings of the 31st Annual Meeting of the Cognitive Science Society* (pp. 2220-2225). Austin, TX: Cognitive Science Society.

Kalashnikova, M., Mattock, K., & Monaghan, P. (2015). The effects of linguistic experience on the flexible use of mutual exclusivity in word learning.

Bilingualism: Language and Cognition, *18*, 626-638. doi: 10.1017/S1366728914000364

Markman, E. M. (1991). The whole-object, taxonomic, and mutual exclusivity assumptions as initial constraints on word meanings. In S. A. Gelman & J. P. Brynes, *Perspectives on language and thought: Interrelations in development* (pp.72-106). New York, NY: Cambridge University Press.

Markman, E. M., & Hutchinson, J. E. (1984). Children's sensitivity to constraints on word meaning: Taxonomic versus thematic relations. *Cognitive Psychology*, *16*, 1-27. doi: 10.1016/0010-0285(84)90002-1

Markman, E. M., & Wachtel, G. F. (1988). Children's use of mutual exclusivity to constrain the meanings of words. *Cognitive Psychology*, *20*, 121-157. doi: 10.1016/0010-0285(88)90017-5

Metzing, C., & Brennan, S. E. (2003). When conceptual pacts are broken: Partner-specific effects on the comprehension of referring expressions. *Journal of Memory and Language*, *49*, 201-213. doi: 10.1016/S0749-596X(03)00028-7

Monaghan, P., & Mattock, K. (2012). Integrating constraints for learning word-referent mappings. *Cognition*, *123*, 133-143. doi: 10.1016/j.cognition.2011.12.010

Pierce, J. W. (2009). Generating stimuli for neuroscience using PsychoPy. *Frontiers in Neuroscience Methods*, *162*, 8-13. doi: 10.3389/neuro.11.010.2008

Poepsel, T. J., & Weiss, D. J. (2014). Context influences conscious appraisal of cross situational statistical learning. *Frontiers in Psychology*, *5*, 691. doi: 10.3389/fpsyg.2014.00691

Poepsel, T. J., & Weiss, D. J. (2016). The influence of bilingualism on statistical word learning. *Cognition*, *152*, 9-19. doi: 10.1016/j.cognition.2016.03.001

Pruden, S. M., Hirsh-Pasek, K., Golinkoff, R. M., & Hennon, E. A. (2006). The birth of words: Ten-month-olds learn words through perceptual salience. *Child development*, *77*, 266-280. doi: 10.1111/j.1467-8624.2006.00869.x

Qian, T., Jaeger, T. F., & Aslin, R. N. (2012). Learning to represent a multi-context environment: more than detecting changes. *Frontiers in Psychology*, *3*, 228. doi: 10.3389/fpsyg.2012.00228

Quine, W. V. O. (1960). *Word and object*. Cambridge, MA: MIT Press.

The Object Databank [Computer software]. (1996). Carnegie Mellon University. Retrieved from: http://wiki.cnbc.cmu.edu/Objects

Tomasello, M. (2000). The social-pragmatic theory of word learning. *Pragmatics*, *10*, 401-413. doi: 10.1075/prag.10.4.01tom

Tomasello, M, & Barton, M. E. (1994). Learning words in nonostensive contexts. *Developmental Psychology*, *30*, 639-650. doi: 10.1037/0012-1649.30.5.639

Trude, A. M., & Brown-Schmidt, S. (2012). Talker-specific perceptual adaptation during online speech perception. *Language and Cognitive Processes*, *27*, 979-1001. doi: 10.1080/01690965.2011.597153

Vouloumanos, A. (2008). Fine-grained sensitivity to statistical information in adult word learning. *Cognition*, *107*, 729-742. doi: 10.1016/j.cognition.2007.08.007

Weiss, D. J., Schwob, N., & Lebkuecher, A. L. (2020). Bilingualism and statistical learning: Lessons from studies using artificial languages. *Bilingualism: Language and Cognition*, *23*, 92-97. doi: 10.1017/S1366728919000579

Yu, C., & Smith, L. B. (2007). Rapid word learning under uncertainty via cross-situational statistics. *Psychological Science*, *18*, 414-420. doi: 10.1111/j.1467-9280.2007.01915.x

Appendix

Stimuli

Words

Familiar

bed	chair	flower	hat
carrot	cup	fork	pear

Novel – from the NOUN Database

bem /bɛm/	fimp /fɪmp/	lorp /lɔp/	sprock /sprɒk/
biss /bɪs/	gasser /gæsə/	modi /məʊdi/	tannin /tænin/
blicket /blɪkɪt/	glark /glak/	poip /pɔɪp/	teebu /tibu/
doff /dɒf/	jefa /jifə/	shill /ʃɪl/	toma təʊmə/
fiffin /fɪfɪn/	koba /kəʊbə/	sibu /sibu/	yosp /yɒsp/

Objects

Familiar – from the TarrLab Object Databank

BED	CHAR4	SFLWR	HAT2
CARO2	CUP2	FORK	PEAR

Unfamiliar – from the NOUN Database

2001	2005	2016	2023
2002	2011	2021	2027

2028	2048	2063
2033	2055	2064

Chapter 4: Adapting to Children's Individual Language Proficiency: An Observational Study of Preschool Teacher Talk Addressing Monolinguals and Multilinguals

This chapter presents an observational study that addresses the second theme of the thesis – the influence of specific linguistic features of the input on language development in children learning the majority language as an additional language at different stages of development. This chapter assessed the general linguistic environment of a preschool classroom with a mix of monolingual and EAL children and compared the quantity and quality of the linguistic input that the two groups of children received. This chapter also examined whether preschool teachers adapted their language use to individual children's language capacity.

Statement of Author Contribution

In the chapter entitled "Adapting to Children's Individual Language Proficiency: An Observational Study of Preschool Teacher Talk Addressing Monolinguals and Multilinguals", the authors agree to the following contributions:

Kin Chung Jacky Chan – 70% (Design, data collection, data analysis, and writing)

Signed: Jacky Date: 19/6/2020

Padraic Monaghan – 15% (Design and review)

Signed: P Monaghan Date: 24/6/2020

Marije Michel – 15% (Design and review)

Signed: Date: 24/6/2020

Text as it appears in Chan, K. C. J., Monaghan, P., & Michel, M. (2020). *Adapting to children's individual language proficiency: An observational study of preschool teacher talk addressing monolinguals and multilinguals*. Manuscript under review.

Abstract

In an increasingly diverse society, young children are likely to speak different first languages that are not the majority language of society. Preschool might be one of the first and few environments where they experience the majority language. The present study investigated how preschool teachers communicate with monolingual English preschoolers and preschoolers learning English as an additional language (EAL). We recorded and transcribed four hours of naturalistic preschool classroom activities and observed whether and how preschool teachers tailored their speech to children of different language proficiency levels and linguistic backgrounds (monolingual English: $n = 13$; EAL: $n = 10$), using a suite of tools for analysing quantity and quality of the speech. We found that teachers used more diverse vocabulary and more complex syntax with the monolingual children and children who were more proficient in English, showing sensitivity to individual children's language capabilities and adapting their language use accordingly.

1. Introduction

In recent decades, society has become increasingly linguistically diverse, supported by greater mobility of populations (e.g., in the UK, Office for National Statistics, 2017; across the EU, Eurostat, 2018; and in the USA, Department of Home and Security, 2018). Vertovec (2007) coined this phenomenon of people from multiple geographic origins in UK society "super-diversity" (see also Acosta-Garcia & Martinez-Ortiz, 2013; Spoonley, 2013; Wiley, 2017). As a consequence of this super-diversity, language diversity increases. As a result, young children in our society become more likely to speak a variety of different first languages that are not the majority language of society. For instance, in January 2019, 21.2% of pupils in UK state-funded primary schools did not speak English as their first language (Department for Education, 2019).

In the case of the UK, the increasing diversity means that many preschool children do not speak English at home and often only use or are exposed to English as an additional language (EAL). As the current policy of the UK Government is to provide free childcare for all children from 3 years, and for children from lower economic backgrounds from 2 years, young children tend to spend at least 15 hours a week at preschool. For EAL children, preschool might be one of the few environments where they experience English, the majority language of society. Many of these EAL children will initially not be as proficient in English as their monolingual English peers, and some may possess none or only minimal English. A pressing issue encountered by preschool teachers in the UK is how to communicate with these children and help them acquire the English language (Hutchinson, 2018), especially when the children first attend preschool. This is not only important for integrating EAL children into the preschool, and later school, environment; it also has implications for the children's later academic achievement, as students who are less proficient in English when beginning reception year in school tend to be less successful throughout their schooling (e.g., Guerrero, 2004; Reardon, 2013; Snow, Burns & Griffin, 1998; von Hippel, Workman, & Downey, 2017). Potential first steps to addressing this issue would be to find out, in a natural preschool environment, how preschool teachers speak to EAL children, and then determine which linguistic features of preschool teacher talk are important or beneficial for EAL children's language development.

1.1 Linguistic Input and Monolingual Language Development

There is ample literature that has looked into the relationship between caregiver language input and English language learning in monolingual children (see Hoff, 2006 for a review). A landmark study by Hart and Risley (1995) described parents' language use with monolingual English children at home and its relationship with the children's vocabulary. They followed 42 American families for 2.5 years, observing the quantity of caregiver language use. Of note, they found that children from a high socioeconomic status (SES) family were, on average, exposed to 153,000 more words per week compared to those from a low SES family, leading to a 30 million word gap (i.e., difference in the number of words) between the linguistic experience of a child from high compared to low SES by age 3. They also found that the children who were exposed to more language, in terms of number of word tokens, word types, and sentences, had a larger vocabulary. In another similar study, Huttenlocher, Haight, Bryk, Seltzer, and Lyons (1991) found that the frequency of a word in caregiver speech is highly related to how early a child would acquire the word, such that the higher the frequency of a word in the input, the earlier the word would be acquired. Taken together, these findings suggest that early language input, in particular the quantity of input, plays an important role in language acquisition (Cartmill et al., 2013; Chang & Monaghan, 2019; Rowe, 2012).

The quality of caregiver speech is also related to monolingual children's language skills (see Rowe & Zuckerman, 2016, for a review). For instance, Newman, Rowe, and Ratner (2016) found that repetitiveness in maternal speech at 7 months, as measured by type-token ratio (TTR), was a significant predictor of monolingual children's language score at 24 months. Another study by Rowe (2012) studying slightly older children found that greater numbers of word types and rare words in caregiver language input at 30 months were associated with better vocabulary skills at 42 months. These results were similar to those in a study by Huttenlocher, Waterfall, Vasilyeva, Vevea, and Hedges (2010) that suggest that number of word types in caregiver speech is a significant predictor of number of word types in later child speech. These findings indicate that quality, in terms of lexical diversity, as well as quantity of the language input is crucial to early language acquisition.

Apart from lexical diversity, other measures of quality, including syntactic complexity, use of questions, and use of decontextualised language – language that is removed from the here-and-now (Snow, 1990) – also influence monolingual children's language development. Huttenlocher et al. (2010) analysed occurrences of different parts of speech and syntactic patterns (e.g., noun phrases, verb phrases) and ways of combining clauses (e.g., coordination, adjunct clauses, and relative clauses) in caregiver and child speech. Their findings revealed that these features in caregiver speech were predictive of their presence in later child speech, demonstrating how syntactic complexity in language input affects children's syntactic development. Further, more recent studies have found that the use of *wh-* questions by fathers at 24 months was related to children's vocabulary skills at 36 months (Rowe, Leech, &

Cabrera, 2016), and parents' use of decontextualised talk at 42 months was predictive of children's vocabulary skills at 54 months (Rowe, 2012). In summary, the quality of early language input at both the vocabulary level and in terms of syntactic variation is critical to children's language development.

Further to linguistic input from parents, research on monolingual children's early language development has also explored linguistic input from preschool teachers. Some studies (e.g., Dickinson & Smith, 1994; Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002; McCartney, 1984) have examined the relation between the linguistic input that monolingual children receive from preschool teachers and their language growth in the short-term. These studies have yielded similar conclusions to those investigating the home language environment, in that the quality of preschool teacher talk is correlated with monolingual preschoolers' language development. For example, Huttenlocher et al. (2002) observed and analysed audio recordings of the speech of teachers in 40 different preschool classrooms and found that the syntactic complexity of the linguistic input that a child received from the teachers, as measured by the proportion of multi-clause sentences in teacher speech, was positively correlated with their gain of scores on a syntax comprehension test over a year. Huttenlocher et al. attributed this association to the children's multiple exposures to the complex syntactic structures, such that children who were exposed to more complex, multi-clause sentences would then become more familiar with the patterning of the units of the language, thus more capable of conceptualising certain linguistic forms and pairing them with their meanings. This implies that the syntactic structure of preschool teachers' speech can influence children's development of syntax.

Preschool teacher talk has also been found to have longer-terms effects on monolingual children's language development. In a US study that followed a cohort of over 13,000 children in childcare nationally, it was found that monolingual preschoolers' language development was positively and significantly correlated with the amount of linguistic input from preschool teachers, as measured by the teachers' self-assessment of language quantity (NICHD Early Child Care Research Network, 2000). More recently, Dickinson and Porche (2011) observed children and teachers at preschools during short periods of free play and group time, and assessed the children's reading comprehension, receptive vocabulary and word recognition when they were in their fourth grade. They found that the preschool teachers' use of low-frequency words (i.e., words beyond the 3,000 most commonly known words by fourth graders) during free play and attention-getting/holding utterances significantly and positively predicted the children's reading comprehension at fourth grade. In addition, the preschool teachers' use of sophisticated vocabulary during free play was a significant predictor of the children's word recognition at fourth grade. Further, the preschool teachers' attempts to correct the preschoolers' utterances during group time and analytic talks (i.e., utterances that explore cause-and-effect relationships or discuss word meanings) during book reading were associated with the children's receptive vocabulary at fourth grade. Taken together, and mirroring the observations from home language use studies, these results suggest that the quantity and quality of preschool teacher talk is highly influential on children's later language abilities.

1.2 Linguistic Input and EAL Language Development

In light of the vast amount of studies looking into monolingual young children's linguistic input at home and at preschool, there is comparatively little research focusing on the linguistic input children learning an additional language receive. In order to address the problems faced by preschool teachers in the UK, it is vital to understand the linguistic input that EAL children receive at preschool. Yet, there are very few extant studies on EAL children's language exposure in preschool settings. One exception is a study by Bowers and Vasilyeva (2011), which directly compared monolingual English and EAL preschoolers' language development in relation to some linguistic features of preschool teacher talk. They observed and audio-recorded the speech of preschool teachers across 10 classrooms, each for about 1.5 hours. They also administered a vocabulary test to the children at two time points, a year apart, to measure the children's English vocabulary. Analyses on the transcripts of the audio recordings focused on how input quantity (number of word tokens), lexical diversity (number of word types), and syntactic complexity (mean length of utterances; MLU) of the preschool teachers influenced the children's vocabulary scores. Although the monolingual English children performed better on the vocabulary test than the EAL children at the start of the study, findings revealed no difference in the average growth of vocabulary scores between the two language groups. However, different factors contributed to the gain of vocabulary scores of the two language groups. Lexical diversity of teacher talk significantly and positively predicted monolingual English children's vocabulary scores, whereas the growth of vocabulary scores of the EAL group was predicted by increasing quantity and decreasing syntactic complexity of the teacher talk.

Bowers and Vasilyeva's (2011) results suggest that the monolingual English and EAL groups were at different stages of language learning, and different linguistic features in the input they received may be more influential on their lexical development at these different stages. For the EAL children, they may still be in early stages of lexical development, thus needing more exposure to high-frequency words than their monolingual peers in order to learn those words. Also, shorter utterances may have helped the EAL children to segment and comprehend the utterances more easily. For the monolingual English children, however, they may have been more ready for exposure to words that are lower in frequency in order to learn these new words. Though this study yielded some interesting findings regarding the relationship between specific linguistic features of preschool teachers' speech and preschoolers' language development, it did not provide a detailed description of how different the linguistic input to monolingual English and EAL children was – a direct comparison of the linguistic input of the two language groups with greater definition of the vocabulary and syntax of the language use could usefully build on these results.

Previous studies have used various indices to measure lexical diversity and syntactic complexity of children's language environment. For lexical diversity, two commonly used measures are number of word types (e.g., Bowers & Vasilyeva, 2011; Rowe, 2012) and type-token ratio (e.g., Youmans, 1990). However, both of these measures are highly influenced by the size of the corpus in that type-token ratio reduces as number of tokens increases (Richards, 1987). A solution to this is to use a mathematically transformed index of the type-token ratio. The Guiraud Index (GI), the number of word types divided by the square root of the number of word tokens, has been found to offer an effective transformation that reflects lexical diversity between different sized corpora (van Hout & Vermeer, 2007). Therefore, GI is a better measure of lexical diversity than number of word types and type-token ratio. For syntactic complexity, again, a range of indices have been used in previous studies. Apart from MLU (e.g., Bowers & Vasilyeva, 2011) and incidences of different parts of speech (e.g., Huttenlocher et al., 2010), which are readily available on the Child Language Analysis (CLAN; MacWhinney, 2000) program, studies of child L1 exposure (e.g., Cameron-Faulkner, Lieven, & Tomasello, 2003; Cameron-Faulkner & Noble, 2013) have used incidences of different utterance construction types (e.g., *wh-* questions and copulas) to measure range of syntactic structures and syntactic complexity in caregiver speech.

Studies of L2 language learning have frequently employed similar sets of measures, but they have also extended to a greater degree of sophistication in determining the syntactic structures that are present in, and produced by, L2 learners (e.g., Alexopoulou, Michel, Murakami, & Meurers, 2017; Housen & Bulté, 2018, 2019). For example, Crossley and McNamara (2014) investigated L2 learners' grammatical constructions in essays in early and later stages of L2 language learning. Using Coh-Metrix (McNamara, Graesser, McCarthy, & Cai, 2014), they investigated a host of measures that discriminated earlier and later language learning sophistication in terms of syntactic structure variety and syntactic complexity. They found a set of measures that distinguished beginning from more advanced learners: left embeddedness (i.e., number of words before main verb), number of modifiers per noun phrase, syntactic similarity (an index based on the proportion of intersecting syntactic nodes between sentences) – so reflecting whether learners use a narrow or wider range of syntactic structures in their productions, incidence of verb phrases, and incidence of negation. The availability of tools such as Coh-Metrix provides an exciting opportunity for researchers in child language development to apply a broader range of text analysis tools to children's language environment than have typically been employed in the past (Meurers, 2012; Meurers & Dickinson, 2017; Monaghan & Rowland, 2017). We used these tools in determining the preschool language environment in the present study.

The aim of the present study was to apply this broader set of analytical tools to provide a detailed description of the linguistic environment of a preschool classroom containing both monolingual English and EAL children, combining methods from second language acquisition with those deployed in first language acquisition. Based on previous studies of preschool teachers' speech (Bowers & Vasilyeva, 2011; Dickinson & Porche, 2011), we anticipated that preschool teachers would accommodate their language to the children's linguistic background, but it was not clear for which linguistic features this adaptation might occur. Through building and analysing a corpus of preschool teacher talk, the present study observed whether and how preschool teachers tailor their interaction, in terms of quantity and quality, to children of different linguistic backgrounds (monolingual English vs. EAL), who varied in their levels of English language proficiency. The measures of quantity of linguistic input that we applied included number of word types, number of word tokens, and number of utterances. Our measures of the quality of linguistic input were lexical diversity: GI and incidences of different parts of speech; and syntactic complexity (MLU, left embeddedness, number of modifiers per noun phrase, syntactic similarity, incidence of verb phrases, and incidence of negation). Observation of a preschool classroom was done through video and audio recording. The recordings were then transcribed, and utterances were distinguished in terms of to which child or children the preschool teachers' speech was directed. Our predictions were that if the preschool teachers were adapting their language use to the children's language proficiency and linguistic backgrounds, then their language directed at the children who were more proficient in English and/or those who belonged to the monolingual English group would be greater in quantity, lexically more diverse, and syntactically more complex. Alternatively, if the preschool teachers were not adapting their language to the children's language proficiency and linguistic backgrounds, then their language to all the children would be similar in quantity, lexical diversity, and syntactic complexity.

2. Method

2.1 Participants

In collaboration with a preschool in the North-West of England, a class of 3- to 4-year-olds, with a mix of monolingual English and EAL children, and the teachers who worked in that classroom were recruited for the study. Twenty-three children (M_{age} = 4;00.15 years, *range* = 3;08.10 – 4;04.06 years), 12 monolingual English and 10 EAL, took part in the study. The EAL group consisted of children speaking the following languages: Czech (*n* = 1), Dutch (*n* = 1), French (*n* = 1), German (*n* = 3), Greek (*n* = 1), Japanese (*n* = 2), Malay (*n* = 1), Russian (*n* = 1), Spanish (*n* = 2), Thai (*n* = 1). At least one of the parents of all children, except for one monolingual child where both parents reported to have completed secondary school, reported to hold degree- or higher-level qualifications. See Table 1 for other demographic information of the children. Seven female teachers took part in the study. All, but one, of them were monolingual English speakers. The remaining teacher was a native Chinese speaker who was also proficient in English. Of the seven teachers, five were Early Years Foundation Stage qualified (Department for Education, 2017) – with four being key staff of the classroom, acting as key person for some children in the classroom – and two were supply teachers.

Table 1

Demographic information of children

	Monolingual English	EAL
Number	13	10
Male	9	7
Female	4	3
Mean age[1]	4;01.02	3;11.24
Range of age[1]	3;08.10 – 4;04.06	3;09.07 – 4;03.11
Average number of years exposed to English[1,2]	4.08 (0.18)	2.23 (1.61)
Proportion of exposure to English at home[2]	100% (0.00%)	18.13% (22.42%)

[1] Calculated in relation to the first recording session. [2] Standard deviations are presented in parentheses.

2.2 Language Proficiency

Three subtests of the Clinical Evaluation of Language Fundamentals – Preschool-2 (CELF-P2; Wiig, Secord, & Semel, 2004), Sentence Structure, Word Structure and Expressive Vocabulary, were administered to every child within one week immediately before and after the first recording session. The Sentence Structure subset contained 22 items which required children to point to one of four pictures that matched the verbal description provided by the experimenter. The Word Structure subset consisted of 24 items for which children had to complete the experimenter's verbal description of a picture. The Expressive Vocabulary subset contained 20 items that required children to answer the experimenter's question regarding a picture. The scores of all three subsets were standardised, and the standardised scores were summed to obtain a Core Language score. The Core Language score provided information about each child's English language proficiency and vocabulary knowledge. One monolingual English and one EAL child did not complete the CELF-P2 as they joined the study after recording had started. In addition, one child in the monolingual English group was registered with special educational needs. These three children were excluded from the analysis involving language proficiency.

An independent t-test revealed that as expected the monolingual English children had significantly higher English Core Language standard scores than the EAL children, $t(11.96) = 4.25$, $p = .001$, $d = 1.96$ ($M_{Monolingual} = 106.82$, $SD_{Monolingual} = 11.48$; $M_{EAL} = 74.11$, $SD_{EAL} = 20.61$).

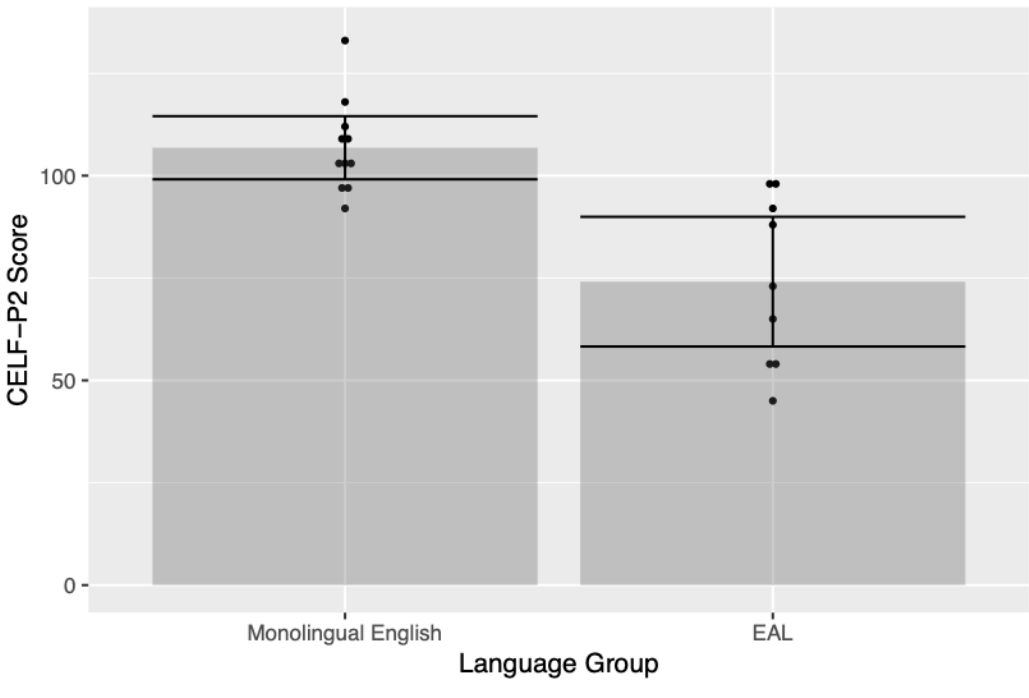

Figure 1. Core Language scores of the monolingual English and EAL children. Each dot represents the score of one child. Error bars represent standard errors.

