Spreading the Word:

Cross-Linguistic Influence

in the Bilingual Child's Lexicon

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Chapter 1: General Introduction

As a child who was growing up bilingually, namely with Greek and Dutch, I rarely thought about how all the knowledge of two languages was stored and accessed in my mind. It was just there, even when I was not actively using it, sometimes showing up in a thought or association. For example, the Greek birthday song used to make me think of a fox, not because this happened to be my favorite animal, but because the Greek word *φως* (pronounced /fos/ and meaning 'light') that appeared in the song sounded like the Dutch word *vos* 'fox' (pronounced /fɔs/ in the region I grew up in). There were also instances when my Greek knowledge helped me in Dutch. For example, I never found the word *xylofoon* particularly difficult to remember or pronounce, as *ξύλο* (*xylo*), meaning 'wood', was a common enough word in my everyday language exposure. These kinds of examples suggest that words from the two languages were somehow interacting in my mind, a phenomenon which in this thesis is referred to as *lexical cross-linguistic influence*.

The term *cross-linguistic influence* (CLI) is used in literature on adult second language acquisition (e.g., Jarvis & Pavlenko, 2008) as well as in child bilingualism research (e.g., Serratrice, 2013), although adult studies often use terms like *cross-linguistic interaction* or *cross-language activation* (e.g., Shook & Marian, 2013; van Hell & Tanner, 2012). Research on CLI in bilingual children has mostly focused on the level of morpho-syntactic development. In this field, findings have shown that morpho-syntactic properties of the two languages can influence each other (e.g., Serratrice, 2013). For example, a French-English bilingual child may say *verte pomme* (literally: 'green apple') instead of *pomme verte* (literally: 'apple green') more often than a monolingual French child would, influenced by the English word order (Nicoladis, 2006). CLI at the level of morpho-syntax has mostly been studied in production and more recently also in comprehension (see van Dijk, 2021).

Compared to morpho-syntactic CLI, there is not much research on lexical CLI in bilingual children, where children's word choices or word processing might be influenced by words from their other language. There is, however, an extensive literature on the bilingual lexicon and bilingual word processing in adults – although, as explained in later sections, several areas remain understudied. The general consensus in the adult literature is that words from both languages can be simultaneously activated in the mind during processing and that they interact (e.g., Dijkstra & van Heuven, 2002, 2018). This interaction affects the processing of words from different languages with form- and/or meaning overlap, such as *φως* and *vos*. This is discussed in more detail in the next section.

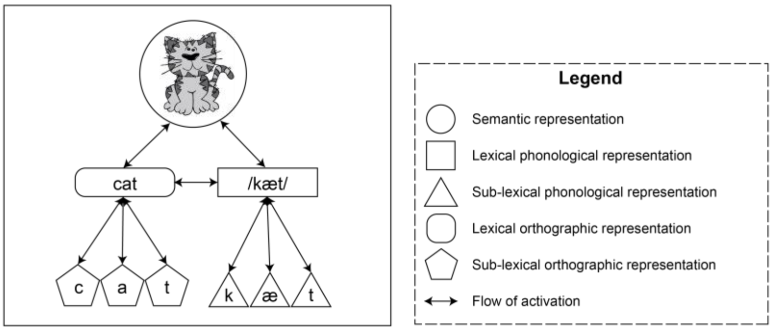
It is unclear to what extent the insights from the adult literature also apply to children, because of two key differences between the populations. Not only do bilingual children and adults differ in chronological age, but they also typically differ in their age of onset: Whereas most studies with adults focus on (late) second language learners (e.g., van Hell & Tanner, 2012), for bilingual children both languages are acquired more or less simultaneously, while both are still developing. Possibly, in simultaneous acquisition the languages interact more than in sequential acquisition, or instead they may be more separated. Empirical research on lexical processing and CLI in bilingual children would thus provide insights into the generalizability of the commonly accepted view on the bilingual lexicon over different groups of bilinguals and also contribute to our understanding of the bilingual lexicon irrespective of age, as will be discussed in later sections. The next sections first discuss the literature on the (bilingual) lexicon in more detail.

1.1. The Mental Lexicon

Psycholinguistic research on the mental lexicon concerns the representation and processing of words in the mind. Both have been modeled in many different ways throughout the decades (see e.g., Coltheart et al., 2001; Dóczi, 2019). This section first discusses the most important properties of currently accepted models of the monolingual lexicon as well as empirical evidence for these properties, before turning to the bilingual lexicon.

Models of the lexicon contain at least semantic (i.e., meaning) representations and phonological and/or orthographic (i.e., spoken and/or written form) representations. On the form level, there may be a distinction between lexical word form representations and sub-lexical phoneme or grapheme representations (e.g., Dell & O'Seaghdha, 1994; McClelland & Rumelhart, 1981). All different representations that correspond to one word are typically modelled to be connected to each other; see Figure 1.1.

Figure 1.1. Different levels of representation in the mental lexicon and their relation to each other for the word *cat*. The image of the cat is used here as a proxy for the complex semantic representation of 'cat'.



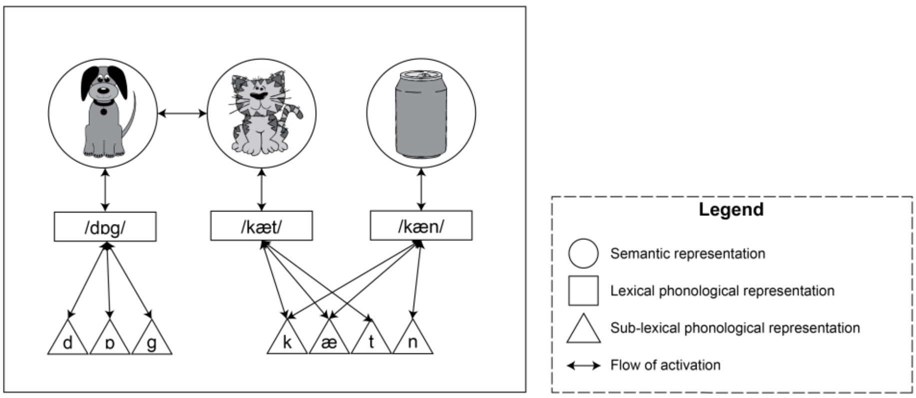
During processing, activation is assumed to resonate (i.e., flow back and forth) between these connected form and meaning representations. For example, in word production, the lexicon is accessed by activating a semantic representation (e.g., the semantic representation of a cat), and this activation spreads to the corresponding form representations (e.g., the lexical representations /kæt/ and *cat*, and the corresponding phonemes /k/, /æ/, /t/ and graphemes <c>, <a>, <t>).[1]

Importantly, representations corresponding to different words are connected as well. Specifically, related or associated meanings, such as *dog* and *cat*, are assumed to be connected to each other (see e.g., Dóczi, 2019), and overlapping word forms, such as *can* and *cat*, are assumed to be connected to

[1] Graphemes are only represented for literate people. Not all models specify grapheme and phoneme representations; for example, in the Multilink model (Dijkstra et al., 2019), lexical representations are directly (co-)activated from the input.

the same phoneme and grapheme[2] representations (e.g., Hamburger & Slowiaczek, 1996; McClelland & Rumelhart, 1981; see also Dufour, 2008); see Figure 1.2. During processing, then, activation not only resonates between corresponding form and meaning representations, but also spreads between connected representations. For example, when the semantic representation of a cat is activated, activation spreads to the representation of a dog. In addition, at the phonological level