2.3 Apparatus

Four video cameras were used to video-record the whole classroom during each recording session. Every teacher who worked in the classroom was required to carry around a small portable audio recorder during the recording sessions in order to clearly record their speech. The number of audio recorders used per session varied between two and three, depending on the number of teachers present.

2.4 Procedure

Parents and preschool teachers were notified of the study approximately 1 month before the study commenced, and informal information sessions were held at pick-up time for them to ask questions about the study during that month. Parental consent for the children and consent from the teachers was gained 2 weeks prior to the first recording session. Three children whose parents did not give consent for the study attended another classroom during the recording sessions. The whole classroom was video- and audio-recorded 1 hour per week for 4.5 months, the present data focused on the first 4 weeks of the recording period. The children and teachers engaged in their usual routines and activities during the recording sessions. The recorded sessions contained a range of activities, including story time, snack time, object play, planned teaching activities, painting, and individual and group conversations. They were representative of a typical preschool classroom.

2.5 Transcription

All video and audio recordings were orthographically transcribed using the Codes for Human Analysis of Transcripts transcription (CHAT) system using CLAN (MacWhinney, 2000). Children and teachers were assigned unique participant codes to ensure anonymity. Only conversations between the teachers and children were transcribed (i.e., interactions amongst children were not included), and utterances were coded for intended recipient(s) (e.g., specific child).

2.6 Preschool Teacher Talk Features

To characterise the preschool teachers' language input, we coded the transcripts for quantity and quality measures of the language environment.

2.6.1 Quantity variables. Number of word types, number of word tokens, and number of utterances were used as indices of the amount of language used by the preschool teachers. All quantity variables were calculated through CLAN. These language features were measured for each of the four recording sessions separately, and the average used for analysis.

2.6.2 Quality variables. The quality of preschool teacher talk in the present study was measured by indices of lexical diversity and syntactic complexity. Lexical diversity was measured through GI and density scores (relative frequencies per 1,000 word tokens) of the following parts of speech: adjectives, adverbs, conjunctions, coordinators, determiners, nouns, numerals, prepositions, pronouns, and verbs. For syntactic complexity, the following measures were used: MLU, left embeddedness (SYNLE), mean number of modifiers per noun phrase (SYNNP), syntactic structure similarity (SYNSTRUTt), density scores of different syntactic patterns, including noun phrase (DRNP), verb phrase (DRVP), and negation expression (DRNEG).

To measure some of the key construction types as features of child-directed speech by caregivers identified by Cameron-Faulkner and colleagues (Cameron-Faulkner et al., 2003; Cameron-Faulkner & Noble, 2013), density score of copulas, the density score combining interrogative determiners and interrogative pronouns to reflect question use, and density score of relative pronouns, alongside those of conjunctions and coordinators, as an index of clause combination to reflect complex constructions (see also Huttenlocher et al., 2010). We also measured the density score combining demonstrative determiners and demonstrative pronouns, as a proxy of decontextualised talk (Rowe, 2012), with a higher value denoting language that is less decontextualised. The density scores of these identified syntactic subcategories were treated as measures of syntactic complexity.

As these quality measures of teacher talk quality are more informative for a larger and richer text sample, measures were taken for all four recording sessions combined.

MLU was obtained through CLAN; GI was computed from the numbers of word types and tokens obtained through CLAN; density scores of different parts of speech were computed using the frequencies of the each part of speech and the number of word tokens obtained through CLAN; whereas all other syntactic complexity indices were obtained through Coh-Metrix (McNamara, Graesser, McCarthy, & Cai, 2014).

3. Results

We first describe the overall language use by the preschool teachers in the classroom. Then, we present analyses of the language directed towards the two language groups, before investigating variation in the language input to individual children.

3.1 General Linguistic Environment of a Preschool Classroom

In the observed preschool classroom, there were, on average, 773 utterances, 4667 word tokens, and 563 word types per hour of observation, with a GI of 8.24. Comparing to the findings of Hart and Risley's (1995) study on home linguistic environment of younger children (0 – 3 years), the preschool classroom in the present study provided a higher quantity of language to children, even higher than that of children from professional (high-SES) families (see Table 2).

Table 2

Comparison of general linguistic environment with Hart and Risley (1995)

		Hart & Risley (1995)		
	Present study	Professional families	Working-class families	Families on welfare
Number of utterances	773	487	301	176
Number of word tokens	4667	2153	1251	616
Number of word types	563	382	251	167
GI	8.24	8.23	7.10	6.73

Note. All measures were averages per hour. The numbers for the present study were added up for all teachers present during the recording sessions.

3.2 Comparing Linguistic Input to Monolingual English and EAL Children

We next investigated the speech that had been coded as directed towards the particular children. The quantity measures reflect the amount of language per hour of the recording sessions, whereas the quality indices were measured across all four recording sessions. To determine whether the preschool teachers modified their speech to monolingual English compared to EAL children, independent-samples t-tests were conducted on all linguistic features of preschool teacher talk. The means and standard deviations of the indices of all linguistic features in the teachers' speech are presented in Table 3. Numbers of word tokens and density scores of numerals were square-root transformed to improve fit to a normal distribution for analysis. The results of the t-tests are also presented in Table 3. The p-values were not transformed for multiple comparison, and so the results ought to be considered with caution, and attention to the effect sizes is also informative.

Table 3

Means and standard deviations of all identified linguistic features of preschool teacher talk in the utterances directed at the monolingual English and EAL groups and comparison between the language input to the two language groups

Linguistic feature	Monolingual English *M* (*SD*)	EAL *M* (*SD*)	t-test monolingual English vs. EAL
Quantity			
Number of word types	143.65 (83.87)	87.33 (35.78)	$t(15.43) = 2.11, p = .052, g = 0.84$
Number of word tokens	462.90 (341.43)	260.05 (167.21)	$t(20) = 1.58, p = .129, g = 0.68$
Number of utterances	60.31 (39.66)	51.99 (41.03)	$t(20) = 0.48, p = .635, g = 0.21$
Quality			
Lexical diversity			
GI	**8.84 (2.28)**	**7.28 (0.83)**	$\mathbf{t(14.36) = 2.20, p = .045, g = 0.87}$
Parts of speech (density scores)			
Adjectives	27.73 (15.10)	23.55 (10.43)	$t(20) = 0.74, p = .468, g = 0.32$
Adverbs	85.92 (16.22)	92.35 (14.88)	$t(20) = -0.96, p = .348, g = 0.41$
Conjunctions	**15.87 (5.02)**	**9.83 (5.78)**	$\mathbf{t(20) = 2.62, p = .016, g = 1.12}$
Coordinators	25.88 (6.13)	21.02 (9.74)	$t(20) = 1.43, p = .169, g = 0.61$
Determiners	81.42 (25.63)	87.04 (30.43)	$t(20) = -0.47, p = .643, g = 0.20$
Nouns	179.39 (32.00)	181.94 (24.20)	$t(20) = -0.21, p = .838, g = 0.09$
Numerals	8.99 (6.73)	13.16 (18.24)	$t(20) = -0.09, p = .933, g = 0.04$
Prepositions	56.13 (11.05)	48.55 (5.04)	$t(15.97) = 2.13, p = .050, g = 0.85$
Pronouns	166.65 (30.69)	178.49 (24.17)	$t(20) = -0.99, p = .334, g = 0.42$
Verbs	134.11 (26.82)	131.85 (23.24)	$t(20) = 0.21, p = .837, g = 0.09$
Syntactic complexity			

MLU	**6.84 (1.11)**	**5.00 (1.13)**	***t*(20) = 3.83, *p* = .001, *g* = 1.64**
SYNLE	**1.46 (0.39)**	**0.96 (0.37)**	***t*(20) = 3.06, *p* = .006, *g* = 1.31**
SYNNP	0.48 (0.16)	0.43 (0.10)	*t*(20) = 0.99, *p* = .335, *g* = 0.42
SYNSTRUTt	**0.11 (0.01)**	**0.12 (0.01)**	***t*(20) = -2.51, *p* = .021, *g* = 1.08**
Syntactic patterns (density scores)			
DRNP	328.27 (17.49)	329.05 (19.89)	*t*(20) = -0.10, *p* = .923, *g* = 0.04
DRVP	256.86 (18.46)	245.22 (35.83)	*t*(20) = 0.98, *p* = .338, *g* = 0.42
DRNEG	20.62 (8.93)	19.66 (11.99)	*t*(20) = 0.22, *p* = .832, *g* = 0.09
Syntactic subcategories (density scores)			
Copulas	28.05 (7.59)	31.59 (10.11)	*t*(20) = -0.94, *p* = .360, *g* = 0.40
Demonstratives	**15.12 (3.65)**	**25.33 (9.72)**	***t*(11.11) = -3.14, *p* = .009, *g* = 1.45**
Interrogatives	11.39 (5.86)	13.38 (4.25)	*t*(20) = -0.90, *p* = .381, *g* = 0.38
Relative pronouns	6.79 (2.85)	6.69 (4.27)	*t*(20) = 0.06, *p* = .951, *g* = 0.03

Notes. Means are based on untransformed data. Uncorrected significant differences between language groups are presented in bold. All density scores were based on density per 1,000 word tokens.

All quantity and most quality indices are higher for the monolingual English than the EAL group, with the exception of SYNSTRUTt, DRNP, some parts of speech measures (adverbs, determiners, nouns, numerals, and pronouns), and most indices of syntactic subcategories, where only the most complex of the tested items, relative pronouns, yielded higher scores for the monolingual English than the EAL group. The standard deviations of the measures suggest that there are large differences within the groups, in particular for word tokens and indices of adjectives and numerals.

For the general properties of speech, the language input to the two language groups differed in terms of MLU and GI, with EAL children receiving shorter utterances and less diverse vocabulary. Apart from the teachers using marginally significantly more word types with the monolingual English than EAL children, all other quantity measures did not differ significantly between the two language groups.

Our more exploratory analysis on parts of speech revealed that the teachers used significantly more conjunctions with the monolingual English children than with the EAL children, but again this was not significant if corrected for multiple comparisons. The teachers also used marginally significantly more prepositions with the monolingual English than EAL children. The teachers' use of other parts of speech with the two language groups was non-significant.

For the syntactic complexity indices identified through Crossley and McNamara (2014), SYNLE and SYNSTRUTt in the teachers' speech differed significantly between the two language groups. Note that correction for multiple comparisons would mean that SYNSTRUTt was no longer a significant difference, though the effect size remained large. These results suggest that the EAL children had less exposure to left embedded utterances and were exposed to less diverse syntactic structures. All other indices identified through Crossley and McNamara did not differ significantly between the two language groups.

Analysis on the subcategories of parts of speech identified through Cameron-Faulkner et al. (2003), Cameron-Faulkner and Noble (2013), and Rowe (2012) revealed that the teachers' use of demonstratives was significantly different between the two language groups, suggesting that the teachers used less decontextualised language with the EAL children. The between group differences in all other identified subcategories were non-significant.

3.3 Relations between Preschool Teacher Talk Features and Children's Language Proficiency

As shown in Figure 1, the EAL children typically scored lower on English proficiency than did the monolingual English children. So, differences between the group in linguistic features likely reflect adaptation of teachers' talk to children's individual language proficiency. As shown in Figure 1, there is also within group variation in English language scores. Our next analysis determined the extent to which preschool teachers adapted their language to the individual children's language proficiency, regardless of whether children were monolingual or acquiring EAL, correlations between the children's Core Language scores and all identified teacher talk features were computed. Again, numbers of word tokens and density scores of numerals were square-root transformed to improve fit for analysis. The correlations can be found in Table 4.

Table 4

Means and standard deviations of all identified linguistic features of preschool teacher talk in the whole classroom and their correlation with the children's language proficiency scores

Linguistic feature	Whole classroom	Correlation with CELF-P2
Quantity		
Number of word types	118.05 (71.11)	$r = .38, p = .102$
Number of word tokens	370.70 (289.37)	$r = .20, p = .396$
Number of utterances	56.53 (39.54)	$r = -.14, p = .568$
Quality		
Lexical diversity		
GI	**8.13 (1.91)**	$\boldsymbol{r = .54, p = .015}$

Parts of speech		
Adjectives	25.83 (13.06)	$r = .37, p = .111$
Adverbs	88.84 (15.60)	$r = -.23, p = .337$
Conjunctions	**13.12 (6.08)**	$\boldsymbol{r = .65, p = .002}$
Coordinators	23.67 (8.16)	$r = .10, p = .671$
Determiners	83.97 (27.37)	$r = -.32, p = .168$
Nouns	180.55 (28.09)	$r = .07, p = .758$
Numerals	10.89 (13.07)	$r = -.25, p = .281$
Prepositions	52.69 (9.47)	$r = .29, p = .208$
Pronouns	**172.04 (27.93)**	$\boldsymbol{r = -.45, p = .045}$
Verbs	133.09 (24.69)	$r = .16, p = .501$
Syntactic complexity		
MLU	**6.00 (1.44)**	$\boldsymbol{r = .78, p < .001}$
SYNLE	**1.23 (0.45)**	$\boldsymbol{r = .74, p < .001}$
SYNNP	0.46 (0.13)	$r = .12, p = .627$
SYNSTRUTt	**0.11 (0.01)**	$\boldsymbol{r = -.61, p = .004}$
Syntactic patterns		
DRNP	328.62 (18.17)	$r = -.16, p = .491$
DRVP	**251.57 (27.64)**	$\boldsymbol{r = .53, p = .017}$
DRNEG	20.19 (10.18)	$r = .20, p = .391$
Identified subcategories		
Copulas	29.66 (8.79)	$r = -.28, p = .237$
Demonstratives	**19.76 (8.64)**	$\boldsymbol{r = -.85, p < .001}$
Interrogatives	12.30 (5.17)	$r = -.37, p = .111$
Relative pronouns	6.74 (3.47)	$r = -.42, p = .064$

Notes. Means are based on untransformed data. Standard deviations are presented in parentheses. All *df*s = 18 for the correlations. Uncorrected significant correlations are presented in bold.

In terms of general linguistic features of teacher talk, none of the quantity measures were significantly correlated with the children's language score.

Positive significant correlations were found between the children's language score and the teachers' MLU and GI, with the MLU correlation still significant after correcting for multiple comparisons, meaning that the teachers used longer utterances and more diverse vocabulary with children who were more proficient in English.

With regard to parts of speech, significant correlations between the children's language scores and the density score of conjunctions and pronouns were found, with conjunctions remaining significant after correction. These results suggest that the teachers used more conjunctions and fewer pronouns with the children who were more proficient in English.

For syntactic complexity indices identified through Crossley and McNamara's (2014) study of EAL adult language use, positive significant correlations were found between the children's language scores and SYNLE and DRVP, whereas a negative significant correlation was found for SYNSTRUTt. These were still significant when correcting for multiple comparisons. These results show that the teachers used a greater number of words before the main verb and more verb phrases with the children who were more proficient in English, whereas they used utterances that were more similar in terms of syntactic construction with the children who were less proficient in English.

Considering the identified subcategories of parts of speech, a positive significant correlation between the children's language scores and the teachers' use of demonstratives was revealed, suggesting that the teachers used more words related to the here and now (i.e., less decontextualised talk) with the children who were less proficient in English. Again, this was significant after correction for multiple comparisons.

4. Discussion

Previous studies of children's early language environment have shown that both quantity and quality of language exposure is critical to children's language development (Rowe & Zuckerman, 2016). In home environments, children's exposure to language can differ greatly in quantity. Hart and Risley's (1995) research on caregiver speech quantity to children in different socio-economic backgrounds varies substantially, leading to identification of a substantial gap in some children's experience of language from birth through to school age. Children with EAL may arrive at preschool with little prior experience of English, and it is a relatively unknown issue how the consequent gap in their English exposure affects their learning, or whether there is substantial compensation from these children's exposure to other languages. A key question is how preschool teachers should speak to children, whose English language is lower in proficiency than their monolingual English peers – whether they should adapt their language to the child's language level, or their chronological stage. Before this can be answered, how preschool teachers actually do speak to children from EAL backgrounds needed to be addressed.

The sparse studies of language environment in preschool of EAL compared to monolingual English children have demonstrated that language development is better supported by vocabulary diversity for the monolingual children, and shorter utterance length and greater quantity was most beneficial to developing vocabulary in the EAL children (Bowyers & Vasilyeva, 2011). However, these previous studies have typically focused on broad, quantity properties of children's language exposure, and studies with adult EAL language learners have identified a number of syntactic features that importantly distinguish variation in language proficiency. Furthermore, tools are now readily available for complex, rich analysis of children's language environment to provide insight into detailed characteristics of the linguistic exposure (McNamara et al., 2014). In our study, we exploited this growing availability of corpus analysis tools.

The key question we asked was whether and how preschool teachers tailor their language use to children of different linguistic backgrounds and levels of language proficiency. In order to address this question, we constructed a corpus of preschool teacher talk based on 4 hours of naturalistic observation of a preschool classroom.

We compared the quantity and quality of language input that a group of monolingual English and EAL preschoolers received from their teachers in a natural preschool classroom setting. Importantly, the *quantity* of language input from the preschool teachers did not differ with respect to the children's language proficiency or linguistic background. Children with lower English language proficiency still received similar amounts of input as the children who were monolingual English. Indeed, the preschool setting in this study offered substantial amounts of linguistic input to the children. This substantial quantity of language was present and available for all children in the setting, meaning that lower proficiency did not relate to less input from staff.

Although Hart and Risley's (1995) study examined the home language environment of younger children who were only in the early stages of language development, the numbers in the present study are still striking when considering the EAL children, who were only beginning to learn English, as they suggest that these EAL children were exposed to more language than the monolingual children who were at a similar stage as them in language learning. If the recording sessions can be taken as representative of the rest of the day, then children received 58% more utterances than in the home environment of children in professional families, 116% more word tokens, and 47% more word types. Yet, it has to be noted that when describing the general linguistic environment in the present study, the overall numbers were not based on averages taken from utterances directed at each child. Instead, the numbers were computed based on all preschool teacher utterances within the classroom, so not all utterances and words were addressed to all the children in the classroom. Nonetheless, previous experimental studies have found that children are able to learn words through overhearing speech that are not directed at them (e.g., Akhtar, Jipson, & Callanan, 2001; Gampe, Liebal, & Tomasello, 2012). Further, the present study discounted peer talk (i.e., talk amongst the children), which has also been found to impact on preschoolers' language development (e.g., Mashburn, Justice, Downer, & Pianta, 2009; Palermo et al., 2014). All considered, the numbers in relation to the general linguistic environment reported in the present study are likely to be good-enough estimates of the amount of the language in the preschool classroom that an average child was exposed to. Our findings, thus, add to the existing literature on language exposure and experiences by extending naturalistic observations to the preschool environment, and are informative for research on the word gap (Hindman, Wasik, & Snell, 2016).

Furthermore, the preschool teachers were adapting their language use to the children's language proficiency and linguistic backgrounds, such that their language directed at the children who were more proficient in English and those who were monolingual was lexically more diverse and syntactically more complex. In the dynamic, sometimes (extremely) noisy setting of the preschool, the staff were still able to modify their language according to the children's language level.

EAL and monolingual English children, early in their preschool careers, had very different distributions of English language proficiency scores. Thus, observations of group differences in language use by preschool teachers are likely to reflect children's language proficiency regardless of whether the children speak another language other than English. Indeed, we found that there were a lot of parallels in the preschool teachers' adaption of language use to children when related to different levels of language proficiency regardless of language background and when related to language background. We found that lexical diversity (GI) and the following measures of syntactic complexity: MLU, SYNLE, SYNSTRUTt, and use of conjunctions and demonstratives distinguished the EAL and monolingual children and were also correlated with overall proficiency level. Similarly, the preschool teachers used less diverse vocabulary, shorter utterances, fewer left embedded utterances, less diverse syntactic structures, fewer conjunctions and more demonstratives (i.e., less decontextualised talk) with children who were of lower proficiency of English and those who belonged to the EAL group.

A recent systematic review (Langeloo, Mascareno Lara, Deunk, Klitzing, & Strijbos, 2019) of teacher-child interactions with multilingual children noted that teachers tend to use language that is of low complexity with immigrant children learning the majority language of society during free play (e.g., Lara-Alecio, Tong, Irby, & Mathes, 2009) and dialogic book reading (e.g., Ping, 2014). Langeloo et al. raised concerns about the impoverished input to children learning an additional language at school. Yet, this seemingly impoverished input might be adaptive to children's language development. Children at different stages of development benefit from different features in the language input (Rowe & Zukerman, 2016). A child at the age of 7 months benefits from hearing words repeatedly (Newman et al., 2016), whereas a child at the age of 30 months benefit from hearing more word types (Rowe, 2012). With the parallels in the present study between the preschool teachers' adaption of language use to the children's language proficiency and linguistic background, it is evident that the teachers were sensitive to the children's stages of language development and could adapt the way they speak accordingly, regardless of the children's linguistic background. This implies that the simplified input to the EAL children was an attempt to provide language ability-appropriate input.

However, this does not mean that the teachers were providing language ability-appropriate scaffolding, as it was impossible to discern causality in the present study. On the one hand, the preschool teachers' language input could be the cause of the effects, such that the language input they provided to the children had an influence on the children's language proficiency. On the other hand, it could be that the effects were driven by the children's language proficiency, such that the quality of the preschool teachers' language was simply a reflection of the children's language use. A longitudinal study looking into how specific linguistic features of preschool teacher talk relate to preschoolers' language development is needed to disentangle the relationships between linguistic features of preschool teacher talk and preschoolers' language skills. The study by Bowyers and Vasilyeva (2011) provides a first answer to this question – with greater diversity benefitting monolingual children in preschool settings, and short utterances benefitting EAL children – suggesting that broader findings that suggested that lexical diversity and syntactic complexity of children's language input are related to their language proficiency (e.g., Rowe, 2012) may be contingent upon children's language stage at the point of exposure.

Despite the many parallels, the preschool teachers' language adaption to the children's language proficiency and linguistic background still exhibited slight differences, in that their language adaption to children's language proficiency involved also their use of verb phrases and pronouns. The preschool teachers used more verb phrases, but fewer pronouns, with children who were more proficient in English. Utterances with a higher density of verb phrases are likely to contain more information with more complex syntax (McNamara et al., 2014). The significant and positive correlation between the density of verb phrases and the children's English proficiency provided further evidence that the preschool teachers were adapting their language to individual children's language ability. However, the significant negative correlation between the preschool teachers' use of pronouns and the children's language proficiency was surprising. Pronouns are difficult to learn because they do not follow certain constraints of word learning, such as mutual exclusivity (e.g, Markman, 1994) and the principle of categorical scope (e.g., Golinkoff, Mervis, & Hirsh-Pasek, 1994). The significant correlation could have been driven by the teachers use of demonstrative pronouns. It is also possible that the preschool teachers attempted to simplify their utterances by using pronouns in place of long noun phrases to shorten their utterances. Both of these explanations suggest that the preschool teachers were trying to reduce the syntactic complexity in their language addressed to the children who were less proficient in English and, presumably, would find long utterances with complex syntax hard to comprehend. More importantly, the preschool teachers' adaptation of use of verb phrases and pronouns to the children's language proficiency but not linguistic background provides evidence that the teachers were not simply providing simplified input to the EAL children; rather, they were tuning in to each and every child's language ability.

A methodological contribution of the present study is that we have shown how to draw on corpus tools that are established for analysing written text in second language learners to complement research into children's language input. The indices provided by Coh-Metrix complement the indices readily available in tools (e.g., CLAN) that are traditionally used in children's language environment (Meurers, 2012; Meurers & Dickinson, 2017; Monaghan & Rowland, 2017). In particular, analysing phrase- and sentence-level attributes in CLAN often requires additional manual coding, which requires substantial effort and time. Tools that can automatically analyse text at phrase and/or sentence levels (e.g., SYNLE, SYNSTRUTt, DRNP, and DRVP available in Coh-Metrix) can streamline the analysis process. In general, exploiting the different analysers available, such as Coh-Metrix and Synlex (Lu, 2010), can make it less time-consuming for researchers to gain a more comprehensive view of children's language exposure.

Unlike some previous studies that only observed children's language environment during one activity, such as book reading (Dickinson & Porche, 2011) and controlled lab tasks (Newman et al., 2016), the present study included a wide range of activities that would take place in a typical preschool classroom. Tamis-LeMonda, Custode, Kuchirko, Escobar, and Lo (2018) observed parental language input to monolingual English 13-month-olds and found that the quantity and quality of maternal language changed as a function of activity. For instance, story time presented ample opportunities for caregivers to verbalise, but feeding did not provide much opportunities for caregivers to speak. Types of words also differed according to activity. For example, there were more shape and number words used during object play and story time compared to mealtime. The present study included observations of a diversity of activities, including story time, snack time, object play, planned teaching activities, painting, and individual and group conversations. The observations in the present study were therefore representative and presented a good level of information about the general linguistic environment of a typical preschool classroom.

Although the present study has already included a vast number of linguistic features of preschool teacher talk compared to other studies (e.g., Bowers & Vasilyeva, 2011; Huttenlocher et al., 2002), the list was not exhaustive. We have omitted some interesting features in the present study mainly due to practicality. For instance, previous studies have found that maternal responsiveness was a significant predictor of a monolingual child's expressive language (Tamis-LeMonda, Bornstein, Baumwell, & Damast, 1996) and how early a monolingual child achieves basic language milestones (Tamis-LeMonda, Bornstein, & Baumwell, 2001). A possible linguistic feature that we could have included in the present study was the preschool teachers' responsiveness to the children's initiation of conversation. However, as it was impossible to equip children with audio recorders, sound quality did not allow for coding when a child was trying to initiate a conversation and what they were uttering - which in turn made it impossible to code preschool teacher responsiveness.

Another note about the present study is that the setting involved in the study was a university-based preschool, and the preschoolers recruited tended to represent families from higher socio-economic groups. The preschool teachers recruited for the present study were likely also more experienced in caring for EAL children than those in other settings given the large proportion of EAL families in the university population. Yet, through informal conversations, the preschool teachers recruited for the present study did not receive additional formal training on caring for EAL children apart from that in their EYFS training. It would be interesting to see whether the results of the present study would replicate in a setting with teachers that are less experienced in caring for EAL children and children that are from low SES families.

To conclude, a preschool classroom presents ample opportunities for preschoolers to experience language. Preschool teachers are sensitive to preschoolers' language ability and linguistic background and can adapt the quality, but not quantity, of their language use accordingly. GI and utterance length of preschool teacher talk and preschool teachers' use of left-embedded sentences, diverse syntactic structures, conjunctions, and decreased use of demonstratives were found to be positively and significantly correlated with the children's language proficiency and related to their linguistic background. In addition, preschool teachers' use of pronouns and verb phrases were correlated with the children's language proficiency. These findings are in line with the language ability-appropriate scaffolding framework (e.g., Rowe, 2012; Rowe & Zuckerman, 2016). Yet, the question remains whether the preschool teachers' language input is truly scaffolding and therefore supporting the children's language development, or that they are merely tuning their language to the children's language proficiency. Future longitudinal studies can explore whether and how these features of preschool teacher talk influence children's language skills and development, and whether these differ for monolingual children and children learning the majority language in addition to their home language.

References

Acosta-Garcia, R., & Martinez-Ortiz, E. (2013). Mexico through a superdiversity lens: Already-existing diversity meets new immigration. *Ethnic and Racial Studies*, *38*, 636-649. doi: 10.1080/01419870.2015.980289

Akhtar, N., Jipson, J., & Callanan, M. A. (2001). Learning words through overhearing. *Child Development*, *72*, 416-430. doi: 10.1111/1467-8624.00287

Alexopoulou, T., Michel, M., Murakami, A., & Meurers, D. (2017). Task effects on linguistic complexity and accuracy: A large-scale learner corpus analysis employing natural language processing techniques. *Language Learning*, *67*, 180-208. doi: 10.1111/lang.12232

Bowers, E. P., & Vasilyeva, M. (2011). The relation between teacher input and lexical growth of preschoolers. *Applied Psycholinguistics*, *32*, 221-241. doi: 10.1017/S0142716410000354

Bulté, B., & Housen, A. (2018). Syntactic complexity in L2 writing: Individual pathways and emerging group trends. *International Journal of Applied Linguistics*, *28*, 147-164. doi: 10.1111/ijal.12196

Bulté, B., & Housen, A. (2019). Beginning L2 complexity development in CLIL and non-CLIL secondary education. *Instructed Second Language Acquisition*, *3*, 153-180. doi: 10.1558/isla.38247

Cameron-Faulkner, T., Lieven, E., & Tomasello, M. (2003). A construction based analysis of child directed speech. *Cognitive Science*, *27*, 843-873. doi: 10.1207/s15516709cog2706_2

Cameron-Faulkner, T., & Noble, C. (2013). A comparison of book text and child directed speech. *First Language*, *33*, 268-279. doi: 10.1177/0142723713487613

Cartmill, E., Armstrong, B. F., Gleitman, L. R., Goldin-Meadows, S., Medinac, T. N., & Trueswell, J. C. (2013). Quality of early parent input predicts child vocabulary 3 years later. *Proceedings of the National Academy of Sciences, 110*, 11278–11283. doi: 10.1073/pnas.1309518110

Chang, Y. N., & Monaghan, P. (2019). Quantity and diversity of preliteracy language exposure both affect literacy development: Evidence from a computational model of reading. *Scientific Studies of Reading*, *23,* 235-253. doi: 10.1080/10888438.2018.1529177

Crossley, S. A., & McNamara, D. S. (2014). Does writing development equal writing quality? A computational investigation of syntactic complexity in L2 learners. *Journal of Second Language Writing*, *26*, 66-79. doi: 10.1016/j.jslw.2014.09.006

Department for Education (2017). Statutory framework for the early years foundation stage: Setting the standards for learning, development and care for children from birth to five. Retrieved from https://www.foundationyears.org.uk/files/2017/03/EYFS_STATUTORY_FRAMEWORK_2017.pdf

Department for Education (2019). Schools, pupils and their characteristics: January 2019. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/812539/Schools_Pupils_and_their_Characteristics_2019_Main_Text.pdf

Department of Homeland Security (2018). *Yearbook of immigration statistics*. Retrieved from https://www.dhs.gov/immigration-statistics/yearbook/2018, downloaded 05/02/20

Dickinson, D. K., & Porche, M. V. (2011). Relation between language experiences in preschool classrooms and children's kindergarten and fourth-grade language and reading abilities. *Child Development*, *82*, 870-886. doi: 10.1111/j.1467-8624.2011.01576.x

Dickinson, D. K., & Smith, M. W. (1994). Long-term effects of preschool teachers' book readings on low-income children's vocabulary and story comprehension. *Reading Research Quarterly*, *29*, 104-122. doi: 10.2307/747807

Eurostat (2018). *People in the EU: Who are we and how do we live?* Retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=People_in_the_EU_–_who_are_we_and_how_do_we_live, downloaded 05/02/20

Gampe, A., Liebal, K., & Tomasello, M. (2012). Eighteen-month-olds learn novel words through overhearing. *First Language*, *32*, 385-397. doi: 10.1177/0142723711433584

Golinkoff, R. M., Mervis, C. B., & Hirsh-Pasek, K. (1994). Early object labels: The case for a developmental lexical principles framework. *Journal of Child Language*, *21*, 125-155. doi: 10.1017/S0305000900008692

Guerrero, M. D. (2004). Acquiring academic English in one year: An unlikely proposition for English language learners. *Urban Education*, *39*, 172-199. doi: 10.1177/0042085903260915

Hart, B., & Risley, T. (1995). *Before Headstart: Differences in the family experiences of 1- and 2-year-old children*. Baltimore, MD: Paul H. Brookes.

Hindman, A. H., Wasik, B. A., & Snell, E. K. (2016). Closing the 30 million word gap: Next steps in designing research to inform practice. *Child Development Perspectives*, *10*(2), 134-139. doi: 10.1111/cdep.12177

Hoff, E. (2006). How social contexts support and shape language development. *Developmental Review*, *26*, 55-88. doi: 10.1016/j.dr.2005.11.002

Hutchinson, J. (2018). Educational outcomes of children with English as an additional language. Retrieved from https://epi.org.uk/wp-content/uploads/2018/02/EAL_Educational-Outcomes_EPI-1.pdf

Huttenlocher, J., Haight, W., Bryk, A., Seltzer, M., & Lyons, T. (1991). Early vocabulary growth relation to language input and gender. *Developmental Psychology*, *27*, 236-248. doi: 10.1037/0012-1649.27.2.236

Huttenlocher, J., Vasilyeva, M., Cymerman, E., & Levine, S. (2002). Language input and child syntax. *Cognitive Psychology*, *45*, 337-374. doi: 10.1019/S0010-0285)02)00500-5

Huttenlocher, J., Waterfall, H., Vasilyeva, M., Vevea, J., & Hedges, L. V. (2010). Sources of variability in children's language growth. *Cognitive Psychology*, *61*, 343-365. doi: 10.1016/j.cogpsych.2010.08.002

Langeloo, A., Mascareño Lara, M., Deunk, M. I., Klitzing, N. F., & Strijbos, J. W. (2019). A systematic review of teacher-child interactions with multilingual young children. *Review of Educational Research*, *89*, 536-568. doi: 10.3102/0034654319855619

Lara-Alecio, R., Tong, F., Irby, B. J., & Mathes, P. (2009). Teachers' pedagogical differences during ESL block among bilingual and English-immersion kindergarten classrooms in a randomized trial story. *Bilingual Research Journal*, *32*, 77-100. doi: 10.1080/15235880902965938

Lu, X. (2010). Automatic analysis of syntactic complexity in second language writing. *International Journal of Corpus Linguistics*, *15*, 474-496. doi: 10.1075/ijcl.15.4.02lu

MacWhinney, B. (2000). *The CHILDES Project: Tools for analyzing talk* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Markman, E. M. (1994). Constraints on word meaning in early language acquisition. *Lingua*, *92*, 199-227. doi: 10.1016/0024-3841(94)90342-5

Mashburn, A. J., Justice, L. M., Downer, J. T., & Pianta, R. C. (2009). Peer effects on children's language achievement during pre-kindergarten. *Child Development*, *80*, 686-702. doi: 10.1111/j.1467-8624.2009.01291.x

McCartney, K. (1984). Effect of quality of day care environment on children's language development. *Developmental Psychology*, *20*, 244-260. doi: 10.1037/0012-1649.20.2.244

McNamara, D. S., Graesser, A. C., McCarthy, P. M., & Cai, Z. (2014). *Automated evaluation of text and discourse with Coh-Metrix*. New York, NY: Cambridge University Press.

Meurers, D. (2012). Natural language processing and language learning. In C. A. Chapelle (Ed.), *Encyclopedia of applied linguistics* (pp. 4193– 4205). Oxford, UK: Wiley.

Meurers, D., & Dickinson, M. (2017). Evidence and interpretation in language learning research: Opportunities for collaboration with computational linguistics. *Language Learning*, *67*, 66-95. doi: 10.1111/lang.12233

Monaghan, P. J., & Rowland, C. F. (2017). Combining language corpora with experimental and computational approaches for language acquisition research. *Language Learning*, *67*, 14-39. doi: 10.1111/lang.12221

Newman, R. S., Rowe, M. L., & Ratner, N. B. (2016). Input and uptake at 7 months predicts toddler vocabulary: the role of child-directed speech and infant processing skills in language development. *Journal of Child Language*, *43*, 1158-1173. doi: 10.1017/S0305000915000446

National Institute of Child Health and Human Development Early Child Care Research Network. (2000). The relation of child care to cognitive and language development. *Child Development*, *71*, 960-980. Retrieved from https://www.jstor.org/stable/1132337

Office for National Statistics. (2017). *Migration statistics quarterly report: May 2017*. Retrieved from: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/internationalmigration/bulletins/migrationstatisticsquarterlyreport/may2017

Palermo, F., Mikulski, A. M., Fabes, R. A., Hanish, L. D., Martin, C. L., Stargel, L. E. (2014). English exposure in the home and classroom: Predictions to Spanish-speaking preschoolers' English vocabulary skills. *Applied Psycholinguistics*, *35*, 1163-1187. doi: 10.1017/S0142716412000732

Ping, M. T. (2014). Group interactions in dialogic book reading activities as a language learning ontext in preschool. *Learning, Culture and Social Interaction*, *3*, 146-158. doi: 10.1016/j.lcsi.2014.03.001

Reardon, S. F. (2013). The widening income achievement gap. *Educational Leadership, 70*, 10–16. Retrieved from http://www.ascd.org/publications/educational-leadership/may13/vol70/num08/The-Widening-Income-Achievement-Gap.aspx

Richards, B. J. (1987). Type/token ratios: What do they really tell us? *Journal of Child Language*, *14*, 201-209. doi: 10.1017/S0305000900012885

Rowe, M. L. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech in vocabulary development. *Child Development*, *83*, 1762-1774. doi: 10.1111/j.1467-8624.2012.01805.x

Rowe, M. L., Leech, K. A., & Cabrera, N. (2016). Going beyond input quantity: *Wh*-questions matter for toddlers' language and cognitive development. *Cognitive Science*, *41*, 162-179. doi: 10.1111/cogs.12349

Rowe, M. L., & Zuckerman, B. (2016). Word gap redux: Developmental sequence and quality. *JAMA Pediatrics*, *170*, 827-828. doi: 10.1001/jamapediatrics.2016.1360

Snow, C. E. (1990). The development of definitional skill. *Journal of Child Language*, *17*, 697-710. doi: 10.1017/s0305000900010953

Snow, C. E., Burns, S., & Griffin, P. (1998). *Preventing reading difficulties in young children*. Washington, DC: National Academy of Sciences.

Spoonley, P. (2013). New diversity, old anxieties in New Zealand: The complex identity politics and engagement of a settler society. *Ethnic and Racial Studies*, *38*, 650-661. doi: 10.1080/01419870.2015.980292

Tamis-LeMonda, C. S., Bornstein, M. H., & Baumwell, L. (2001). Maternal responsiveness and children's achievement of language milestones. *Child Development*, *72*, 748-767. doi: 10.1111/1467-8624.00313

Tamis-LeMonda, C. S., Bornstein, M. H., Baumwell, L., & Damast, A. M. (1996). Responsive parenting in the second year: Specific influences on children's language and play. *Infant and Child Development*, *5*, 173-183. doi: 10.1002/(SICI)1099-0917(199612)5:4<173::AID-EDP131>3.0.CO;2-V

Tamis-LeMonda, C. S., Custode, S., Kuchirko, Y., Escobar, K., & Lo, T. (2018). Routine language: Speech directed to infants during home activities. *Child Development*, *90*, 2135-2152. doi: 10.1111/cdev.13089

van Hout, R., & Vermeer, A. (2007). Comparing measures of lexical richness. In H. Daller, J. Milton & J. Treffers-Daller (Eds.), *Modelling and assessing vocabulary knowledge* (pp. 93-115). Amsterdam, Netherlands: Benjamins.

Vertovec, S. (2007). Super-diversity and its implications. *Ethnic and Racial Studies*, *30*, 1024-1054. doi: 10.1080/01419870701599465

von Hippel, P., Workman, J., & Downey, D. B. (2017). *Inequality in reading and math skills comes mainly from early childhood: A replication, and partial correction, of 'Are schools the great equalizer?' Sociology of Education*, *91*, 323-357. doi: 10.2139/ssrn.3036094

Wiig, E., Secord, W. A., & Samuel, E. (2004). *The Clinical Evaluation of Language Fundamentals – Preschool* (2nd ed.). San Antonio, TX: Harcourt Assessment.

Wiley, T. G. (2017). Diversity, super-diversity, and monolingual language ideology in the United States. *Review of Research in Education*, *38*, 1-32. doi: 10.3102/0091732X13511047

Youmans, G. (1990). Measuring lexical style and competence: The type-token vocabulary curve. *Style*, *24*, 584-599. Retrieved from https://www.jstor.org/stable/42946163

Chapter 5: Features of Language Input and Preschoolers' Language Development: A Longitudinal Observation of Preschool Teacher Talk

The same group of preschoolers in the study presented in Chapter 4 was followed longitudinally for 4.5 months in order to examine whether specific linguistic features and changes in linguistic input could predict the children's language development. More specifically, the study presented in this chapter aimed to find out whether the adaptations observed in the preschool teacher talk in Chapter 4 could be seen as scaffolding and supporting children's language development or simply tuning to children's language proficiency. The language development of the two language groups was compared, and changes in the linguistic features of preschool teacher talk assessed. The relationship between these changes were examined to determine if preschool teachers' changing language practice was sensitive to the children's developing language capacity. Finally, a potential predictor of EAL children's language development was identified.

Statement of Author Contribution

In the chapter entitled "Features of language input and preschoolers' language development: A longitudinal observation of preschool teacher talk", the authors agree to the following contributions:

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Signed: Date: 24/6/2020

Abstract

Various linguistic features in caregiver speech have been identified as potential predictors of young children's language development and some of these have been presented in an age- or language ability-appropriate scaffolding framework. However, less is known about how different linguistic features contribute to the language development of children learning English as an additional language (EAL). The present study followed a group of monolingual English (n = 13) and EAL (n = 10) preschoolers (age = 4 years) for 4.5 months and observed how preschool teachers speak to the children. We recorded and transcribed sessions of naturalistic preschool classroom activities and tested the children's English language proficiency at two time points. Within 4.5 months, we found substantial improvement in the EAL children. Across time, the preschool teachers increased the lexical diversity and syntactic complexity in their language towards the children. They also adapted the quality of their language use to individual children's language proficiency. In addition, we found that the teachers were sensitive to individual EAL children's language proficiency and adapted their grammar accordingly. Further, the teachers' use of coordinators has been identified as a predictor of EAL children's language development. These findings suggest that preschool talk can scaffold and therefore support EAL children's language development.

1. Introduction

As a consequence of super-diversity in recent decades, the phenomenon that people from multiple geographic origins live in our society (Vertovec, 2007), language diversity within our society increases. This has led to an increasing number of young children in our society growing up with a variety of different first languages that are not the majority language of society. In the case of the UK, this means that an increasing number of preschool children use English as an additional language (EAL). With the current free childcare policy in the UK, young children tend to spend at least 15 hours a week at preschool. For EAL children from homes where mainly the minority language is spoken, preschool may be their main or perhaps only source of contact with English, the majority language. Initially, when these EAL children start preschool, they may possess minimal English. A pressing issue that confronts preschool teachers in the UK is how to communicate with these children and help them acquire the English language. A potential way to address this would be to understand which linguistic features of preschool teacher talk in a natural setting are important for or can predict EAL children's language development.

Although a lot of intervention studies on improving EAL children's language abilities have been conducted, many of them were with primary pupils or older, and only a few were based in the UK (Murphy & Unthiah, 2015; Oxley & de Cat, 2019). These previous intervention studies often employed strategies that are not practically viable for all settings or readily transferrable to use in the UK. For instance, some interventions relied on preschool teachers running extra sessions with EAL children and parents (e.g., Leyva & Skorb, 2017; Melzi, Schick, & Scarola, 2018), which would lead to an increase in staff workload and demand in resources. Not all settings can manage to cope with all these demands. Some other interventions relied on the teachers using the children's home language (e.g., Leacox & Jackson, 2014), which would be impractical for use in the UK, as EAL children in UK settings are often less homogeneous in terms of home language compared to those in the US, where EAL children usually speak the same home language (e.g., Spanish or Chinese; Oxley & de Cat, 2019).

Considering the situation of EAL children in the UK, they are automatically immersed in a second language environment. Immersion programmes have been found helpful for children learning a second language (e.g., Barik & Swain, 1978; Genesee, 1981; Lambert & Tucker, 1972). However, although many of these immersion programmes were implemented from preschool years, children's target learning outcomes were usually measured at school-age. One exception was a recent study by Bergström, Klatte, Steinbrink, and Lachmann (2016), where two groups of German preschoolers learning English, one group through an immersion programme and the other through conventional instruction (i.e., explicit teaching of the English language), were compared. It was found that, over the 2.5 years that the children spent at preschool, although both groups showed an increase in their English proficiency levels, the immersion group showed greater improvement, especially for receptive language. Yet, the immersion programme implemented by Bergström et al. was a partial immersion, such that there was also a German-speaking teacher in the classroom and all the children in their study shared the same first language. It is, therefore, unclear how a full immersion in an additional language, with only a few, or sometimes in the absences of, peers who could speak the same language, during preschool years would impact on preschoolers' proficiency of that additional language.

Another limitation, which is common to all previous immersion programmes, is that the teachers were only given instructions to speak the second language to the children and encourage the children to use the second language, but not how they should speak to the children. In addition, none of previous immersion programmes have directly examined specifically which linguistic features in the language environment were related to the children's improvement in the additional language. These, as suggested by Pearson (2002), are potentially due to the general belief that young children can acquire languages, including second languages, quickly and effortlessly simply through continuous exposure to the languages. They raise the interesting question of whether preschool teachers should speak to EAL children in the same way as they would to monolingual children of the same age, or should they speak to EAL children as if they were younger monolingual children. Research with EAL children has challenged the view that young children learn languages like linguistic sponges (see Hammar, Hoff, Uchikoshi, Gillanders, Castro, & Sandilos, 2014; McCabe et al., 2013 for reviews). For instance, a study by Páez, Tabors, and López (2007) followed a sample of EAL preschoolers and measured their English vocabulary scores at two time points, six months apart. They found that at both time points, the EAL children lagged behind monolinguals of the same age to a similar extent, despite showing slight improvements. This suggests that merely immersing children in a language would not be sufficient to bring their language skills to the same level as that of monolingual children of the same age. Researchers have suggested other potential interventions, such as dialogic book reading (e.g., Crevecoeur, Coyne, & McCoach, 2014; Vadasy & Sanders, 2015) and oral language programmes (e.g., *Talking Time*; Dockrell, Stuart, & King, 2010). However, all of these interventions share the limitation of not providing a clear answer as to how preschool teachers could create a linguistic environment that is optimal for EAL children's language development.

Previous research with monolingual children has shown that some qualities of preschool teacher talk are correlated with preschoolers' language development (e.g., Dickinson & Smith, 1994; Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002; McCartney, 1984). For instance, Huttenlocher et al. found that syntactic complexity of teacher talk, as measured by the proportion of multi-clause sentences present in naturalistic teacher talk, positively correlated with preschoolers' gain scores on a syntax comprehension test over a year. Other studies (e.g., Dickinson & Porche, 2011; NICHD Early Child Care Research Network, 2000) have highlighted the importance of quantity of linguistic input from preschool teachers to monolingual preschooler's language development. To illustrate, the study by the NICHD Early Child Care Research Network followed a large cohort of US children in childcare and found that preschoolers' language development was positively and significantly correlated with the amount of linguistic input they receive from their teachers, as measured by the teachers' self-assessment of language quantity. Taken together, the findings from these studies suggest that both quality and quantity of preschool teacher talk is highly influential on children's later language abilities. In order to develop effective interventions akin to immersion programmes for preschool teachers in the UK to support EAL children's language development, it is vital to understand the linguistic input that EAL children receive at preschool and its influence on EAL children's language development (e.g., Snow, Burns, & Griffin, 1998; Uchikoshi, 2006). To date, only one study has compared monolingual English and EAL children's vocabulary development in relation to the linguistic input they receive from preschool teachers.

Bowers and Vasilyeva (2011) analysed 1.5-hour long audio recordings from 10 classroom observations, they found that input quantity (number of word tokens), lexical diversity (number of word types), and syntactic complexity (mean length of utterances; MLU) of preschool teacher talk contributed to monolingual English and EAL preschoolers' growth of English vocabulary in different ways. Their data also showed that lexical diversity of teacher talk significantly and positively predicted the monolingual English children's vocabulary scores, whereas increasing input quantity and decreasing syntactic complexity were significant predictors of the growth of the EAL children's vocabulary scores. Bowers and Vasilyeva interpreted their data as that the monolingual English and EAL groups were at different stages of language learning, and their lexical development at these different stages may rely on different features of the linguistic input. For example, the EAL children may still be in early stages of lexical development, thus needed shorter utterances to aid deconstruction and comprehension; yet, the monolingual English children may need exposure to words that are of low frequency in order to learn these words. These findings and interpretations imply that a scaffolding approach, similar to Vygotsky's (1978) concept of zone of proximal development (ZPD), might be feasible in supporting EAL children's language development.

Under a scaffolding framework, a teacher would provide linguistic input that is slightly advanced of a child's proficiency level, in other words adapt to the child's language proficiency level, to help the child develop or learn more advanced language skills. The problem with implementing this scaffolding approach is that there is relatively little known about the relationships between caregiver input and EAL children's language development. Yet, findings from studies with monolingual children might be informative. Early case studies and observations of small groups of

EAL children (e.g., Clarke, 1999; Hakuta, 1976; Tabors, 1997) have revealed common language milestones of EAL children. When they start to have exposure, EAL children typically begin with a preproduction silent period during which they start to have exposure to and begin to comprehend some English, then they proceed to an early production stage where they produce utterances with one or two words. Later, they would be able to use short phrases and sentences and show fluency of using English. Strikingly, this course of language acquisition is, in general, similar to that of younger monolingual speakers (Genesee, Paradis, & Crago, 2004). Hence, it is possible that interventions or strategies that work for younger monolingual children also work for EAL children at an older age, but at a similar stage of language development. This would allow us to draw on the ample literature that has looked into the relationship between caregiver language input and language development in monolingual children.

Of note, Rowe and Zuckerman (2016) have proposed an age-appropriate scaffolding framework of language development in relation to caregiver speech. They integrated findings from various studies and concluded that repetitiveness in caregiver speech at 7 months (Newman, Rowe, & Ratner, 2016), the use of *wh-* questions at 24 months (Rowe, Leech, & Cabrera, 2016) greater numbers of word types and rare words in caregiver speech at 30 months (Rowe, 2012), and use of decontextualised talk – language that is removed from the here-and-now (Snow, 1990) – at 42 months were all predictive of children's later language development. Adapting this framework to use with EAL children at preschool would mean that teachers provide language ability-appropriate scaffolding, in other words, adapt their use of specific linguistic features at appropriate language milestones of EAL children.

In a recent study by Chan, Monaghan and Michel (2020), several linguistic features of preschool teacher talk have been identified as potential predictors of monolingual English and EAL children's language development. Transcripts of naturalistic preschool classroom recording of preschool teacher talk were analysed for a range of quantity and quality measures. It was found that despite using comparable amounts of language to all children, preschool teachers used more diverse vocabulary and more complex syntax (i.e., longer utterances, more left-embedded sentences, more diverse syntactic structures, more conjunctions, and more demonstratives) with the monolingual children and the children who were more proficient in English. It was also found that the teachers' use of pronouns and verb phrases were correlated with the children's proficiency. These suggested that the preschool teachers were adapting their language use to the specific children's language proficiency levels. Yet, as the study focused on the children's language proficiency at one time point, it was impossible to determine whether the preschool teachers' language adaptation was scaffolding and therefore supporting the children's language development, or that they were merely tuning their language to the children's language proficiency.

In order to determine the directionality of the correlation between linguistic features of preschool teacher talk and preschoolers' language proficiency, the present study followed the same class of monolingual English and EAL preschoolers for 4.5 months, and observed how the teachers spoke to those children in the classroom across two time points (T_1 & T_2). Through building and analysing a corpus of preschool teacher talk, the present study looked into how quickly the EAL children developed their English, determined whether and how linguistic features in preschool teacher talk changed over time, investigated whether the teachers were sensitive to the children's language development, and identified the predictors of the children's language development. Based on Chan et al. (2020), our measures of quantity of linguistic input included number of word types, number of word tokens, and number of utterances. The measures of quality of linguistic input we included were lexical diversity: Guiraud Index (GI) and incidences of different parts of speech, and syntactic complexity: MLU, left embeddedness, number of modifiers per noun phrase, syntactic similarity, and incidences of verb phrases, negation, and linguistic features (i.e., copulas, demonstratives, interrogatives, and relative pronouns) that have been identified in the literature (Cameron-Faulkner, Lieven, & Tomasello, 2003; Cameron-Faulkner & Noble, 2013; Crossley & McNamara, 2014; Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Lu, 2010; Rowe, 2012) to reflect the use of complex syntax. Observation of the preschool classroom was done through video and audio recording. The recordings were then transcribed, and utterances were distinguished in terms of to which child or children the preschool teachers' speech was directed. We hypothesised that all children's English proficiency would have developed by T_2, and the EAL children would demonstrate more development due to a greater scope for development compared to their monolingual counterparts. We made the following predictions based on the linguistic features that were identified in Chan et al. as potential predictors: GI, MLU, left embeddedness, syntactic similarity, and incidences of verb phrases, conjunctions, pronouns, and demonstratives. Analyses on other variables were included as exploratory analyses. Based on the finding that the preschool teachers were apt at adapting their language use to children's language proficiency level (Chan et al., 2020), we predicted that the teacher talk would increase in lexical diversity and syntactic complexity across the two time points. Further, to reflect the teachers' sensitivity to individual children's language proficiency, we hypothesised that the changes in linguistic features of the teacher talk would predict changes in the children's language scores. Finally, we hypothesised that the identified linguistic features at T_1 would predict changes in the children's language scores, and, based on findings from Bowers and Vasilyeva (2011), these predictors may differ for the two language groups (monolingual English vs. EAL).

2. Method

Part of the method and data of the present study have been presented in Chan et al. (2020).

2.1 Participants

In collaboration with a preschool in the North-West of England, a class with a mix of monolingual English and EAL 3- to 4-year-olds and the teachers who worked in that classroom were recruited for the study. Twenty-three children (M_{age} = 4;00;15 years, *range* = 3;08;10 – 4;04;06 years), 12 monolingual English and 10 EAL, took part in the study. The EAL group consisted of children speaking the following languages: Czech (*n* = 1), Dutch (*n* = 1), French (*n* = 1), German (*n* = 3), Greek (*n* = 1), Japanese (*n* = 2), Malay (*n* = 1), Russian (*n* = 1), Spanish (*n* = 2), Thai (*n* = 1). For all children, except for one monolingual child whose caregivers stated secondary or state school as their highest level of school completed, at least one of the caregivers reported to hold degree- or higher-level qualifications. See Table 1 for other demographic information of the children. Seven female teachers, six monolingual English speakers and one native Chinese speaker who was also proficient in English, took part in the study. Of the seven teachers, five were Early Years Foundation Stage qualified (Department for Education, 2017) – with four being key staff of the classroom, acting as key person for some children in the classroom – and two were supply teachers.

Table 1

Demographic information of children

	Monolingual English	EAL
Number	13	10
Male	9	7
Female	4	3
Average age[1]	4;01;02	3;11;24
Range of age[1]	3;08;10 – 4;04;06	3;09;07 – 4;03;11
Average number of years exposed to English[1,2]	4.08 (0.18)	2.23 (1.61)
Average exposure to English at home[2]	100% (0.00%)	18.13% (22.42%)

[1] Calculated in relation to the first recording session. [2] Standard deviations are presented in parentheses.

2.2 Language Proficiency

Three subtests of the Clinical Evaluation of Language Fundamentals – Preschool-2 (CELF-P2; Wiig, Secord, & Semel, 2004), Sentence Structure, Word Structure and Expressive Vocabulary, were administered by an experimenter to every child within one week immediately before and after the first and final recording sessions. The Sentence Structure subset contained 22 items which required children to point to one of four pictures that matched the verbal description provided by the experimenter. The Word Structure subset consisted of 24 items for which children had to complete the experimenter's verbal description of a picture. The Expressive Vocabulary subset contained 20 items that required children to answer the experimenter's question regarding a picture. The scores of all three subsets were standardised, and a Core Language score obtained by summing the standardised scores. The Core Language score provided information about each child's English language proficiency and vocabulary knowledge at the two time points, providing a baseline and an outcome score.

2.3 Apparatus

The whole classroom was video-recorded by four video cameras during each recording session. In order to clearly record the teachers' speech, all teachers working in the classroom were required to carry around a small portable audio recorder during the recording sessions.

2.4 Procedure

Parents and preschool teachers were notified of the study approximately 1 month before the study commenced. They also had the opportunity to ask questions about the study during informal information sessions at pick-up time during that month. Parental consent for the children and consent from the teachers were sought 2 weeks prior to the first recording session. Three children whose parents did not give consent for the study attended another classroom during the recording sessions. The whole classroom was video- and audio-recorded 1 hour per week for 4.5 months. The present data focused on the first two weeks (T_1) and the final two weeks (T_2) of the recording period. The children and teachers engaged in their usual routines and activities during the recording sessions. The recorded sessions contained a range of activities, including story time, snack time, object play, planned teaching activities, painting, and individual and group conversations. They were representative of a typical preschool classroom.

2.5 Transcription

All video and audio recordings were orthographically transcribed using the Codes for Human Analysis of Transcripts transcription (CHAT) system using the Child Language Analysis (CLAN; MacWhinney, 2000) program. To ensure anonymity, the children and teachers were assigned unique participant codes. Only conversations between the teachers and children were transcribed (i.e., interactions amongst children were not transcribed). The intended recipient(s) of each utterance (e.g., specific child) was also coded.

2.6 Preschool Teacher Talk Features

As in Chan et al. (2020), the transcripts were coded for quantity and quality measures of the language environment to characterise the preschool teachers' language input.

2.6.1 Quantity variables. Number of word types, number of word tokens, and number of utterances were used as indices of the amount of language used by the preschool teachers. All quantity variables were calculated through CLAN. These linguistic features were measured for each of the four recording sessions separately, and the average for each time point used for analysis.

2.6.2 Quality variables. The quality of preschool teacher talk was measured through indices of lexical diversity and syntactic complexity. Lexical diversity was measured through GI and density scores (relative frequencies per 1,000 word tokens) of the following parts of speech: adjectives, adverbs, conjunctions, coordinators, determiners, nouns, numerals, prepositions, pronouns, and verbs. For syntactic complexity, the following measures were used: MLU, left embededdness (SYNLE), mean number of modifiers per noun phrase (SYNNP), syntactic structure similarity (SYNSTRUTt), density scores of different syntactic patterns, including noun phrase (DRNP), verb phrase (DRVP), and negation expression (DRNEG).

The following key construction types identified from previous studies by Cameron-Faulkner and colleagues (Cameron-Faulkner et al., 2003; Cameron-Faulkner & Noble, 2013; see Chan et al., 2020 for details) were also included as measures of syntactic complexity of preschool teacher talk: density score of copulas, the density score combining interrogative determiners and interrogative pronouns to reflect question use, and density score of relative pronouns as an index of clause combination to reflect complex constructions. The density score combining demonstrative determiners and demonstrative pronouns as a proxy of decontextualised talk, based on Rowe (2012), was also measured.

All quality measures of teacher talk were taken for both sessions combined for each time point.

MLU was obtained through CLAN; GI was computed from the numbers of word types and tokens obtained through CLAN; density scores of different parts of speech were computed using the frequencies of each part of speech and the number of word tokens obtained through CLAN; whereas all other syntactic complexity indices were obtained through Coh-Metrix (McNamara, Graesser, McCarthy, & Cai, 2014).

We have chosen to focus on the following linguistic features that were identified in Chan et al. (2020) to be significantly associated with children's language proficiency: GI, MLU, SYNLE, SYNSTRUTt, DRVP, and density scores of conjunctions, pronouns, and demonstratives. Other variables were included as exploratory analyses.

3. Results

We first present our examination and comparison of the English language proficiency of the monolingual English and EAL groups at the two time points. Next, we describe the overall language use by the preschool teachers in the classroom, focusing on whether there were changes in the identified linguistic features. Then, we present analyses investigating the teachers' sensitivity, in relation to their language use, to the language proficiency of the two language groups and each child individually. Finally, we report our analyses identifying linguistic features in preschool teacher talk that predict changes in the children's language proficiency scores.

One monolingual English child and two EAL children only completed the baseline test, and one monolingual English and one EAL child only completed the outcome test. In addition, one child in the monolingual English group had special educational needs. These six children were excluded from the analyses that involved language proficiency.

3.1 English Language Development

A 2 between (Language Group: monolingual English vs. EAL) X 2 within (Time Point: baseline vs. outcome) mixed ANOVA revealed that the monolingual English children had significantly higher Core Language scores than the EAL children, $F(1, 15) = 13.31$, $p = .002$, $\eta_p^2 = .47$ (see Table 2 for *M*s and *SD*s), meaning that the monolingual English children were more proficient in English than the EAL children. In addition, a significant main effect of time point was found, $F(1, 15) = 8.31$, $p = .011$, $\eta_p^2 = .36$ ($M_{Baseline} = 93.35$, $SD_{Baseline} = 23.89$; $M_{Outcome} = 99.18$, $SD_{Outcome} = 17.48$), suggesting that the class, as a whole, performed better on the outcome language proficiency test. Further, the interaction of language group and time point was also significant, $F(1, 15) = 7.62$, $p = .015$, $\eta_p^2 = .34$ (see Figure 1). Subsequent post-hoc pair-wise comparison tests revealed that the monolingual English children's performance on the baseline and outcome tests did not differ significantly, $t(9) = 0.10$, $p = .922$, $d = 0.03$ (see Table 2 for *M*s and *SD*s); whereas the EAL children's performance on the outcome test was significantly better than that in the baseline test, $t(6) = 3.48$, $p = .013$, $d = 1.32$ (see Table 2 for *M*s and *SD*s).

Table 2

Means (and standard deviations) of Core Language scores of children

	Monolingual English	EAL
Overall	107.45 (12.42)	80.29 (20.20)
Baseline	107.30 (11.98)	73.42 (22.80)
Outcome	107.60 (13.50)	87.14 (15.95)

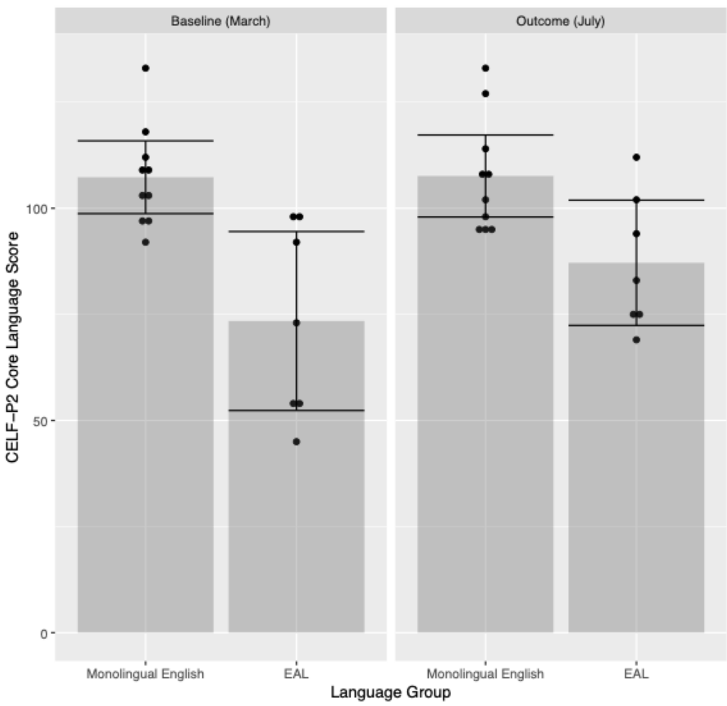

Figure 1. Baseline and outcome Core Language scores of the monolingual English and EAL children. Each dot represents the score of one child. Error bars represent standard errors.

3.2 Changes in Teacher Talk Linguistic Features

We next investigated, in the general linguistic environment, whether the teachers changed the way they spoke across the two time points. For each time point, the quantity measures reflect the amount of language per hour of the recording sessions, whereas the quality indices were measured across both recording sessions. Paired-sample t-tests with time point (T_1 vs. T_2) as the within-subject factor were conducted on all linguistic features of preschool teacher talk. The means and standard deviations of the indices of all linguistic features in the teachers' speech are presented in Table 3. SYNSTRUTt and density scores of noun phrases, adverbs, numerals, nouns, and pronouns were square-root transformed to improve fit to a normal distribution for analysis. The results of the t-tests are also presented in Table 3. As p-values were not adjusted for multiple comparisons, our results ought to be considered with caution and giving attention to effect sizes proves valuable.

Table 3

Descriptive statistics and t-tests of all linguistic features of preschool teacher talk at the two time points

Linguistic feature	T_1 *M* (*SD*)	T_2 *M* (*SD*)	t-test T_1 vs. T_2
	Measures in Focus		
GI	**6.15 (0.92)**	**7.21 (0.82)**	**$t(15) = -3.95, p = .001, d = 1.22$**
Conjunctions	14.73 (11.08)	14.90 (6.23)	$t(15) = -0.07, p = .949, d = 0.02$
Pronouns	**193.82 (32.64)**	**210.54 (20.86)**	**$t(15) = -2.53, p = .023, d = 0.59$**
MLU	**5.49 (0.82)**	**6.70 (1.00)**	**$t(15) = -4.81, p < .001, d = 1.32$**
SYNLE	**1.01 (0.42)**	**1.41 (0.43)**	**$t(15) = -3.54, p = .003, d = 0.94$**
SYNSTRUTt	**0.13 (0.04)**	**0.11 (0.01)**	**$t(15) = 2.65, p = .018, d = 0.87$**

DRVP	258.00 (34.81)	255.41 (19.90)	*t*(15) = 0.36, *p* = .724, *d*= 0.09
Demonstratives	23.51 (7.13)	23.99 (5.75)	*t*(15) = -0.20, *p* = .842, *d*= 0.07
Exploratory Measures			
Quantity			
Number of word types	**81.91 (36.67)**	**124.66 (55.13)**	***t*(15) = -3.49, *p* = .003, *d*= 0.91**
Number of word tokens	**222.59 (155.65)**	**390.81 (263.59)**	***t*(15) = -2.95, *p* = .010, *d*= 0.78**
Number of utterances	37.94 (28.29)	55.72 (37.05)	*t*(15) = -2.00, *p* = .064, *d*= 0.58
Quality			
Lexical diversity			
Parts of speech (density scores)			
Adjectives	**12.88 (10.70)**	**25.94 (6.99)**	***t*(15) = -4.11, *p* = .001, *d*= 1.44**
Adverbs	83.36 (29.17)	71.93 (20.66)	*t*(15) = 1.33, *p* = .202, *d*= 0.48
Coordinators	25.14 (10.71)	25.97 (9.64)	*t*(15) = -0.25, *p* = .805, *d*= 0.08
Determiners	58.01 (13.63)	64.49 (9.71)	*t*(15) = -1.45, *p* = .168, *d*= 0.55
Nouns	171.59 (42.47)	161.14 (19.24)	*t*(15) = 1.15, *p* = .268, *d*= 0.29
Numerals	7.06 (9.15)	4.89 (4.72)	*t*(15) = 0.15, *p* = .884, *d*= 0.05
Prepositions	**36.63 (17.49)**	**55.97 (13.38)**	***t*(15) = -3.45, *p* = .004, *d*= 1.24**
Verbs	141.95 (26.25)	132.82 (20.22)	*t*(15) = 1.04, *p* = .317, *d*= 0.39
Syntactic complexity			
SYNNP	0.37 (0.07)	0.37 (0.06)	*t*(15) = -0.27, *p* = .793, *d*= 0.08
Syntactic patterns (density scores)			
DRNP	341.72 (37.34)	346.26 (21.89)	*t*(15) = -0.52, *p* = .613, *d*= 0.17
DRNEG	19.50 (11.34)	19.20 (10.31)	*t*(15) = 0.07, *p* = .942, *d*= 0.03
Syntactic subcategories (density scores)			
Copulas	32.57 (15.67)	35.55 (11.99)	*t*(15) = -0.58, *p* = .572, *d*= 0.21
Interrogatives	**8.00 (6.74)**	**16.34 (5.82)**	***t*(15) = -4.41, *p* = .001, *d*= 1.32**
Relative pronouns	11.28 (8.12)	12.43 (5.18)	*t*(15) = -0.43, *p* = .673, *d*= 0.17

Notes. Means and standard deviations are based on untransformed data. Uncorrected significant differences between time points are presented in bold. All density scores are based on density per 1,000 word tokens.

Across the two time points, all quantity indices and most quality indices have increased, with the exception of SYNSTRUTt, DRVP, DRNEG, and density scores of adverbs, nouns, numerals, and verbs which decreased between T_1 and T_2. The standard deviations of the measures suggest that there were great variations within each time point, in particular for word tokens, DRNEG, and indices of adjectives, conjunctions, numerals, interrogatives, and relative pronouns.

For the linguistic features we have chosen to focus on based on Chan et al. (2020), only GI, MLU, SYNLE, SYNSTRUTt, and the index of pronouns were significantly different between the two time points, with all measures, except that of SYNSTRUTt, being higher at T_2. These differences suggest that the teachers used a more diverse vocabulary, longer utterances, more modifiers before nouns, more diverse sentence structures, and more pronouns with the children as they grew. The teachers' use of other parts of speech and syntactic structures identified through Chan et al. was non-significant.

Our exploratory analyses revealed that the teachers used significantly more word types, word tokens, adjectives, prepositions, and interrogatives when they spoke to the children at T_2 compared to T_1. All other linguistic features did not significantly differ between the two time points.

3.3 Teachers' Sensitivity to Children's Proficiency

To address our research question regarding teachers' sensitivity to individual children's language proficiency levels, multiple regression analyses were conducted to predict changes in the children's language proficiency scores from changes in the linguistic features of teacher talk, the children's linguistic background, and their interaction. The interaction term was to investigate whether the teachers' sensitivity, if present, was the same across their language use towards both language groups. For all multiple regression analyses, the following approach was used: (1) we first built a model with the two main effects and the interaction term; (2) if the interaction term was non-significant, it would be removed from the model, and the resulting model used. The means and standard deviations of the difference of all linguistic features in the utterances directed at each language group between the two time points are presented in Table 4. Changes in the follow linguistic features were square-root transformed to improve fit to a normal distribution for analysis: SYNSTRUTt and density scores of verb phrases, adverbs, numerals, nouns, copulas, and verbs. Difference of the indices of each linguistic feature was centred prior to analysis to avoid potential issues of collinearity. Note that the p-values have not been corrected for multiple comparisons.

Table 4

Descriptive statistics of the difference of each linguistic feature of preschool teacher talk between the two time points by utterances directed at each language group

	Monolingual English	EAL
Linguistic feature	*M* (*SD*)	*M* (*SD*)
Measures in Focus		
GI	1.15 (0.44)	1.32 (1.18)
Conjunctions	9.11 (7.65)	7.96 (5.13)
Pronouns	22.02 (15.33)	22.40 (24.40)

MLU	1.40 (0.89)	1.40 (0.48)
SYNLE	0.66 (0.40)	0.33 (0.19)
SYNSTRUTt	0.01 (0.01)	0.04 (0.05)
DRVP	20.86 (10.16)	21.53 (25.99)
Demonstratives	7.52 (3.83)	7.61 (7.08)
Exploratory Measures		
Quantity		
Number of word types	54.38 (35.79)	57.75 (29.40)
Number of word tokens	229.25 (186.13)	229.69 (145.23)
Number of utterances	26.63 (24.33)	33.56 (27.19)
Quality		
Lexical diversity		
Parts of speech (density scores)		
Adjectives	12.42 (9.38)	17.73 (10.58)
Adverbs	13.53 (15.81)	32.15 (40.27)
Coordinators	9.31 (8.45)	11.25 (7.78)
Determiners	14.39 (12.37)	15.77 (10.44)
Nouns	20.13 (24.27)	27.25 (26.75)
Numerals	4.72 (4.56)	10.21 (10.84)
Prepositions	20.78 (12.97)	25.78 (22.65)
Verbs	25.09 (35.99)	21.31 (17.91)
Syntactic complexity		
SYNNP	0.07 (0.07)	0.05 (0.02)
Syntactic patterns (density scores)		
DRNP	22.91 (24.46)	39.43 (24.35)

DRNEG	12.40 (8.15)	13.56 (11.74)
Syntactic subcategories (density scores)		
Copulas	8.05 (5.58)	17.98 (21.35)
Interrogatives	7.99 (6.08)	8.95 (8.98)
Relative pronouns	6.20 (7.82)	9.49 (6.39)

Notes. Means and standard deviations are based on untransformed data. All density scores are based on density per 1,000 word tokens.

Only the final model of the index of demonstratives, among those of the eight measures in focus, contains the interaction term (see Table 5). All the remaining final models consist of only the two main effects. Model summary of the final model of each linguistic feature is presented in Table 6. The significant interaction of language group and difference of the teachers' use of demonstratives between the two time points suggest that the teachers' increased use of demonstratives was associated with the EAL children's English language development, whereas the teachers' use of demonstratives only exerted a subtle effect on the monolingual English children's language development, in that decreased use of demonstratives was associated with slightly greater improvement ($\beta = 0.70$, $t(10) = 2.72$, $p = .022$; see Figure 2). The main effect of language group was significant in all final models, as expected from our analysis on the Core Language scores reported earlier (all $|t|$s ≥ 2.35, ps $\leq .038$). None of the final models contain a significant main effect of difference in linguistic feature (all $|t|$s ≤ 1.52, ps $\geq .158$).

In our more exploratory analyses, the final model of the following linguistic features contain the interaction term: SYNNP and indices of coordinators and determiners (see Table 5). All the remaining final models consist of only the two main effects. Again, model summaries of all final models are presented in Table 6. The significant interactions of language group and each of the following linguistic features present similar patterns: SYNNP ($\beta = 0.61$, $t(10) = 2.78$, $p = .019$; see Figure 3), coordinators ($\beta = 0.52$, $t(10) = 2.51$, $p = .031$; see Figure 4), and determiners ($\beta = 0.51$, $t(10) = 3.27$, $p = .008$; see Figure 5). They suggest that the teachers' use of increasingly more modifiers per noun phrase and increased use of coordinators and determiners were associated with the EAL children's English language development. However, changes in the same linguistic features did not seem to be related to the monolingual children's English language development. Again, the main effect of language group was significant in all final models (all $|t|$s ≥ 2.67, ps $\leq .022$), and none of the final models contain a significant main effect of linguistic feature (all $|t|$s ≤ 1.41, ps $\geq .187$).

Table 5

Models of all final models investigating teachers' sensitivity to children's language development that contain the interaction term

Predictor	*B*	*β*	*t*	*p*
Demonstratives				
(Intercept)	3.47 (1.94)	-	1.79	.104
Language group (mono. vs. EAL)	14.04 (3.04)	0.80	4.61	.001
Difference in linguistic feature	-0.69 (0.54)	-0.32	-1.27	.233
Language group × Difference in linguistic feature	1.98 (0.73)	0.70	2.72	.022
SYNNP				
(Intercept)	3.68 (2.01)	-	1.84	.096

Language group (mono. vs. EAL)	18.14 (3.81)	1.03	4.76	.001
Difference in linguistic feature	-21.75 (32.17)	-0.12	-0.68	.514
Language group × Difference in linguistic feature	408.03 (146.63)	0.61	2.78	.019
Coordinators				
(Intercept)	3.45 (1.99)	-	1.74	.113
Language group (mono. vs. EAL)	14.52 (3.13)	0.82	4.64	.001
Difference in linguistic feature	-0.06 (0.25)	-0.05	-0.22	.828
Language group × Difference in linguistic feature	1.17 (0.47)	0.52	2.51	.031
Determiners				
(Intercept)	3.44 (1.70)	-	22.03	.070
Language group (mono. vs. EAL)	10.99 (2.61)	0.62	4.21	.001
Difference in linguistic feature	-0.08 (0.15)	-0.11	-0.57	.583
Language group × Difference in linguistic feature	0.76 (0.23)	0.62	3.27	.008

Note. Standard errors of *B* are given in parentheses.

Table 6

Model summaries of all final models investigating teachers' sensitivity to children's language development

Linguistic feature	Model summary
Measures in Focus	
GI	$F = 6.43$, $p = .014$, adjusted $R^2 = .46$
Conjunctions	$F = 5.02$, $p = .028$, adjusted $R^2 = .38$

Pronouns	$F = 5.10$, $p = .027$, adjusted $R^2 = .39$
MLU	$F = 6.19$, $p = .016$, adjusted $R^2 = .44$
SYNLE	$F = 4.97$, $p = .029$, adjusted $R^2 = .38$
SYNSTRUTt	$F = 6.90$, $p = .011$, adjusted $R^2 = .48$
DRVP	$F = 7.16$, $p = .010$, adjusted $R^2 = .49$
Demonstratives	**$F = 8.50$, $p = .004$, adjusted $R^2 = .63$**
Exploratory Measures	
Quantity	
Number of word types	$F = 5.32$, $p = .024$, adjusted $R^2 = .40$
Number of word tokens	$F = 4.99$, $p = .029$, adjusted $R^2 = .38$
Number of utterances	$F = 5.98$, $p = .017$, adjusted $R^2 = .43$
Quality	
Lexical diversity	
Parts of speech (density scores)	
Adjectives	$F = 5.76$, $p = .019$, adjusted $R^2 = .42$
Adverbs	$F = 6.39$, $p = .014$, adjusted $R^2 = .45$
Coordinators	**$F = 8.13$, $p = .005$, adjusted $R^2 = .62$**
Determiners	**$F = 12.16$, $p = .001$, adjusted $R^2 = .72$**
Nouns	$F = 4.97$, $p = .029$, adjusted $R^2 = .38$
Numerals	$F = 6.18$, $p = .016$, adjusted $R^2 = .44$
Prepositions	$F = 5.64$, $p = .021$, adjusted $R^2 = .42$
Verbs	$F = 5.41$, $p = .023$, adjusted $R^2 = .40$
Syntactic complexity	
SYNNP	**$F = 7.93$, $p = .005$, adjusted $R^2 = .62$**
Syntactic patterns (density scores)	

DRNP	$F = 6.12$, $p = .016$, adjusted $R^2 = .44$
DRNEG	$F = 6.86$, $p = .012$, adjusted $R^2 = .47$
Syntactic subcategories (density scores)	
Copulas	$F = 5.06$, $p = .028$, adjusted $R^2 = .38$
Interrogatives	$F = 5.57$, $p = .021$, adjusted $R^2 = .41$
Relative pronouns	$F = 4.99$, $p = .029$, adjusted $R^2 = .38$

Notes. Final models of linguistic features in bold contain the interaction term and their *df*s are (3, 10); *df*s are (2, 11) for the remaining linguistic features. All *VIF*s ≤ 2.35.

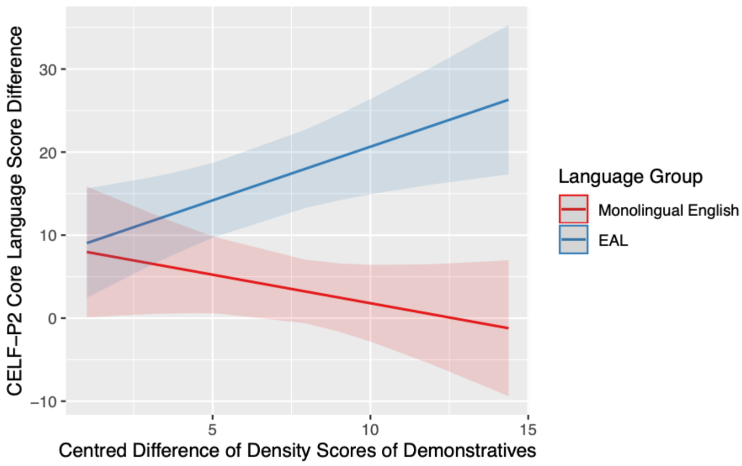

Figure 2. Interaction of language group and centred difference of density scores of demonstratives in teacher talk between the two time points. Shaded areas represent standard errors.

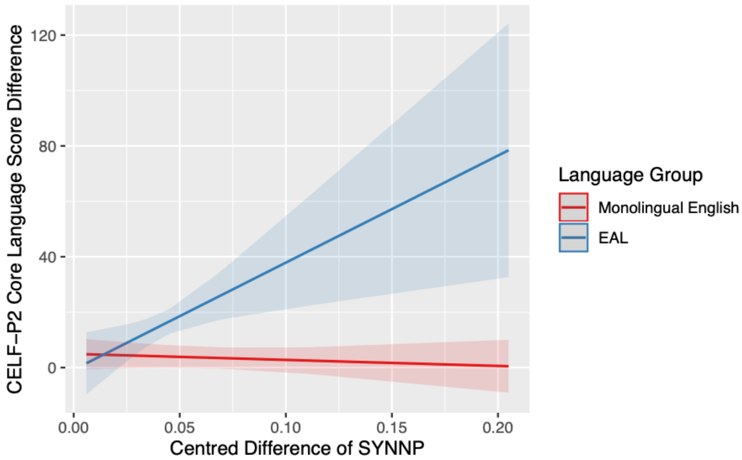

Figure 3. Interaction of language group and centred difference of SYNNP in teacher talk between the two time points. Shaded areas represent standard errors.

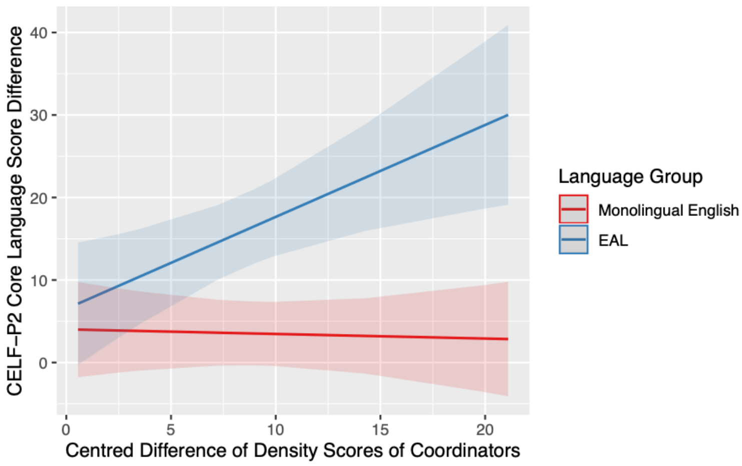

Figure 4. Interaction of language group and centred difference of density scores of coordinators in teacher talk between the two time points. Shaded areas represent standard errors.

Figure 5. Interaction of language group and centred difference of density scores of determiners in teacher talk between the two time points. Shaded areas represent standard errors.

3.4 Predictors of Children's Language Development

We then attempted to identify linguistic features in teacher talk that could predict the children's language proficiency scores. Multiple regression analyses were conducted to predict changes in the children's language proficiency scores from linguistic features of teacher talk at T_1, the children's linguistic background, and the interaction of the two. The interaction term was to see if predictive linguistic features are different for the two language groups, as suggested by Bowers and Vasilyeva's (2011) findings. The backwards elimination approach described earlier was used to obtain final models. The means and standard deviations of all linguistic features in the utterances directed at each language group at T_1 are presented in Table 7. Indices of the following linguistic features were square-root transformed to improve fit to a normal distribution for analysis: SYNSTRUTt and density scores of adverbs, numerals, nouns, and pronouns. All indices of linguistic features were centred prior to analysis. The p-values were, again, not transformed for multiple comparisons.

Table 7

Descriptive statistics of the indices of linguistic features of preschool teacher talk directed at each language group at T_1

	Monolingual English	EAL
Linguistic feature	*M* (*SD*)	*M* (*SD*)
Measures in Focus		
GI	6.37 (0.80)	5.93 (1.03)
Conjunctions	16.77 (9.79)	12.68 (12.56)
Pronouns	195.76 (19.45)	191.87 (43.54)
MLU	6.00 (0.66)	4.99 (0.66)
SYNLE	1.22 (0.36)	0.79 (0.37)
SYNSTRUTt	0.11 (0.01)	0.14 (0.05)
DRVP	263.33 (16.51)	252.68 (47.54)
Demonstratives	19.65 (6.92)	27.36 (5.22)
Exploratory Measures		
Quantity		
Number of word types	84.06 (24.34)	79.75 (47.73)
Number of word tokens	217.94 (99.11)	227.25 (205.04)
Number of utterances	34.00 (14.71)	41.88 (38.25)
Quality		
Lexical diversity		
Parts of speech (density scores)		
Adjectives	13.15 (9.54)	12.61 (12.41)
Adverbs	80.38 (14.94)	86.35 (39.75)
Coordinators	25.73 (11.07)	24.56 (11.06)

Determiners	55.60 (11.83)	60.42 (15.66)
Nouns	168.60 (28.88)	174.58 (54.87)
Numerals	4.92 (4.69)	9.19 (12.12)
Prepositions	40.31 (12.24)	32.95 (21.78)
Verbs	144.93 (33.99)	138.97 (17.35)
Syntactic complexity		
SYNNP	0.36 (0.06)	0.38 (0.08)
Syntactic patterns (density scores)		
DRNP	329.00 (28.63)	354.44 (42.40)
DRNEG	20.86 (8.76)	18.15 (13.95)
Syntactic subcategories (density scores)		
Copulas	28.38 (10.29)	36.76 (19.50)
Interrogatives	8.26 (7.20)	7.74 (6.74)
Relative pronouns	12.89 (6.08)	9.68 (9.92)

Notes. Means and standard deviations are based on untransformed data. All density scores are based on density per 1,000 word tokens.

For the eight measures in focus, none of the final models contain the interaction term – all of them consist of only the two main effects. Model summary of the final model of each linguistic feature is presented in Table 8. The main effect of language group was significant in the final models involving DRVP, conjunctions, and pronouns (all $|t|$s ≥ 2.27, ps $\leq .040$). This was expected from our analysis on the Core Language scores. However, in the remaining five final models, the main effect of language group was non-significant (all $|t|$s ≤ 1.99, ps $\geq .067$). Importantly, none of the final models contain a main effect of linguistic feature (all $|t|$s ≤ 1.90, ps $\geq .078$).

In our more exploratory analyses, only the final model of the density score of coordinators contains the interaction term (see Table 9). All the remaining final models consist of only the two main effects. Model summaries of all final models can be found in Table 8. The significant interaction of language group and density score of coordinators at T_1 suggest that the teachers' use of coordinators at T_1 positively predicted the EAL children's language development but did not seem to predict that of the monolingual English children ($\beta = 0.74$, $t(10) = 2.51$, $p = .031$; see Figure 6). The main effect of language group was significant in all (all $|t|s \geq 2.18$, $ps \leq .047$) but five final models that involved DRNEG, coordinators, copulas, numerals, and prepositions (all $|t|s \leq 2.10$, $ps \geq .0.54$). These significant main effects of language group were, again, expected from our analysis on the children's language proficiency scores. Importantly, all final models contain a non-significant main effect of linguistic feature (all $|t|s \leq 2.14$, $ps \geq .051$).

Table 8

Final model of density score of coordinators at T_1

Predictor	*B*	*β*	*t*	*p*
(Intercept)	4.02 (3.05)	-	1.32	.217
Language group (mono. vs. EAL)	2.49 (4.99)	0.14	0.50	.629
Difference in linguistic feature	-0.06 (0.25)	-0.05	-0.22	.828
Language group × Difference in linguistic feature	1.17 (0.47)	0.74	2.51	.031

Note. Standard errors of *B* are given in parentheses.

Table 9

Model summaries of all final models identifying linguistic features of teacher talk that are predictive of children's language development

Linguistic feature	Model summary
Measures in Focus	
GI	$F = 2.84$, $p = .092$, adjusted $R^2 = .19$
Conjunctions	$F = 2.77$, $p = .098$, adjusted $R^2 = .18$
Pronouns	$F = 2.86$, $p = .091$, adjusted $R^2 = .19$
MLU	$F = 2.97$, $p = .084$, adjusted $R^2 = .20$
SYNLE	$F = 3.52$, $p = .058$, adjusted $R^2 = .24$
SYNSTRUTt	$F = 4.69$, $p = .028$, adjusted $R^2 = .32$
DRVP	$F = 4.19$, $p = .038$, adjusted $R^2 = .28$
Demonstratives	$F = 5.22$, $p = .020$, adjusted $R^2 = .35$
Exploratory Measures	
Quantity	
Number of word types	$F = 3.16$, $p = .074$, adjusted $R^2 = .21$
Number of word tokens	$F = 3.08$, $p = .078$, adjusted $R^2 = .21$
Number of utterances	$F = 3.15$, $p = .074$, adjusted $R^2 = .21$
Quality	
Lexical diversity	
Parts of speech (density scores)	
Adjectives	$F = 2.77$, $p = .097$, adjusted $R^2 = .18$
Adverbs	$F = 2.75$, $p = .099$, adjusted $R^2 = .18$
Coordinators	**$F = 3.92$, $p = .034$, adjusted $R^2 = .35$**
Determiners	$F = 3.01$, $p = .082$, adjusted $R^2 = .20$
Nouns	$F = 2.84$, $p = .092$, adjusted $R^2 = .19$

Numerals	$F = 5.79$, $p = .015$, adjusted $R^2 = .37$
Prepositions	$F = 3.14$, $p = .075$, adjusted $R^2 = .21$
Verbs	$F = 2.72$, $p = .101$, adjusted $R^2 = .18$
Syntactic complexity	
SYNNP	$F = 3.88$, $p = .046$, adjusted $R^2 = .26$
Syntactic patterns (density scores)	
DRNP	$F = 5.89$, $p = .014$, adjusted $R^2 = .38$
DRNEG	$F = 4.21$, $p = .037$, adjusted $R^2 = .29$
Syntactic subcategories (density scores)	
Copulas	$F = 4.42$, $p = .032$, adjusted $R^2 = .30$
Interrogatives	$F = 3.74$, $p = .050$, adjusted $R^2 = .26$
Relative pronouns	$F = 3.81$, $p = .048$, adjusted $R^2 = .26$

Notes. Final model of the density score of coordinators (presented in bold) contain the interaction term and its *df*s are (3, 13); *df*s are (2, 14) for the remaining linguistic features. All *VIF*s ≤ 1.59.

Figure 6. Interaction of language group and centred density scores of coordinators in teacher talk at T_1. Shaded areas represent standard errors.

4. Discussion

Previous studies of immersion programmes have shown that EAL children would be able to acquire the English language by being exposed to it in the preschool environment (e.g., Bergström et al., 2016; Genesee, 1981). However, it was not clear from these studies what specific linguistic features in the teacher talk were important to the children's additional language development. A key question is how preschool teachers should speak to children, whose English language is lower in proficiency than their monolingual English peers – whether they should adapt their language to the child's language level, or their chronological age. Before this can be answered, how preschool teachers actually do speak to children from EAL backgrounds needed to be addressed, and which linguistic features seem to be important to EAL children's language development identified. In the present study, we asked four key questions: (1) how quickly do EAL children's English develop in comparison to their monolingual English peers; (2) whether and how preschool teachers changed the way they speak to preschoolers, in relation to measured linguistic features, as the preschoolers grew; (3) are changes in linguistic features in teacher talk, if any, contingent on the children's language development; and (4) what linguistic features predict the children's language development. As in Chan et al. (2020), we have exploited the growing availability of corpus analysis tools to assess a vast array of linguistic features. We constructed a corpus of preschool teacher talk based on 4 hours of naturalistic observation of a preschool classroom to address our four key questions.

To address the first key question, we compared the development of the English language of a group of monolingual English and EAL children across 4.5 months. At both time points, the EAL children were behind the monolingual English children.

This is in line with findings in the literature that these two groups typically demonstrate large skill differences (e.g., Oller & Eilers, 2002). In general, there was a significant improvement from T_1 to T_2. This was mainly due to the improvement in the EAL group, as the monolingual English children's baseline and outcome language scores did not differ significantly, whereas those of the EAL children differed significantly. These suggest that the monolingual English children's language proficiency was developing at the typical rate, as the CELF-P2 Core Language scores were standardised by age, and the EAL children were catching up substantially – their improvement in English language proficiency was more than what would be expected by the typical development rate. Previous immersion programme studies (e.g., Bergström et al., 2016) and naturalistic observations (e.g., Bowers & Vasilyeva, 2011) that have reported gains in EAL children's language proficiency usually document children's language development across a year. Given the baseline and outcome tests in the present study were only administered 4.5 months apart, the observed improvement was impressive.

We then examined whether and how preschool teacher talk differed in terms of a range of measured linguistic features across two time points. We found that, compared to T_1, the teachers used significantly more word types, word tokens, adjectives, prepositions, pronouns, and interrogatives, a more diverse vocabulary, longer utterances, more modifiers before nouns, and more diverse sentence structures at T_2. These changes suggest that, over time, the general linguistic environment of the classroom had changed, in that the teachers' utterances were more lexically diverse and syntactically complex. These changes are indicators that the teachers were adapting their language use as the children grew and as their language developed. Yet, these changes only illustrate the overall changes in the general linguistic environment of the classroom, not how the teacher talk directed towards each individual child had changed, which was our third key question.

In addressing our third key question, we investigated whether changes in linguistic features in the teacher talk were contingent on the children's language development. We found that the teachers were sensitive to the children's developing language skills. For both language groups, the teachers' use of demonstratives was contingent on the children's changing language capacities, such that they increased their use of demonstratives more with the EAL children who were progressing more, but decreased their use of demonstratives with monolingual English children who showed greater development. For the EAL group, the teachers' increasing use of demonstratives with the children's developing language proficiency likely reflects that the teachers increasingly talked about things or events in the classroom in order to gauge the children's attention and initiate conversations as the children's language developed. For the monolingual English group, this finding likely reflects that the teachers were using more decontextualised talk, thus less demonstratives, with the children whose language was developing at a quicker rate, which, according to Rowe's (2012) finding that the use of decontextualised talk at 42 months benefits children's language development, would be language ability-appropriate adaptation.

In addition, the teachers were also more likely to increase the number of modifiers before nouns and use more coordinators and determiners with the EAL children whose language skills had developed more. These show that the teachers were introducing longer sentences and more complex sentences and grammatical structures in their speech as the EAL children's language developed. It is important to note that it is highly unlikely that the teachers consciously monitored and deliberately adapted their use of such linguistic features – these adaptations were likely unconscious. These demonstrate the teachers' implicit sensitivity to the EAL children's changing grammatical capacities. Apart from overall changes in the teacher talk, these analyses revealed that the teacher talk changed in accordance with the children's changing language proficiency, showing that the teachers were (implicitly) sensitive to the children's changing language proficiency levels and adapted their language use.

Finally, we attempted to identify potential predictors of the children's language development. Only frequency of coordinators was identified as a significant predictor, and this was only for the EAL children. The teachers' use of coordinators predicted the EAL, but not monolingual English, children's language improvement. The teachers' increased use of coordinators is an indicator of them joining phrases and clauses, thus increasing grammatical complexity in their utterances. As the teachers' use of coordinators with the EAL children was a significant predictor of the children's language development and contingent on the children's developing language skills, it is likely that adapting the use of coordinators is a means for preschool teachers to scaffold EAL children's language proficiency.

The lack of significant predictors for the monolingual group was not unexpected, as the preschool classroom was only one of the many contexts where the monolingual children would be exposed to English, and teacher talk may not be their primary source of input of the English language. Yet, our results are still rather surprising, as they do not seem to be in line with Bowers and Vasilyeva's (2011) findings that number of word types in teacher talk predicted monolingual English preschoolers' language proficiency and number of word tokens and decreasing MLU predicted that of EAL preschoolers. This difference could be attributed to the way we measured language proficiency. We used a composite measure of knowledge on sentence structures, word structures, and vocabulary, whereas Bowers and Vasilyeva only used a single measure of vocabulary. It is possible that different linguistic features predict different subsets of language skills. For instance, greater number of word tokens in teacher talk means the children would have more exposure to words, hence associated with the development of vocabulary; whereas greater number of coordinators means more complex sentences and is therefore associated with the development of knowledge on sentence structures.

Another possibility for the differences between our findings and those of Bowers and Vasilyeva (2011) is the timing of assessing children's language proficiency. Our baseline and outcome tests were administered 4.5 months apart, whereas those of Bowers and Vasilyeva's study were administered a year apart. In a similar observational study by Aukrust (2007) studying Turkish-speaking children learning Norwegian, it was found that number of word types, word tokens, and word types within explanatory talk in preschool talk predicted children's vocabulary knowledge at first grade, but showed no relation to the children's vocabulary knowledge during preschool years. This shows that the effects of linguistic features of preschool talk may not be observed within a short timeframe, as in the present study. Following from this, although we have only identified one predictor of children's language development, and only for the EAL group, it does not necessarily mean that other linguistic features are not important. Future studies tracking the same EAL children for a more extended period of time, for instance into school years, would be helpful in determining the long-term effects of different linguistic features in preschool talk on children's language development.

Our results suggest that, when developing effective interventions to aid EAL children's acquisition of the English language at preschool that are akin to immersion programmes, teachers could be advised to pay special attention to their use of coordinators. This immersion approach could be used in conjunction with other interventions or strategies. For example, teachers could incorporate dialogic book reading into story times – stories and prompt questions can contain coordinators, and a set of books with varying levels in terms of the use of coordinators can be developed for use as the children grow and their language develops. Having written prompts and having coordinators embedded in activity materials can reduce the teachers' effort in having to monitor and adapt their use of coordinators, but at the same time ensure an appropriate amount and diversity of coordinators are used.

As with Chan et al. (2020), a limitation of the present study is that we have excluded some potentially interesting linguistic features (e.g., teacher responsiveness) and peer talk due to practicality. Another limitation of the present study is that the composite score of language proficiency we used was standardised by age. As such, the lack of a difference in scores between the two time points does not necessarily mean no difference in the raw scores of the different test subsets. Our results may, therefore, have the tendency to underplay the teachers' sensitivity to the children's language proficiency levels and effects of some linguistic features on the children's language development, especially those of the monolingual English children.

To conclude, within a short timeframe, EAL children's English proficiency could improve substantially by natural exposure to the language in a preschool classroom. In general, we found that preschool teachers would adapt the way they speak – using language that is more lexically diverse and syntactically complex – to children as they grow. Moreover, preschool teachers are sensitive to preschoolers' language ability and can adapt the quality, but not quantity, of their language use accordingly. In particular, preschool teachers' changing use of demonstratives was found to be differentially associated with monolingual English and EAL children's language development, with increasing use of demonstratives associated with EAL children's language development and decreasing use of demonstratives associated with monolingual English children's language development. In addition, preschool teachers' use of increasingly more modifiers before nouns and increasing use of coordinators and determiners were found to be associated with EAL children's language development. In general, the teachers were tracking individual EAL children's language proficiency and adapted their grammar accordingly. Further, we have identified the use of coordinators in teacher talk as a predictor of EAL children's language development. These findings show that preschool teachers' language input to EAL children can scaffold and therefore support the children's language development.

References

Aukrust, V. G. (2007). Young children acquiring second language vocabulary in preschool group-time: Does amount, diversity, and discourse complexity of teacher talk matter?. *Journal of Research in Childhood Education*, *22*, 17-37. doi: 10.1080/02568540709594610

Barik, H. C., & Swain, M. (1978). Evaluation of a French immersion program: The Ottawa study through Grade five. *Canadian Journal of Behavioural Science*, *10*, 192-201. doi: doi.org/10.1037/h0081548

Bergström, K., Klatte, M., Steinbrink, C., & Lachmann, T. (2016). First and second language acquisition in German children attending a kindergarten immersion program: A combined longitudinal and cross-sectional study. *Language Learning*, *66*, 386-418. doi: 10.1111/lang.12162

Bowers, E. P., & Vasilyeva, M. (2011). The relation between teacher input and lexical growth of preschoolers. *Applied Psycholinguistics*, *32*, 221-241. doi: 10.1017/S0142716410000354

Cameron-Faulkner, T., Lieven, E., & Tomasello, M. (2003). A construction based analysis of child directed speech. *Cognitive Science*, *27*, 843-873. doi: 10.1207/s15516709cog2706_2

Cameron-Faulkner, T., & Noble, C. (2013). A comparison of book text and child directed speech. *First Language*, *33*, 268-279. doi: 10.1177/0142723713487613

Chan, K. C. J., Monaghan, P., & Michel, M. (2020). *Adapting to children's individual language proficiency: An observational study of preschool teacher talk addressing monolinguals and multilinguals*. Manuscript submitted for publication.

Clarke, P. (1999). Investigating second language acquisition in preschools: A longitudinal study of four Vietnamese-speaking children's acquisition of English in a bilingual preschool. *International Journal of Early Years Education*, *7*, 17-24. doi: 10.1080/0966976990070102

Crevecoeur, Y. C., Coyne, M. D., & McCoach, D. B. (2014). English language learners and English-only learners' response to direct vocabulary instruction. *Reading & Writing Quarterly*, *30*, 51-78. doi: 10.1080/10573569.2013.758943

Crossley, S. A., & McNamara, D. S. (2014). Does writing development equal writing quality? A computational investigation of syntactic complexity in L2 learners. *Journal of Second Language Writing*, *26*, 66-79. doi: 10.1016/j.jslw.2014.09.006

Department for Education (2017). *Statutory framework for the early years foundation stage: Setting the standards for learning, development and care for children from birth to five*. Retrieved from https://www.foundationyears.org.uk/files/2017/03/EYFS_STATUTORY_FRAMEWORK_2017.pdf

Dickinson, D. K., & Porche, M. V. (2011). Relation between language experiences in preschool classrooms and children’s kindergarten and fourth-grade language and reading abilities. *Child Development*, *82*, 870-886. doi: 10.1111/j.1467-8624.2011.01576.x

Dickinson, D. K., & Smith, M. W. (1994). Long-term effects of preschool teachers’ book readings on low-income children’s vocabulary and story comprehension. *Reading Research Quarterly*, *29*, 104-122. doi: 10.2307/747807

Dockrell, J. E., Stuart, M., & King, D. (2010). Supporting early oral language skills for English language learners in inner city preschool provision. *British Journal of Educational Psychology*, *80*, 497-515. doi: 10.1348/000709910X493080

Genesee, F. (1981). A comparison of early and late second language learning. *Canadian Journal of Behavioural Science*, *13*, 115-128. doi: 10.1037/h0081168

Genesee, F., Paradis, J., & Crago, M. B. (2004). *Dual language development and disorders: A handbook on bilingualism and second language learning*. Baltimore, MD: Paul H. Brookes Publishing.

Hakuta, K. (1976). A case study of a Japanese child learning English. Language Learning, 26, 321-351. doi: 10.1111/j.1467-1770.1976.tb00280.x

Hammer, C. S., Hoff, E., Uchikoshi, Y., Gillanders, C., Castro, D. C., & Sandilos, L. E. (2014). The language and literacy development of young dual language learners: A critical review. *Early childhood research quarterly*, *29*, 715-733. doi: 10.1016/j.ecresq.2014.05.008

Huttenlocher, J., Vasilyeva, M., Cymerman, E., & Levine, S. (2002). Language input and child syntax. *Cognitive Psychology*, *45*, 337-374. doi: 10.1019/S0010-0285)02)00500-5

Lambert, W. E., & Tucker, G. R. (1972). *The bilingual education of children: The St. Lambert experiment*. Rowley, MA: Newbury House.

Leacox, L., & Jackson, C. W. (2014). Spanish vocabulary-bridging technology-enhanced instruction for young English language learners' word learning. *Journal of Early Childhood Literacy*, *14*, 175-197. doi: 10.1177/1468798412458518

Leyva, D., & Skorb, L. (2017). Food for thought: Family food routines and literacy in Latino kindergarteners. *Journal of Applied Developmental Psychology*, *52*, 80-90. doi: 10.1016/j.appdev.2017.07.001

Lu, X. (2010). Automatic analysis of syntactic complexity in second language writing. *International Journal of Corpus Linguistics*, *15*, 474-496. doi: 10.1075/ijcl.15.4.02lu

MacWhinney, B. (2000). *The CHILDES Project: Tools for analyzing talk* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

McCabe, A., Bornstein, M. H., Guerra, A. W., Kuchirko, Y., Páez, M., Tamis-LeMonda, C. S., ... & Golinkoff, R. (2013). Multilingual children: Beyond myths and toward best practices and commentaries. *Society for Research on Child Development Social Policy Report*, *27*, 3-21. doi: 10.1002/j.2379-3988.2013.tb00077.x

McCartney, K. (1984). Effect of quality of day care environment on children's language development. *Developmental Psychology*, *20*, 244-260. doi: 10.1037/0012-1649.20.2.244

McNamara, D. S., Graesser, A. C., McCarthy, P. M., & Cai, Z. (2014). *Automated evaluation of text and discourse with Coh-Metrix*. New York, NY: Cambridge University Press.

Melzi, G., Schick, A., & Scarola, L. (2018). Building bridges between home and school for Latinx families of preschool children. *Occasional Paper Series*, *2018*(39). Retrieved from https://educate.bankstreet.edu/occasional-paper-series/vol2018/iss39/10

Murphy, V. A., & Unthiah, A. (2015). *A systematic review of intervention research examining English language and literacy development in children with English *as an Additional Language (EAL)*. London, UK: Educational Endowment Foundation.

Newman, R. S., Rowe, M. L., & Ratner, N. B. (2016). Input and uptake at 7 months predicts toddler vocabulary: the role of child-directed speech and infant processing skills in language development. *Journal of Child Language*, *43*, 1158-1173. doi: 10.1017/S0305000915000446

National Institute of Child Health and Human Development Early Child Care Research Network. (2000). The relation of child care to cognitive and language development. *Child Development*, *71*, 960-980. Retrieved from https://www.jstor.org/stable/1132337

Oller, D. K., & Eilers, R. E. (2002). *Language and literacy in bilingual children*. Clevedon, UK: Multilingual Matters.

Oxley, E., & de Cat, C. (2019). A systematic review of language and literacy interventions in children and adolescents with English as an additional language (EAL). *The Language Learning Journal*. doi: 10.1080/09571736.2019.1597146

Páez, M. M., Tabors, P. O., & López, L. M. (2007). Dual language and literacy development of Spanish-speaking preschool children. *Journal of Applied Developmental Psychology*, *28*, 85-102. doi: 10.1016/j.appdev.2006.12.007

Pearson, B. Z. (2002). Bilingual infants. In M. Suárez-Orozco & M. Páez (Eds.), *Latino remaking America* (pp. 306-320). Los Angeles: University of California Press and David Rockefeller Center for Latin American Studies, Harvard University.

Rowe, M. L. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech in vocabulary development. *Child Development*, *83*, 1762-1774. doi: 10.1111/j.1467-8624.2012.01805.x

Rowe, M. L., Leech, K. A., & Cabrera, N. (2016). Going beyond input quantity: *Wh*-questions matter for toddlers' language and cognitive development. *Cognitive Science*, *41*, 162-179. doi: 10.1111/cogs.12349

Rowe, M. L., & Zuckerman, B. (2016). Word gap redux: Developmental sequence and quality. *JAMA Pediatrics*, *170*, 827-828. doi: 10.1001/jamapediatrics.2016.1360

Snow, C. E. (1990). The development of definitional skill. *Journal of Child Language*, *17*, 697-710. doi: 10.1017/s0305000900010953

Snow, C. E., Burns, S., & Griffin, P. (1998). *Preventing reading difficulties in young children*. Washington, DC: National Academy of Sciences.

Tabors, P. O. (1997). *One child, two languages: A guide for preschool eucators of children learning English as a second language*. Baltimore, MD: Paul H. Brookes.

Uchikoshi, Y. (2006). English vocabulary development in bilingual kindergarteners: What are the best predictors?. *Bilingualism: Language and Cognition*, *9*, 33-49. doi: 10.1017/S1366728905002361

Vadasy, P. F., Sanders, E. A., & Logan Herrera, B. (2015). Efficacy of rich vocabulary instruction in fourth-and fifth-grade classrooms. *Journal of Research on Educational Effectiveness*, *8*, 325-365. doi: 10.1080/19345747.2014.933495

Vertovec, S. (2007). Super-diversity and its implications. *Ethnic and Racial Studies*, *30*, 1024-1054. doi: 10.1080/01419870701599465

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wiig, E., Secord, W. A., & Samuel, E. (2004). *The Clinical Evaluation of Language Fundamentals – Preschool* (2nd ed.). San Antonio, TX: Harcourt Assessment.

Chapter 6: General Discussion

This thesis aimed to understand how monolingual and bilingual language learners utilise different strategies when learning the meaning of words and find out how preschool teachers could support the acquisition of the majority language in children learning English as an additional language (EAL). Although various accounts that try to explain language learners' ability to solve the complex word-learning problem using one or two mechanisms, for example lexical constraints (e.g., Markman, 1994; Mervis & Bertrand, 1994), socio-pragmatic skills (e.g., Baldwin, 1993; Tomasello & Akhtar, 1995), linguistic input (e.g., Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010), and cross-situational statistical learning (CSSL; e.g., Smith & Yu, 2008; Yu & Smith, 2007) have been proposed, each of these accounts, on their own, does not seem sufficient. There is compelling evidence that language learners integrate multiple cues to learn the meaning of words (e.g., Hollich, Hirsh-Pasek, & Golinkoff, 2000; Yu & Ballard, 2007; Yu & Smith, 2012). Yet, it is still unclear how the different word-learning cues interact with each other to inform learning. Also, despite previous studies showing that bilinguals are more likely to relax mutual exclusivity (ME) and accept lexical overlap (e.g., Byers-Heinlein & Werker, 2009; Kalashnikova, Mattock, & Monaghan, 2015), and that monolinguals and bilinguals might hold different expectations for how words map onto objects (e.g., Byers-Heinlein, Chen, & Xu, 2014), it is unclear how prior language experience and varying contextual information influence a language learner's use of and reliance on different word-learning strategies. Further, despite findings in the literature highlighting the importance of quantity and quality of linguistic input on language learners' lexical development (e.g., Hart & Risley, 1995; Rowe, 2012), little is known about how these factors influence lexical development of children learning the majority language as an additional language.

Four studies were presented to address these gaps in the literature. In two experimental studies, monolingual and bilingual language learners' integration of multiple word-learning strategies, including lexical constraints, socio-pragmatic cues, and cross-situational statistics, was examined to understand the influence of socio-pragmatic information regarding speaker identity on the application of ME and CSSL. In two observational studies, the ways that preschool teachers communicate with monolingual English and EAL children in a UK setting were compared to identify potential strategies that are helpful in supporting EAL children's acquisition of the majority language in a preschool setting. This chapter will first summarise the key findings of each of the four studies presented in the thesis, then discuss their implications for word-learning theories and language interventions targeting EAL preschoolers. Finally, limitations of the thesis and future directions will be discussed.

6.1 Summary of Results

In Chapter 2, a study investigating whether socio-pragmatic information on linguistic background of speaker would differentially affect 3- to 4-year-old monolinguals and bilinguals' use of ME and acceptance of lexical overlap was presented. The children were first taught names of novel objects under ME or lexical overlap conditions. In one condition, the two speakers in the task both spoke English, whereas in the other condition, the two speakers spoke different languages. The children were tested on a referent-selection task immediately after learning the names of the objects and again after a 10-minute delay. It was found that both language groups performed similarly on trials where ME was required, and both groups were more likely to accept lexical overlap in the two-language condition. This suggests that both monolingual and bilingual preschoolers are sensitive to the socio-pragmatic cues in their linguistic environment and could adapt their word-learning strategies accordingly when learning the meaning of new words. In addition, it was also found that the children's use of ME and acceptance of lexical overlap were related to their vocabulary knowledge and timing of testing, showing a tendency to be more reliant on socio-pragmatic cues as their language developed and providing some evidence that they draw on CSSL and/or associative learning when determining the meaning of new words.

A study exploring the influence of socio-pragmatic information on speaker identity on monolingual and bilingual language learners' learning of one-to-one and two-to-one word-object mappings in a cross-situational word-learning task was then presented in Chapter 3. Socio-pragmatic cues (number of speakers – one vs. two – and presence of cue to speaker linguistic background) and referential ambiguity (number of distractors – one vs. three) were varied. It was found that both monolingual and bilingual adults could learn both types of mappings via CSSL and that the monolinguals were initially better at learning the one-to-one mappings, whereas the bilinguals were open to learning the two-to-one mappings. Also, it was found that these discrepancies between the two language groups reduced in the presence of socio-pragmatic cues on speaker identity. Moreover, when referential ambiguity was increased, learning worsened; and the monolinguals showed better learning than the bilinguals, potentially showing an advantage based on their higher familiarity with the phonology of the novel words. Together, these results suggest that prior language experience of a language learner, being monolingual or bilingual, and familiarity of the sounds of the target language(s), plays a role in the application of different word-learning strategies and this influence varies with the availability of contextual information of the learning situation and referential ambiguity.

In Chapter 4, an observational study investigating how preschool teachers communicate with monolingual English and EAL preschoolers was presented. Naturalistic preschool classroom activities were recorded and a corpus of preschool teacher talk built. The quantity and quality of the teacher talk were analysed. It was found that lexical diversity and utterance length of preschool teacher talk and the preschool teachers' use of left-embedded sentences, diverse syntactic structures, conjunctions, and decreased use of demonstratives were positively and significantly correlated with the children's language proficiency and related to their linguistic background. Also, the teachers used more pronouns and verb phrases with the children who were more proficient in English. These findings show that the teachers used more diverse vocabulary and complex syntax with the monolingual English children and children who were more proficient in English, showing sensitivity to the children's linguistic background and language proficiency.

The same classroom was followed longitudinally in Chapter 5 to investigate whether the adaptations observed in the teacher talk was scaffolding and supporting the children's language development or simply tuning to the children's language proficiency. It was found that, within 4.5 months of observation, the EAL children showed substantial improvement in English. Across time, the preschool teachers increased the number of word types, word tokens, adjectives, prepositions, pronouns, and interrogatives in their utterances, and used increasingly more diverse vocabulary, longer utterances, more modifiers before nouns, and more diverse sentence structures. The teachers' use of demonstratives was found to be different for the two language groups: increased use of demonstratives with the EAL children who were progressing more, but decreased use of demonstratives with monolingual English children who showed greater development. The teachers also used more modifiers before nouns, coordinators, and determiners with the EAL children whose language skills had developed more. In addition, it was found that the teachers were sensitive to individual EAL children's language proficiency and adapted their grammar accordingly. Further, the teachers' use of coordinators has been identified as a predictor of the EAL children's language development. These results indicate that the teachers increased the lexical diversity and syntactic complexity in their language towards the children, and this was adapted to individual children's language proficiency. They also suggest that preschool teachers' language input to EAL children can scaffold and therefore support the children's language development.

6.2 Implications for Word Learning Theories

The first theme of the thesis was to investigate the integration of lexical constraints, socio-pragmatic cues, and CSSL in word learning.

6.2.1 Multiple-Cues Account of Word Learning

In the two empirical studies (Chapters 2 and 3), support for the multiple-cues account of word learning has been consistently found. First, consistent with Kalashnikova et al. (2015), the findings in Chapter 3 showed that when there is no reliable socio-pragmatic cues to the number of languages in the linguistic environment, bilinguals tend to more readily relax ME and accept lexical overlap, whereas monolinguals are more inclined to adhere to ME when mapping novel words to objects. However, in Chapters 2 and 3, when socio-pragmatic cues on speaker identity were introduced to word-learning tasks, both language groups performed similarly. This suggests that with appropriate socio-pragmatic cues in the linguistic environment, monolinguals could also perform like bilinguals, in other words accept lexical overlap to a similar extent. Taken together, these findings suggest that socio-pragmatic cues differentially influence monolingual and bilingual learners' reliance on ME, which in turn constrains their cross-situational word learning.

With this in mind, monolingual and bilingual word learning do not seem to be fundamentally different – monolingual and bilingual learners do not seem to rely on different word-learning strategies. Rather, they utilise the same set of word-learning strategies differently. Here, a key question to consider is what contributes to the difference in performance between monolingual and bilingual language learners. Considering the findings in Chapters 2 and 3, it is highly likely that the performance difference reflects the language experience of the two language groups. The bilinguals' openness to learning two-to-one word-object mappings and the monolinguals' preference for one-to-one word-object mappings in situations without socio-pragmatic cues in Chapter 3 is in line with their prior language experience with word-object mappings. Yet, the same difference between the two language groups was not observed in the same-language condition in Chapter 2. Notably, this was consistent with Kalashnikova et al.'s (2015) finding that when their participants were divided into younger and older subgroups, significant differences between language groups were only observed for the older children. These provide compelling evidence that monolingual and bilingual word learning are not fundamentally different, and the difference between the two language groups observed in Chapter 3 and in the older children of Kalashnikova et al.'s study is likely one that is developed through the language learners' prior exposure to word-object mappings. Hence, our findings, alongside Kalashnikova et al.'s, emphasise the role of prior language experience in word learning.

In addition, the finding in Chapter 2 that preschoolers' use of ME and acceptance of lexical overlap was related to their vocabulary knowledge, together with similar previous findings on ME alone (Bion, Borovsky, & Fernald, 2013; Kalashnikova et al., 2016b), lend further weight to the notion that prior language experience plays an important role in word learning. In sum, it seems that the key to extending word-learning theories to the bilingual population, which represent the majority of language learners in the world, is to take into account prior language experience, including age, vocabulary knowledge, and learner language background. In conceptualising learner language background, it is important to look past the monolingual-bilingual dichotomy. As discussed above, in forming expectations for the plausibility of different types of word-object mappings, language learners accumulate information about how words map onto objects from their linguistic input. This information cannot possibly be fully captured by a simple monolingual-bilingual dichotomy (Luk, 2015). This dichotomy has to be broken into continuous measures of a range of factors, including age of first exposure and length of exposure to each language, current and cumulative amount of input, and output feature, to better quantify and represent the language background of a language learner (Armon-Lotem & Meir, 2018; Serratrice, 2018). In refining the theoretical framework of word learning, future research can test how the different factors on language background interact with different word-learning mechanisms.

6.2.2 Learning Context

The results of the empirical studies (Chapters 2 and 3) of this thesis also highlight the importance of learning context in word learning. First, as discussed in the previous section, contextual information carried by socio-pragmatic cues on speaker identity influences monolingual and bilingual language learners' learning of one-to-one and two-to-one word-object mappings. Second, in Chapter 3, when referential ambiguity of the CSSL task increased, the performance of both language groups worsened, and this also led to an unexpected monolingual advantage in learning both one-to-one and two-to-one word-object mappings, possibly due to the monolinguals' high familiarity with the sounds of the words used in the task. These results suggest that learning context can influence a language learners' use of different word-learning strategies in a complex way. An important question raised by these contextual effects is how do language learners navigate the learning environment to keep track of all sources and cope with all these varied learning situations.

Some recent studies have found that caregivers tend to name objects that are in children's view (Pereira, Smith, & Yu, 2014; Yu & Smith, 2012), and that caregivers and children selectively focus attention and learning on only a subset of objects available in the environment (Raz, Abney, Crandall, Yu, & Smith, 2019). Also, work by Abney, Dale, Louwerse, and Kello (2018) has shown that infants' learning opportunities for word-object mappings come in spurts, rather than distribute uniformly across time. Thus, experimental studies on word learning may present learning contexts that are far from naturalistic word-learning environments. It is recommended that future research that aims to examine the effects of contextual information on word learning should better align experimental designs with word learning situations in the real world. This may include varying the distribution of words in the input, both of amount of each type (Raz et al., 2019), and how sparse tokens are distributed (Abney et al., 2018).

6.3 Implications for Language Interventions Targeting EAL Preschoolers

A key question raised in Chapters 4 and 5 is how preschool teachers should speak to EAL children in supporting their majority language learning. Two possibilities are: (1) speak to them in a similar fashion as to monolinguals of the same age (adapt to chronological age); or (2) speak to them as if they were younger monolinguals (adapt to language ability). Although these possibilities were not explicitly tested in this thesis, the results of Chapters 4 and 5 clearly show that the EAL children improved substantially with the preschool teachers' speech showing sensitivity to their language proficiency level. Therefore, it is highly likely that adapting to EAL children's English proficiency is a good strategy to foster their learning of English. This also means that preschool teachers could potentially make use of strategies and interventions that work with younger monolinguals or children with lower language skills in supporting EAL children's language development. A caveat to the findings in Chapters 4 and 5 is that a more general language proficiency measure (i.e., not specific to lexical knowledge) was used. Yet, it was determined that a more general language proficiency measure would be more well-suited for the purpose of the studies as the input measures used captured both lexical and grammatical aspects of language. It is important to note that vocabulary knowledge formed part of the language proficiency measure used in these studies.

6.3.1 Incidental Learning

As discussed in Chapter 5, EAL children in a preschool setting are very similar to participating in an immersion programme. There is ample support in the literature that language acquisition could happen through incidental learning – learning without intention and awareness (e.g., Hart & Risley, 1974, 1975; Pelucchi, Hay, & Saffran, 2009; Saffran, Newport, Aslin, Tunick, & Barrueco, 1997). Early studies by Hart and Risley (1974, 1975) have found that preschoolers from low socio-economic status backgrounds with lower language skills could benefit from incidental learning in learning language constructions such as adjective-noun combinations and compound sentences. Of note, Hart and Risley (1974) found that a scaffolding approach whereby teachers build on children's current language skills and introduce them to more complex constructions (e.g., adjective-noun combinations and compound sentences) was beneficial to the children's language development. It was found that the children's use of the target construction of each phase increased during the phase and sustained into the next phase. Seeing as preschool teacher talk can scaffold and support EAL preschoolers' language development (Chapter 5), incidental learning, when adapted to individual EAL children's language proficiency level, or their knowledge on specific language constructions, could be helpful in boosting their language. A potential language construction to include in a graded incidental learning approach would be constructions involving coordinators, as it was found in Chapter 5 to be a potential predictor of EAL preschoolers' language development.

More recently, a study by Denhovska, Serratrice, and Payne (2018) found that a language learner's understanding of a given language construction is influenced by the frequency of the construction in the input. This does not seem to tally with the results from the two observational studies (Chapters 4 and 5). Although Chapters 4 and 5 did not look into specific language constructions, indices on the frequencies of interrogatives and relative pronouns could be seen as indices of questions and relative clauses; and these indices did not seem to influence the children's language development. Yet, it must be noted that the children's language scores were not fine-grained scores on each language construction, and this would likely downplay the influence of the frequencies of such constructions. More fine-grained analyses between linguistic input and children's language development and language production (e.g., test the influence on frequency of relative clause on children's understanding and/or production of relative clause) are needed to identify what language constructions could be included in a graded incidental learning approach and at what point of development. These could also be extended to look at the influence of frequency of a particular word or types of word (e.g., adjectives) in the input on children's later comprehension and production of such words.

6.3.2 Planned Language Training

Other than unplanned learning, support could also be offered through planned language training. Already discussed in Chapter 5 is the idea of integrating dialogic book reading and the graded use of coordinators, such that preschool teachers can read carefully-designed stories with varying levels of coordinators with EAL children in supporting their learning of English. Results from the empirical studies of this thesis (Chapters 2 and 3) could also offer some insights into developing useful planned language training. First, the findings that learning contexts matter emphasise that the set-up of the learning environment is important. Findings in Chapter 3 also highlight that language learners can learn one-to-one and two-to-one word-object mappings via CSSL. When considered together, it could mean that preschool teachers could create learning environments that are low in referential ambiguity (e.g., focus on one or two objects at a time), contains ample contextual information that they are using English (e.g., by using English words that the EAL children already know), and teach the same words in multiple situations (e.g., during free play and story time).

As seen in Chapters 2 and 3, a language learner's prior language experience plays an important role in their word learning. In particular, a learner's expectation for how words map onto objects depends on their experience with word-object mappings. In this sense, exposing monolingual children to more two-to-one word-object mappings could potentially guide them to relax ME and become more open to accepting lexical overlap. Another possible strategy to support EAL children's

English lexical development would be to teach them the English word for objects that they already know the name of in their first language(s), so that their expectations for plausible word-object mappings could be changed in adaptation to learning an additional word in English for each referent.

6.4 Limitations and Future Directions

Apart from the limitations already discussed in this and previous chapters, there are several general limitations of this thesis.

6.4.1 Adult vs. Children

This thesis aimed to investigate word learning in bilingual children. Yet, the CSSL study (Chapter 3) presented in this thesis tested adults instead of children. This decision was made on the assumption that statistical learning is fundamentally the same for children and adults (Weiss, Poepsel, & Gerfen, 2015), and most studies investigating cross-situational word learning were initially done with adults (e.g., Benitez, Yurovsky, & Smith, 2016; Poepsel & Weiss, 2014, 2016; Yu & Smith, 2007). However, the results of Chapters 2 and 3 clearly show that word learning does not only rely on CSSL, but the interaction of CSSL and other cues, and the dynamics of the integration of these cues change as a function of prior language experience. This implies that children and adults would weigh different word-learning strategies, including CSSL, differently. Therefore, although there may not be fundamental differences between CSSL in adults and children, when looking at cue-combination in word learning, it is crucial to take into account the age of learners as a source of prior language experience. Therefore, although this thesis, testing both children and adults, has shed light on the changing dynamics of the integration of different word-learning mechanisms, further child research is needed to better understand how socio-pragmatic cues influence the learning of one-to-one and two-to-one word-object mappings at an early age.

6.4.2 Contribution of Individual Languages

Another limitation of this thesis is that bilingual language learners and EAL children were treated as homogeneous groups (i.e., not distinguished for the different languages they speak). The decision to treat them as homogeneous groups was for pragmatic reasons. First, the ultimate goal of the thesis was to identify strategies that preschool teachers in a UK setting could use to support EAL children's development of English. In the UK, preschool teachers are often faced with a group of children speaking different first languages, and it would be impractical to take into account the individual languages that each EAL child speak (e.g., insufficient knowledge of all the different languages) when supporting them. Therefore, the aim was to develop strategies that could be used with all EAL children, irrespective of their language backgrounds. Hence, treating the EAL children as a homogeneous group was appropriate for the purposes of this thesis. Given the ultimate goal of the thesis, the same treatment was adopted for the bilinguals in the experimental studies.

However, it must be noted that this treatment is not the best for studying bilingual word learning, as previous research by Byers-Heinlein and Werker (2013) has found effects of individual languages on bilingual learners' application of ME. More specifically, they found that bilingual infants who knew more translation equivalents between their two languages (i.e., two-to-one word-object mappings) were less likely to rely on ME. The implication of this is that the number of translation equivalents between the two languages that a bilingual learner speaks could influence their flexible use of ME. Therefore, when studying bilingual word learning, it is important to take into account the languages that the bilingual participants speak.

Moreover, treating bilingual language learners who speak different languages as a homogeneous group would also mean ignoring the potential effects of linguistic distance. In Chapter 3, the unexpected monolingual advantage was attributed to the monolinguals' familiarity with the phonology of the test stimuli. A similar explanation was also used by Poepsel and Weiss (2016) in a similar study using more homogeneous groups of bilinguals (i.e., Chinese-English and Spanish-English bilinguals). More homogeneous groups of bilinguals are needed to clarify whether the monolingual advantage found in Chapter 3 is instead due to linguistic distance between the test language and the first language(s) of the language learners.

6.4.3 Influence of Low Quality and Messy Input

One other limitation of the thesis is that all four studies presented looked at linguistic input of high quality and consistency – well-formed language produced by adults who speak one language. However, in reality, language learners are not exposed to such perfect input, but also lower quality or messier input, for instance utterances produced by peers that might be ungrammatical or contain wrong words for referents. Some studies (e.g., Mashburn, Justice, Downer, & Pianta, 2009; Palermo et al., 2014) have found evidence that peer talk (i.e., talk amongst children) quantity could positively influence children's language development, including vocabulary skills. However, less is known about the influence of the quality of such input. Also, bilingual children may hear input from not only native but also non-native speakers. These non-native speakers may vary in their level of proficiency of the language (Fernald, 2006). Children's lack of improvement on a second or additional language has been attributed to the non-native input they received (e.g., Cornips & Hulk, 2008; Paradis, 2011). Yet, the reason why non-native input is less effective than native input in supporting language development remains unclear. Further, bilingual children are also likely to encounter code-switching in their linguistic input (e.g., Chung, 2006). This would result in a messier input than the experimental studies in this thesis. Whether and how this added uncertainty influence language learners' use of different word-learning mechanisms is unknown and remains a question for further research.

6.5 Conclusions

In conclusion, this thesis aimed to explore how children integrate multiple cues, in particular lexical constraints, socio-pragmatic cues, and cross-situational statistics, to learn the meaning of new words and how different features of the linguistic input influence children's language development. The empirical studies add to the growing literature on the multiple-cues account of word learning and show that monolingual and bilingual language learners may bring different expectations for how words map onto objects to a word-learning task based on their prior experience with word-object mappings, and when provided with appropriate socio-pragmatic cues that there are multiple languages in the learning context, monolingual language learners could perform similarly as bilingual language learners in accepting lexical overlap. These show a complex interaction between the different word-learning strategies and prior language experience and suggest that the key to extending word-learning theories to the bilingual population is to take into account prior language experience of a language learner. The observational studies add to the vast literature on the influence of linguistic input on children's language development by showing that preschool teachers' language use could scaffold and support EAL children's acquisition of English. Taken together, these findings have provided insights into developing useful strategies that preschool teachers can use to support children learning an additional language in a preschool setting.

Consolidated Bibliography

Abney, D. H., Dale, R., Louwerse, M. M., & Kello, C. T. (2018). The bursts and lulls of multimodal interaction: Temporal distributions of behavior reveal differences between verbal and non-verbal communication. *Cognitive Science*, *42*, 1297-1316. doi: 10.1111/cogs.12612

Acosta-Garcia, R., & Martinez-Ortiz, E. (2013). Mexico through a superdiversity lens: Already-existing diversity meets new immigration. *Ethnic and Racial Studies*, *38*, 636-649. doi: 10.1080/01419870.2015.980289

Akhtar, N., Carpenter, M., & Tomasello, M. (1996). The role of discourse novelty in early word learning. *Child Development*, *67*, 635-645. doi: 10.1111/j.1467-8624.1996.tb01756.x

Akhtar, N., Jipson, J., & Callanan, M. A. (2001). Learning words through overhearing. *Child Development*, *72*, 416-430. doi: 10.1111/1467-8624.00287

Akhtar, N., & Tomasello, M. (1996). Two-year-olds learn words for absent objects and actions. *Developmental Psychology*, *14*, 79-93. doi: 10.1111/j.2044-835X.1996.tb00695.x

Akhtar, N., & Tomasello, M. (2000). The social nature of words and word learning. In R. Golinkoff & K. Hirsh-Pasek (Eds.), *Becoming a word learner: A debate on lexical acquisition* (pp. 115-135). Oxford, UK: Oxford University Press.

Alexopoulou, T., Michel, M., Murakami, A., & Meurers, D. (2017). Task effects on linguistic complexity and accuracy: A large-scale learner corpus analysis employing natural language processing techniques. *Language Learning*, *67*, 180-208. doi: 10.1111/lang.12232

Armon-Lotem, S., & Meir, N. (2018). The nature of exposure and input in early bilingualism. In A. de Houwer, A. & L. Ortega (Eds.), *The Cambridge Handbook of Bilingualism* (pp. 193-212). Cambridge, UK: Cambridge University Press.

Au, T. K., & Glusman, M. (1990). The principle of mutual exclusivity in word learning: To honor or not to honor?, *Child Development*, *61*, 1474-1490. doi: 10.1111/j.1467-8624.1990.tb02876.x

Augusti, E.-M., Melinder, A., & Gredeback, G. (2010). Look who's talking: Pre-verbal infants' perception of face-to-face and back-to-back social interactions. *Frontiers in Psychology*, *161*, 1-7. doi: 10.3389/fpsyg.2010.00161

Aukrust, V. G. (2007). Young children acquiring second language vocabulary in preschool group-time: Does amount, diversity, and discourse complexity of teacher talk matter?. *Journal of Research in Childhood Education*, *22*, 17-37. doi: 10.1080/02568540709594610

Baayen, R. H. (2008). *Analyzing linguistic data*. Cambridge, UK: Cambridge University Press.

Baldwin, D. A. (1991). Infants' contribution to the achievement of joint reference. *Child Development*, *62*, 875–890. doi: 10.1111/j.1467-8624.1991.tb01577.x

Baldwin, D. A. (1993a). Early referential understanding: Infants' ability to recognize referential acts for what they are. *Developmental Psychology*, *29*, 832–843. doi: 10.1037/0012-1649.29.5.832

Baldwin, D. A. (1993b). Infants' ability to consult the speaker for clues to word reference. *Journal of Child Language*, *20*, 395-418. doi: 10.1017/S0305000900008345

Baldwin, D. A., & Moses, L. J. (2001). Links between social understanding and early word learning: Challenges to current accounts. *Social Development*, *10*, 309–329. doi: doi.org/10.1111/1467-9507.00168

Barik, H. C., & Swain, M. (1978). Evaluation of a French immersion program: The Ottawa study through Grade five. *Canadian Journal of Behavioural Science*, *10*, 192-201. doi: doi.org/10.1037/h0081548

Bates, E., Marchman, V., Thal, D., Fenson, L., Dale, P., Reznick, J. S., … Hartung, J. (1994). Developmental and stylistic variation in the composition of early vocabulary. *Journal of Child Language*, *21*, 85–124. doi: 10.1017/s0305000900008680

Behrend, D. A., Scofield, J., & Kleinknecht, E. E. (2001). Beyond fast mapping: Young children's extensions of novel words and novel facts. *Developmental Psychology*, *37*, 698-705. doi: 10.1037/0012-1649.37.5.698

Benitez, V. L., Yurovsky, D., & Smith, L. B. (2016). Competition between multiple words for a referent in cross-situational word learning. *Journal of Memory and Language*, *90*, 31-48. doi: 10.1016/j.jml.2016.03.004

Bergström, K., Klatte, M., Steinbrink, C., & Lachmann, T. (2016). First and second language acquisition in German children attending a kindergarten immersion program: A combined longitudinal and cross-sectional study. *Language Learning*, *66*, 386-418. doi: 10.1111/lang.12162

Bion, R. A. H., Borovsky, A., & Fernald, A. (2013). Fast mapping, slow learning: Disambiguation of novel word – object mappings in relation to vocabulary learning at 18, 24, and 30 months. *Cognition*, *126*, 39-53. doi: 10.1016/j.cognition.2012.08.008

Bloom, P. (1998). Theories of word learning: Rationalist alternatives to associationism. In T. K. Bhatia & W. C. Ritchie (Eds.), *Handbook of language acquisition*. Cambridge, MA: Academic Press.

Bloom, P. (2000). *How children learn the meanings of words*. Cambridge, MA: MIT Press.

Bowers, E. P., & Vasilyeva, M. (2011). The relation between teacher input and lexical growth of preschoolers. *Applied Psycholinguistics*, *32*, 221-241. doi: 10.1017/S0142716410000354

Brooks, R., & Meltzoff, A. N. (2005). The development of gaze following and its relation to language. *Developmental science*, *8*, 535-543. doi: 10.1111/j.1467-7687.2005.00445.x

Bulté, B., & Housen, A. (2018). Syntactic complexity in L2 writing: Individual pathways and emerging group trends. *International Journal of Applied Linguistics*, *28*, 147-164. doi: 10.1111/ijal.12196

Bulté, B., & Housen, A. (2019). Beginning L2 complexity development in CLIL and non-CLIL secondary education. *Instructed Second Language Acquisition*, *3*, 153-180. doi: 10.1558/isla.38247

Byers-Heinlein, K., Chen, K. H., & Xu, F. (2014). Surmounting the Tower of Babel: Monolingual and bilingual 2-year-olds' understanding of the nature of foreign language words. *Journal of Experimental Child Psychology*, *119*, 87-100. doi: 10.1016/j.jecp.2013.09.011

Byers-Heinlein, K., & Werker, J. F. (2009). Monolingual, bilingual, trilingual: Infants' language experience influences the development of a word-learning heuristic. *Developmental Science*, *12*, 815-823. doi: 10.1111/j.1467-7687.2009.00902.x

Byers-Heinlein, K., & Werker, J. F. (2013). Lexicon structure and the disambiguation of novel words: Evidence from bilingual infants. *Cognition*, *128*, 407-416. doi: 10.1016/j.cognition.2013.05.010

Callanan, M. A. (1985). How parents name objects for young children: The role of input in the acquisition of category hierarchies. Child Development, 56, 508-523. doi: 10.2307/1129738

Callanan, M. A., & Sabbagh, M. A. (2004). Multiple labels for objects in conversations with young children: Parents' language and children's developing expectations about word meanings. *Developmental Psychology*, *40*, 746-763. doi: 10.1037/0012-1649.40.5.746

Cameron-Faulkner, T., Lieven, E., & Tomasello, M. (2003). A construction based analysis of child directed speech. *Cognitive Science*, *27*, 843-873. doi: 10.1207/s15516709cog2706_2

Cameron-Faulkner, T., & Noble, C. (2013). A comparison of book text and child directed speech. *First Language*, *33*, 268-279. doi: 10.1177/0142723713487613

Carey, S. (1978). The child as a word learner. In J. Bresnan, G. Miller, & M. Halle (Eds.), *Linguistic theory and psychological reality* (pp. 264-293). Cambridge, MA: MIT Press.

Cartmill, E., Armstrong, B. F., Gleitman, L. R., Goldin-Meadows, S., Medinac, T. N., & Trueswell, J. C. (2013). Quality of early parent input predicts child vocabulary 3 years later. *Proceedings of the National Academy of Sciences, 110*, 11278–11283. doi: 10.1073/pnas.1309518110

Chan, K. C. J., Monaghan, P., & Michel, M. (2020). *Adapting to children's individual language proficiency: An observational study of preschool teacher talk* *addressing monolinguals and multilinguals*. Manuscript submitted for publication.

Chang, Y. N., & Monaghan, P. (2019). Quantity and diversity of preliteracy language exposure both affect literacy development: Evidence from a computational model of reading. *Scientific Studies of Reading*, *23,* 235-253. doi: 10.1080/10888438.2018.1529177

Choi, S., & Gopnik, A. (1995). Early acquisition of verbs in Korean: A cross-linguistic study. *Journal of Child Language*, *22*, 497-529. doi: 10.1017/S0305000900009934

Chung, H. H. (2006). Code switching as a communicative strategy: A case study of Korean–English bilinguals. *The Journal of the National Association for Bilingual Education*, *30*, 293-307. doi: 10.1080/15235882.2006.10162878

Clark, E. V. (1987). The principle of contrast: A constraint on language acquisition. In B. MacWhinney (Ed.), *Mechanisms of language acquisition* (pp. 1-33). Hillsdale, NJ: Lawrence Erlbaum Associates.

Clark, E. V. (1988). On the logic of contrast. *Journal of Child Language*, *15*, 317-335. doi: 10.1017/S0305000900012393

Clark, E. V. (1990). On the pragmatics of contrast. *Journal of Child Language*, *17*, 417-431. doi: 10.1017/S0305000900013842

Clark, E. V., & Wong, A. D. W. (2002). Pragmatic directions about language use: Offers of words and relations. *Language and Society*, *31*, 181-212. doi: 10.1017.S0047404501020152

Clarke, P. (1999). Investigating second language acquisition in preschools: A longitudinal study of four Vietnamese-speaking children's acquisition of

English in a bilingual preschool. *International Journal of Early Years Education*, *7*, 17-24. doi: 10.1080/0966976990070102

Cornips, L., & Hulk, A. (2008). Factors of success and failure in the acquisition of grammatical gender in Dutch. *Second Language Research*, *24*, 267-295. doi: 10.1177/0267658308090182

Crevecoeur, Y. C., Coyne, M. D., & McCoach, D. B. (2014). English language learners and English-only learners' response to direct vocabulary instruction. *Reading & Writing Quarterly*, *30*, 51-78. doi: 10.1080/10573569.2013.758943

Crossley, S. A., & McNamara, D. S. (2014). Does writing development equal writing quality? A computational investigation of syntactic complexity in L2 learners. *Journal of Second Language Writing*, *26*, 66-79. doi: 10.1016/j.jslw.2014.09.006

Denhovska, N., Serratrice, L., & Payne, J. (2018). Frequency and working memory effects in incidental learning of a complex agreement pattern. *Lingua*, *207*, 49-70. doi: 10.1016/j.lingua.2018.02.009

Department for Education (2017). Statutory framework for the early years foundation stage: Setting the standards for learning, development and care for children from birth to five. Retrieved from https://www.foundationyears.org.uk/files/2017/03/EYFS_STATUTORY_FRAMEWORK_2017.pdf

Department for Education (2019). Schools, pupils and their characteristics: January 2019. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/812539/Schools_Pupils_and_their_Characteristics_2019_Main_Text.pdf

Department of Homeland Security (2018). *Yearbook of immigration statistics*. Retrieved from https://www.dhs.gov/immigration-statistics/yearbook/2018, downloaded 05/02/20

Dickinson, D. K., & Porche, M. V. (2011). Relation between language experiences in preschool classrooms and children's kindergarten and fourth-grade language and reading abilities. *Child Development*, *82*, 870-886. doi: 10.1111/j.1467-8624.2011.01576.x

Dickinson, D. K., & Smith, M. W. (1994). Long-term effects of preschool teachers' book readings on low-income children's vocabulary and story comprehension. *Reading Research Quarterly*, *29*, 104-122. doi: 10.2307/747807

Dienes, Z. (2014). Using Bayes to get the most out of non-significant results. *Frontiers in Psychology*, *5*, 781. doi: 10.3389/fpsyg.2014.00781

Diesendruck, G., & Markson, L. (2001). Children's avoidance of lexical overlap: A pragmatic account. *Developmental Psychology*, *37*, 630-641. doi: 10.1037/0012-1649.37.5.630

Dockrell, J. E., Stuart, M., & King, D. (2010). Supporting early oral language skills for English language learners in inner city preschool provision. *British Journal of Educational Psychology*, *80*, 497-515. doi: 10.1348/000709910X493080

Dunn, L. M., Dunn, D. M., Styles, B., & Sewell, J. (2009). *British picture vocabulary scale III*. Winsor, UK: NFER-Nelson.

Escudero, P., Mulak, K. E., Fu, C. S. L., & Singh, L. (2016). More limitations to monolingualism: Bilinguals outperform monolinguals in implicit word learning. *Frontiers in Psychology, 7*, 1218. doi: 10.3389/fpsyg.2016.01218

Eurostat (2018). *People in the EU: Who are we and how do we live?* Retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=People_in_the_EU_–_who_are_we_and_how_do_we_live, downloaded 05/02/20

Fenson, L., Dale, P., Reznick, J., Bates, E., Thai, D., Pethick, S., … Stiles, J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development*, *59* (5, Serial No. 242). doi: 10.2307/1166093

Fernald, A. (2006). When infants hear two languages: Interpreting research on early speech perception by bilingual children. In E. Hoff & P. McCardle (Eds.), *Childhood bilingualism: Research on infancy through school age* (pp. 19-29). Clevedon, UK: Multilingual Matters.

Fitneva, S. A., & Christiansen, M. H. (2011). Looking in the wrong direction correlates with more accurate word learning. *Cognitive Science*, *35*, 367–380. doi:10.1111/j.1551-6709.2010.01156.x

Frank, M. C., Goodman, N. D., & Tenenbaum, J. B. (2009). Using speakers' referential intentions to model early cross-situational word learning. *Psychological Science*, *20*, 578-585. doi: 10.1111/j.1467-9280.2009.02335.x

Gampe, A., Liebal, K., & Tomasello, M. (2012). Eighteen-month-olds learn novel words through overhearing. *First Language*, *32*, 385-397. doi: 10.1177/0142723711433584

Gebhart, A. L., Aslin, R. N., & Newport, E. L. (2009). Changing structures in midstream: Learning along the statistical garden path. *Cognitive Science*, *33*, 1087-1116. doi: 10.1111/j.1551-6709.2009.01041.x

Genesee, F. (1981). A comparison of early and late second language learning. *Canadian Journal of Behavioural Science*, *13*, 115-128. doi: 10.1037/h0081168

Genesee, F., Paradis, J., & Crago, M. B. (2004). *Dual language development and disorders: A handbook on bilingualism and second language learning*. Baltimore, MD: Paul H. Brookes Publishing.

Gentner, D. (1978). What looks like a jiggy but acts like a zimbo?: A study of early word meaning using artificial objects. *Papers and Reports on Child Development*, *15*, 1-6.

Gentner, D. (1982). Why nouns are learned before verbs: Linguistic relativity versus natural partitioning. In S. Kuczaj (Ed.), *Language development: Language, cognition, and culture* (pp. 301–334). Hillsdale, NJ: Erlbaum.

Gleitman, L. R., Cassidy, K., Nappa, R., Papafragou, A., & Trueswell, J. C. (2005). Hard words. *Language Learning and Development*, *1*, 23-64. doi: 10.1207/s15473341lld0101_4

Graham, S. A., Poulin-Dubois, D., & Baker, R. K. (1998). Infants' disambiguation of novel object words. *First Language*, *18*, 149-164. doi: 10.1177/014272379801805302

Golinkoff, R. M., Mervis, C. B., & Hirsh-Pasek, K. (1994). Early object labels: The case for a developmental lexical principles framework. *Journal of Child Language*, *21*, 125-155. doi: 10.1017/S0305000900008692

Guerrero, M. D. (2004). Acquiring academic English in one year: An unlikely proposition for English language learners. *Urban Education*, *39*, 172-199. doi: 10.1177/0042085903260915

Hakuta, K. (1976). A case study of a Japanese child learning English. Language Learning, 26, 321-351. doi: 10.1111/j.1467-1770.1976.tb00280.x

Halberda, J. (2003). The development of a word-learning strategy. *Cognition*, *87*, B23-B34. doi: 10.1016/S0010-0277(02)00186-5

Hammer, C. S., Hoff, E., Uchikoshi, Y., Gillanders, C., Castro, D. C., & Sandilos, L. E. (2014). The language and literacy development of young dual language learners: A critical review. *Early childhood research quarterly*, *29*, 715-733. doi: 10.1016/j.ecresq.2014.05.008

Hamrick, P., & Rebuschat, P. (2012). How implicit is statistical learning?. In P. Rebuschat & J. N. Williams (Eds.), *Statistical learning and language acquisition* (pp. 365-382). Berlin: de Gruyter Mouton.

Hart, B., & Risley, T. (1974). Using preschool materials to modify the language of disadvantaged children. *Journal of Applied Behavior Analysis*, *7*, 243-256. doi: 10.1901/jaba.1974.7-243

Hart, B., & Risley, T. (1975). Incidental teaching of language in the preschool. *Journal of Applied Behavior Analysis*, *8*, 411-420. doi: 10.1901/jaba.1975.8-411

Hart, B., & Risley, T. (1995). *Before Headstart: Differences in the family experiences of 1- and 2-year-old children*. Baltimore, MD: Paul H. Brookes.

Hartley, C., Bird, L. A., & Monaghan, P. (2020). Comparing cross-situational word learning, retention, and generalisation in children with autism and typical development. *Cognition*, *200*, 104265. doi: 10.1016/j.cognition.2020.104265

Henderson, A. M., & Graham, S. A. (2005). Two-year-olds' appreciation of the shared nature of novel object labels. *Journal of Cognition and Development*, *6*, 381-402. doi: 10.1207/s15327647jcd0603_4

Henderson, A. M. E., & Scott, J. C. (2015). She called that thing a mido, but should you call it a mido too? Linguistic experience influences infants’ expectations of conventionality. *Frontiers in Psychology*, *6*, 332. doi: 10.3389/fpsyg.2015.00332

Hindman, A. H., Wasik, B. A., & Snell, E. K. (2016). Closing the 30 million word gap: Next steps in designing research to inform practice. *Child Development Perspectives*, *10*(2), 134-139. doi: 10.1111/cdep.12177

Hoff, E. (2006). How social contexts support and shape language development. *Developmental Review*, *26*, 55-88. doi: 10.1016/j.dr.2005.11.002

Hollich, G. J., Hirsh-Pasek, K., & Golinkoff, R. M. (2000). Breaking the language barrier: An Emergentist Coalition Model for the origins of word learning. *Monographs of the Society for Research in Child Development*, *65* (3, Serial No. 262). Retrieved from http://www.jstor.org/stable/3181533

Horst, J. S., & Hout, M. C. (2016). The Novel Object and Unusual Name (NOUN) Database: A collection of novel images for use in experimental research. *Unpublished manuscript*.

Horst, J. S., & Samuelson, L. K. (2008). Fast mapping but poor retention by 24-month-old infants. *Infancy*, *13*, 128-157. doi: 10.1080/15250000701795598

Horst, J. S., Samuelson, L. K., Kucker, S. C., & McMurray, B. (2011). What's new? Children prefer novelty in referent selection. *Cognition*, *118*, 234-244. doi: 10.1016/j.cognition.2010.10.015

Hutchinson, J. (2018). Educational outcomes of children with English as an additional language. Retrieved from https://epi.org.uk/wp-content/uploads/2018/02/EAL_Educational-Outcomes_EPI-1.pdf

Huttenlocher, J., Haight, W., Bryk, A., Seltzer, M., & Lyons, T. (1991). Early vocabulary growth relation to language input and gender. *Developmental Psychology*, *27*, 236-248. doi: 10.1037/0012-1649.27.2.236

Huttenlocher, J., Vasilyeva, M., Cymerman, E., & Levine, S. (2002). Language input and child syntax. *Cognitive Psychology*, *45*, 337-374. doi: 10.1019/S0010-0285)02)00500-5

Huttenlocher, J., Waterfall, H., Vasilyeva, M., Vevea, J., & Hedges, L. V. (2010). Sources of variability in children's language growth. *Cognitive Psychology*, *61*, 343-365. doi: 10.1016/j.cogpsych.2010.08.002

Ichinco, D., Frank, M., & Saxe, R. (2009). Cross-situational word learning respects mutual exclusivity. In N. Taatgen & H. van Rijn (Eds.), *Proceedings of the 31st Annual Meeting of the Cognitive Science Society* (pp. 2214-2219). Austin, TX: Cognitive Science Society.

Jeffreys, H. (1939/1961). *The Theory of Probability*, (1st/3rd ed.). Oxford, UK: Oxford University Press.

Jiang, J. (2007). *Linear and generalized linear mixed models and their applications*. New York, NY: Springer.

Kachergis, G., Yu, C., & Shiffrin, R. M. (2009). Frequency and contextual diversity effects in cross-situational word learning. In N. Taatgen & H. van Rijn (Eds.), *Proceedings of the 31st Annual Meeting of the Cognitive Science Society* (pp. 2220-2225). Austin, TX: Cognitive Science Society.

Kalashnikova, M., Mattock, K., & Monaghan, P. (2014). Disambiguation of novel labels and referential facts: A developmental perspective. *First Language*, *34*, 125-135. doi: 10.1177/0142723714525946

Kalashnikova, M., Mattock, K., & Monaghan, P. (2015). The effects of linguistic experience on the flexible use of mutual exclusivity in word learning. *Bilingualism: Language and Cognition*, *18*, 626-638. doi: 10.1017/S1366728914000364

Kalashnikova, M., Mattock, K., & Monaghan, P. (2016a). Flexible use of mutual exclusivity in word learning. *Language Learning and Development*, *12*, 79-91. doi: 10.1080/15475441.2015.1023443

Kalashnikova, M., Mattock, K., & Monaghan, P. (2016b). Mutual exclusivity develops as a consequence of abstract rather than particular vocabulary knowledge. *First Language*, *36*, 451-464. doi: 10.1177/0142723716648850

Lambert, W. E., & Tucker, G. R. (1972). *The bilingual education of children: The St. Lambert experiment*. Rowley, MA: Newbury House.

Langeloo, A., Mascareño Lara, M., Deunk, M. I., Klitzing, N. F., & Strijbos, J. W. (2019). A systematic review of teacher-child interactions with multilingual young children. *Review of Educational Research*, *89*, 536-568. doi: 10.3102/0034654319855619

Lara-Alecio, R., Tong, F., Irby, B. J., & Mathes, P. (2009). Teachers' pedagogical differences during ESL block among bilingual and English-immersion kindergarten classrooms in a randomized trial story. *Bilingual Research Journal*, *32*, 77-100. doi: 10.1080/15235880902965938

Leacox, L., & Jackson, C. W. (2014). Spanish vocabulary-bridging technology-enhanced instruction for young English language learners' word learning. *Journal of Early Childhood Literacy*, *14*, 175-197. doi: 10.1177/1468798412458518

Leyva, D., & Skorb, L. (2017). Food for thought: Family food routines and literacy in Latino kindergarteners. *Journal of Applied Developmental Psychology*, *52*, 80-90. doi: 10.1016/j.appdev.2017.07.001

Littschwager, J. C., & Markman, E. M. (1994). Sixteen- and 24-month-olds' use of mutual exclusivity as a default assumption in second-label learning. *Developmental Psychology*, *30*, 955-968. doi: 10.1037/0012-1649.30.6.955

Lu, X. (2010). Automatic analysis of syntactic complexity in second language writing. *International Journal of Corpus Linguistics*, *15*, 474-496. doi: 10.1075/ijcl.15.4.02lu

Luk, G. (2015). Who are the bilinguals (and monolinguals)?. *Bilingualism: Language and Cognition*, *18*, 35–36. doi: 10.1017/S1366728914000625

Macnamara, J. (1972). Cognitive basis of language learning in infants. *Psychological Review*, *79*, 1-13. doi: 10.1037/h0031901

MacWhinney, B. (2000). *The CHILDES Project: Tools for analyzing talk* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Markman, E. M. (1989). *Categorization and naming in children*. Cambridge, MA: MIT Press.

Markman, E. M. (1990). Constraints children place on word meanings. *Cognitive Science*, *14*, 57-77. doi: 10.1207/s15516709cog1401_4

Markman, E. M. (1991). The whole-object, taxonomic, and mutual exclusivity assumptions as initial constraints on word meanings. In S. A. Gelman & J. P. Brynes, *Perspectives on language and thought: Interrelations in development* (pp.72-106). New York, NY: Cambridge University Press.

Markman, E. M. (1994). Constraints on word meaning in early language acquisition. *Lingua*, *92*, 199-227. doi: 10.1016/0024-3841(94)90342-5

Markman, E. M., & Hutchinson, J. E. (1984). Children's sensitivity to constraints on word meaning: Taxonomic versus thematic relations. *Cognitive Psychology*, *16*, 1-27. doi: 10.1016/0010-0285(84)90002-1

Markman, E. M., & Wachtel, G. F. (1988). Children's use of mutual exclusivity to constrain the meanings of words. *Cognitive Psychology*, *20*, 121-157. doi: 10.1016/0010-0285(88)90017-5

Markman, E. M., Wasow, J. L., & Hansen, M. B. (2003). Use of the mutual exclusivity assumption by young word learners. *Cognitive Psychology*, *47*, 241-275. doi: 10.1016/S0010-0285(03)00034-3

Mashburn, A. J., Justice, L. M., Downer, J. T., & Pianta, R. C. (2009). Peer effects on children's language achievement during pre-kindergarten. *Child Development*, *80*, 686-702. doi: 10.1111/j.1467-8624.2009.01291.x

Masur, E. F. (1997). Maternal labeling of novel and familiar objects: Implications for children's development of lexical constraints. *Journal of Child Language*, *24*, 427-439. doi: 10.1017/S0305000997003115

Mather, E., & Plunkett, K. (2010). Novel labels support 10-month-olds' attention to novel objects. *Journal of Experimental Child Psychology*, *105*, 232-242. doi: 10.1016/j.jecp.2009.11.004

Mather, E., & Plunkett, K. (2012). The role of novelty in early word learning. *Cognitive Science*, *36*, 1157-1177. doi: 10.1111/j.1551-6709.2012.01239.x

McCabe, A., Bornstein, M. H., Guerra, A. W., Kuchirko, Y., Páez, M., Tamis-LeMonda, C. S., ... & Golinkoff, R. (2013). Multilingual children: Beyond myths and toward best practices and commentaries. *Society for Research on Child Development Social Policy Report*, *27*, 3-21. doi: 10.1002/j.2379-3988.2013.tb00077.x

McCartney, K. (1984). Effect of quality of day care environment on children's language development. *Developmental Psychology*, *20*, 244-260. doi: 10.1037/0012-1649.20.2.244

McNamara, D. S., Graesser, A. C., McCarthy, P. M., & Cai, Z. (2014). *Automated evaluation of text and discourse with Coh-Metrix*. New York, NY: Cambridge University Press.

Melzi, G., Schick, A., & Scarola, L. (2018). Building bridges between home and school for Latinx families of preschool children. *Occasional Paper Series*, *2018*(39). Retrieved from https://educate.bankstreet.edu/occasional-paper-series/vol2018/iss39/10

Mervis, C. B., & Bertrand, J. (1994). Acquisition of the Novel Name-Nameless Category (N3C) Principle. *Child Development*, *65*, 1646-1662. doi: 10.2307/1131285

Metzing, C., & Brennan, S. E. (2003). When conceptual pacts are broken: Partner-specific effects on the comprehension of referring expressions. *Journal of Memory and Language*, *49*, 201-213. doi: 10.1016/S0749-596X(03)00028-7

Meurers, D. (2012). Natural language processing and language learning. In C. A. Chapelle (Ed.), *Encyclopedia of applied linguistics* (pp. 4193– 4205). Oxford, UK: Wiley.

Meurers, D., & Dickinson, M. (2017). Evidence and interpretation in language learning research: Opportunities for collaboration with computational linguistics. *Language Learning*, *67*, 66-95. doi: 10.1111/lang.12233

Monaghan, P., & Mattock, K. (2012). Integrating constraints for learning word-referent mappings. *Cognition*, *123*, 133-143. doi: 10.1016/j.cognition.2011.12.010

Monaghan, P. J., & Rowland, C. F. (2017). Combining language corpora with experimental and computational approaches for language acquisition research. *Language Learning*, *67*, 14-39. doi: 10.1111/lang.12221

Murphy, V. A., & Unthiah, A. (2015). *A systematic review of intervention research examining English language and literacy development in children with English as an Additional Language (EAL)*. London, UK: Educational Endowment Foundation.

Nelson, K. (1973). Structure and strategy in learning to talk. *Monographs of the Society for Research in Child Development*, *38*, (1-2, Serial No. 149). doi: 10.2307/1165788

Nelson, K. (1988). Constraints on word meaning?. *Cognitive Development*, *3*, 221-246. doi: 10.1016/0885-2014(88)90010-X

Newman, R. S., Rowe, M. L., & Ratner, N. B. (2016). Input and uptake at 7 months predicts toddler vocabulary: the role of child-directed speech and infant processing skills in language development. *Journal of Child Language*, *43*, 1158-1173. doi: 10.1017/S0305000915000446

National Institute of Child Health and Human Development Early Child Care Research Network. (2000). The relation of child care to cognitive and language development. *Child Development*, *71*, 960-980. Retrieved from https://www.jstor.org/stable/1132337

Naigles, L. (1990). Children use syntax to learn verb meanings. *Journal of Child Language*, *17*, 357-374. doi: 10.1017/S0305000900013817

Office for National Statistics. (2017). *Migration statistics quarterly report: May 2017*. Retrieved from: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/internationalmigration/bulletins/migrationstatisticsquarterlyreport/may2017

Oller, D. K., & Eilers, R. E. (2002). *Language and literacy in bilingual children*. Clevedon, UK: Multilingual Matters.

Oxley, E., & de Cat, C. (2019). A systematic review of language and literacy interventions in children and adolescents with English as an additional language (EAL). *The Language Learning Journal*. doi: 10.1080/09571736.2019.1597146

Páez, M. M., Tabors, P. O., & López, L. M. (2007). Dual language and literacy development of Spanish-speaking preschool children. *Journal of Applied Developmental Psychology*, *28*, 85-102. doi: 10.1016/j.appdev.2006.12.007

Palermo, F., Mikulski, A. M., Fabes, R. A., Hanish, L. D., Martin, C. L., Stargel, L. E. (2014). English exposure in the home and classroom: Predictions to Spanish-speaking preschoolers' English vocabulary skills. *Applied Psycholinguistics*, *35*, 1163-1187. doi: 10.1017/S0142716412000732

Paradis, J. (2011). Individual differences in child English second language acquisition: Comparing child-internal and child-external factors. *Linguistic Approaches to Bilingualism*, *1*, 213-237. doi: 10.1075/lab.1.3.01par

Parise, E., & Csibra, G. (2013). Neural responses to multimodal ostensive signals in 5-month-old infants. *PloS One*, *8*, e72360. doi: 10.1371/journal.pone.0072360

Pearson, B. Z. (2002). Bilingual infants. In M. Suárez-Orozco & M. Páez (Eds.), *Latino remaking America* (pp. 306-320). Los Angeles: University of California Press and David Rockefeller Center for Latin American Studies, Harvard University.

Pearson, B., Fernandez, S., & Oller, D. K. (1993). Lexical development in bilingual infants and toddlers: Comparison to monolingual norms. *Language Learning*, *43*, 93-120. doi: 10.1111/j.1467-1770.1993.tb00174.x

Pelucchi, B., Hay, J. F., & Saffran, J. R. (2009). Statistical learning in a natural language by 8-month-old infants. *Child Development*, *80*, 674-685. doi: 10.1111/j.1467-8624.2009.01290.x

Pereira, A. F., Smith, L. B., & Yu, C. (2014). A bottom-up view of toddler word learning. *Psychonomic Bulletin and Review*, *21*, 178-185. doi: 10.3758/s13423-013-0466-4

Pierce, J. W. (2009). Generating stimuli for neuroscience using PsychoPy. *Frontiers in Neuroscience Methods*, *162*, 8-13. doi: 10.3389/neuro.11.010.2008

Ping, M. T. (2014). Group interactions in dialogic book reading activities as a language learning ontext in preschool. *Learning, Culture and Social Interaction*, *3*, 146-158. doi: 10.1016/j.lcsi.2014.03.001

Pinker, S. (1994). *The language instinct: How the mind creates language*. New York, NY: Morrow.

Poepsel, T. J., & Weiss, D. J. (2014). Context influences conscious appraisal of cross situational statistical learning. *Frontiers in Psychology*, *5*, 691. doi: 10.3389/fpsyg.2014.00691

Poepsel, T. J., & Weiss, D. J. (2016). The influence of bilingualism on statistical word learning. *Cognition*, *152*, 9-19. doi: 10.1016/j.cognition.2016.03.001

Pruden, S. M., Hirsh-Pasek, K., Golinkoff, R. M., & Hennon, E. A. (2006). The birth of words: Ten-month-olds learn words through perceptual salience. *Child Development*, *77*, 266-280. doi: 10.1111/j.1467-8642.2006.00869.x

Qian, T., Jaeger, T. F., & Aslin, R. N. (2012). Learning to represent a multi-context environment: more than detecting changes. *Frontiers in Psychology*, *3*, 228. doi: 10.3389/fpsyg.2012.00228

Quine, W. V. O. (1960). *Word and object*. Cambridge, MA: MIT Press.

Raz, H. K., Abney, D. H., Crandall, D. J., Yu, C., & Smith, L. B. (2019). How do infants start learning object names in a sea of clutter?. In A. K. Goel, C. M. Seifert, & C. Freksa (Eds.), *Proceedings of the 41st Annual Conference of the Cognitive Science Society* (pp. 521-526). Montreal, QB: Cognitive Science Society.

Reardon, S. F. (2013). The widening income achievement gap. *Educational Leadership, 70*, 10–16. Retrieved from http://www.ascd.org/publications/educational-leadership/may13/vol70/num08/The-Widening-Income-Achievement-Gap.aspx

Richards, B. J. (1987). Type/token ratios: What do they really tell us? *Journal of Child Language*, *14*, 201-209. doi: 10.1017/S0305000900012885

Roembke, T. C., & McMurray, B. (2016). Observational word learning: Beyond propose-but-verify and associative bean counting. *Journal of Memory and Language*, *87*, 105-127. doi: 10.1016/j.jml.2015.09.005

Rosch, E., Mervis, C. B., Gray, W. D., Johnson, D. M., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology*, *8*, 382-439. doi: 10.1016/0010-0285(76)90013-X

Rourke, B. P., & Tsatsanis, K. D. (1996). Syndrome of nonverbal learning disabilities: Psycholinguistic assets and deficits. *Topics in Language Disorders*, *16*, 30-34.

Rowe, M. L. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech in vocabulary development. *Child Development*, *83*, 1762-1774. doi: 10.1111/j.1467-8624.2012.01805.x

Rowe, M. L., Leech, K. A., & Cabrera, N. (2016). Going beyond input quantity: *Wh*-questions matter for toddlers' language and cognitive development. *Cognitive Science*, *41*, 162-179. doi: 10.1111/cogs.12349

Rowe, M. L., & Zuckerman, B. (2016). Word gap redux: Developmental sequence and quality. *JAMA Pediatrics*, *170*, 827-828. doi: 10.1001/jamapediatrics.2016.1360

Rowland, C. F. (2014). *Understanding child language acquisition*. New York, NY: Routledge.

Saffran, J. R., Newport, E. L., Aslin, R. N., Tunick, R. A., & Barrueco, S. (1997). Incidental language learning: Listening (and learning) out of the corner of your ear. *Psychological Science*, *8*, 101-105. doi: 10.1111/j.1467-9280.1997.tb00690.x

Samara, A., Smith, K., Brown, H., & Wonnacott, E. (2017). Acquiring variation in an artificial language: Children and adults are sensitive to socially conditioned linguistic variation. *Cognitive Psychology*, *94*, 85-114. doi: 10.1016/j.cogpsych.2017.02.004

Samuelson, L. K., & Smith, L. B. (1998). Memory and attention make smart word learning: An alternative account of Akhtar, Carpenter, and Tomasello. *Child Development*, *69*, 94-104. doi: 10.1111/j.1467-8624.1998.tb06136.x

Scott, J. C., & Henderson, A. M. (2013). Language matters: Thirteen-month-olds understand that the language a speaker uses constrains conventionality. *Developmental Psychology*, *49*, 2102-2111. doi: 10.1037/a0031981

Serratrice, L. (2018). Becoming bilingual in early childhood. In A. de Houwer, A. & L. Ortega (Eds.), *The Cambridge Handbook of Bilingualism* (pp. 15-35). Cambridge, UK: Cambridge University Press.

Slavin, S. (2014). PsyScript 3 (Version 3.2.1) [Computer software]. Lancaster University. Retrieved from: http://www.lancaster.ac.uk/psychology/research/research-software/psyscript3

Smith, L. B. (2000). Avoiding associations when it's behaviorism you really hate. In R. Golinkoff & K. Hirsh-Pasek (Eds.), *Becoming a word learner: A debate on lexical acquisition* (pp. 169–172). Oxford, UK: Oxford University Press.

Smith, L., & Yu, C. (2008). Infants rapidly learn word-referent mappings via cross-situational statistics. *Cognition*, *106*, 1558-1568. doi: 10.1016/j.cognition.2007.06.010

Snow, C. E. (1990). The development of definitional skill. *Journal of Child Language*, *17*, 697-710. doi: 10.1017/s0305000900010953

Snow, C. E., Burns, S., & Griffin, P. (1998). *Preventing reading difficulties in young children*. Washington, DC: National Academy of Sciences.

Spoonley, P. (2013). New diversity, old anxieties in New Zealand: The complex identity politics and engagement of a settler society. *Ethnic and Racial Studies*, *38*, 650-661. doi: 10.1080/01419870.2015.980292

Tabors, P. O. (1997). *One child, two languages: A guide for preschool eucators of children learning English as a second language*. Baltimore, MD: Paul H. Brookes.

Tamis-LeMonda, C. S., Bornstein, M. H., & Baumwell, L. (2001). Maternal responsiveness and children's achievement of language milestones. *Child Development*, *72*, 748-767. doi: 10.1111/1467-8624.00313

Tamis-LeMonda, C. S., Bornstein, M. H., Baumwell, L., & Damast, A. M. (1996). Responsive parenting in the second year: Specific influences on children's language and play. *Infant and Child Development*, *5*, 173-183. doi: 10.1002/(SICI)1099-0917(199612)5:4<173::AID-EDP131>3.0.CO;2-V

Tamis-LeMonda, C. S., Custode, S., Kuchirko, Y., Escobar, K., & Lo, T. (2018). Routine language: Speech directed to infants during home activities. *Child Development*, *90*, 2135-2152. doi: 10.1111/cdev.13089

Tardif, T. (1996). Nouns are not always learned before verbs: Evidence from Mandarin speakers' early vocabularies. *Developmental Psychology*, *32*, 492. doi: 10.1037/0012-1649.32.3.492

The Object Databank [Computer software]. (1996). Carnegie Mellon University. Retrieved from: http://wiki.cnbc.cmu.edu/Objects

Tomasello, M. (2000). The social-pragmatic theory of word learning. *Pragmatics*, *10*, 401-413. doi: 10.1075/prag.10.4.01tom

Tomasello, M. (2003). *Constructing a language: A usage-based theory of language acquisition*. Cambridge, MA: Harvard University Press.

Tomasello, M., & Akhtar, N. (1995). Two-year-olds use pragmatic cues to differentiate reference to objects and actions. *Cognitive Development*, *10*, 201-224. doi: 10.1016/0885-2014(95)90009-8

Tomasello, M, & Barton, M. E. (1994). Learning words in nonostensive contexts. *Developmental Psychology*, *30*, 639-650. doi: 10.1037/0012-1649.30.5.639

Trude, A. M., & Brown-Schmidt, S. (2012). Talker-specific perceptual adaptation during online speech perception. *Language and Cognitive Processes*, *27*, 979-1001. doi: 10.1080/01690965.2011.597153

Trueswell, J. C., Medina, T. N., Hafri, A., & Gleitman, L. R. (2013). Propose but verify: Fast mapping meets cross-situational word learning. *Cognitive Psychology*, *66*, 126-156. doi: 10.1016/j.cogpsych.2012.10.001

Twomey, K. E., Ma, L., & Westermann, G. (2018). All the right noises: Background variability helps early word learning. *Cognitive Science*, *42*, 413-438. doi: 10.1111cogs.12539

Uchikoshi, Y. (2006). English vocabulary development in bilingual kindergarteners: What are the best predictors?. *Bilingualism: Language and Cognition*, *9*, 33-49. doi: 10.1017/S1366728905002361

Vadasy, P. F., Sanders, E. A., & Logan Herrera, B. (2015). Efficacy of rich vocabulary instruction in fourth-and fifth-grade classrooms. *Journal of Research on Educational Effectiveness*, *8*, 325-365. doi: 10.1080/19345747.2014.933495

van Hout, R., & Vermeer, A. (2007). Comparing measures of lexical richness. In H. Daller, J. Milton & J. Treffers-Daller (Eds.), *Modelling and assessing vocabulary knowledge* (pp. 93-115). Amsterdam, Netherlands: Benjamins.

Vertovec, S. (2007). Super-diversity and its implications. *Ethnic and Racial Studies*, *30*, 1024-1054. doi: 10.1080/01419870701599465

Vlach, H. A., & DeBrock, C. A. (2019). Statistics learned are statistics forgotten: Children's retention and retrieval of cross-situational word learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *45*, 711-711. doi: 10.1037/xlm0000611

Vlach, H. A., & Johnson, S. P. (2013). Memory constraints on infants' cross-situational statistical learning. *Cognition*, *127*, 375-382. doi: 10.1016/j.cognition.2013.02.015

Vlach, H. A., & Sandhofer, C. M. (2011). Developmental differences in children's context-dependent word learning. *Journal of Experimental Child Psychology*, *108*, 394-401. doi: 10.1016/j.jecp.2010.09.011

von Hippel, P., Workman, J., & Downey, D. B. (2017). *Inequality in reading and math skills comes mainly from early childhood: A replication, and partial correction, of 'Are schools the great equalizer?' Sociology of Education*, *91*, 323-357. doi: 10.2139/ssrn.3036094

Vouloumanos, A. (2008). Fine-grained sensitivity to statistical information in adult word learning. *Cognition*, *107*, 729-742. doi: 10.1016/j.cognition.2007.08.007

Vouloumanos, A., Martin, A., & Onishi, K. H. (2014). Do 6-month-olds understand that speech can communicate?. *Developmental Science*, *17*, 872-879. doi: 10.1111/desc.12170

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Waxman, S. R. (1989). Linking language and conceptual development: Linguistic cues and the construction of conceptual hierarchies. *Genetic Epistemologist*, *17*, 13-19. Retrieved from: http://groups.psych.northwestern.edu/waxman/linkinglangandconceptualdev.pdf

Waxman, S. R., & Hatch, T. (1992). Beyond the basics: Preschool children label objects flexibly at multiple hierarchical levels. *Journal of Child Psychology*, *19*, 153-166. doi: 10.1017/S0305000900013672

Weiss, D. J., Poepsel, T., & Gerfen, C. (2015). Tracking multiple inputs: The challenge of bilingual statistical learning. In Rebuschat, P. (Eds.), *Implicit and Explicit Learning of Languages* (pp. 167-190). Amsterdam: John Benjamins.

Weiss, D. J., Schwob, N., & Lebkuecher, A. L. (2020). Bilingualism and statistical learning: Lessons from studies using artificial languages. *Bilingualism: Language and Cognition*, *23*, 92-97. doi: 10.1017/S1366728919000579

Wiig, E., Secord, W. A., & Samuel, E. (2004). *The Clinical Evaluation of Language Fundamentals – Preschool* (2nd ed.). San Antonio, TX: Harcourt Assessment.

Wiley, T. G. (2017). Diversity, super-diversity, and monolingual language ideology in the United States. *Review of Research in Education*, *38*, 1-32. doi: 10.3102/0091732X13511047

Woodward, A. & Markman, E. (1999). Early word learning. In D. Kuhn & R. S. Siegler (Vol. Eds.), & W. Damon (Series, Ed.), *Handbook of child psychology: Vol. 2. Cognition, perception, and language* (5th ed., pp. 371-420). New York, NY: Wiley.

Youmans, G. (1990). Measuring lexical style and competence: The type-token vocabulary curve. *Style*, *24*, 584-599. Retrieved from https://www.jstor.org/stable/42946163

Yu, C., & Ballard, D. H. (2007). A unified model of early word learning: Integrating statistical and social cues. *Neurocomputing*, *70*, 2149-2165. doi: 10.1016/j.neucom.2006.01.034

Yu, C., & Smith, L. B. (2007). Rapid word learning under uncertainty via cross-situational statistics. *Psychological Science*, *18*, 414-420. doi: 10.1111/j.1467-9280.2007.01915.x

Yu, C., & Smith, L. B. (2012). Modeling cross-situational word–referent learning: Prior questions. *Psychological Review*, *119*, 21-39. doi: 10.1037/a0026182

Zhang, Y., Chen, C.-H., & Yu, C. (2019). Mechanisms of cross-situational learning: Behavioral and computational evidence. *Advances in Child Development and Behavior*, *56*, 37-63. doi: 10.1016/bs.acdb.2019.01.001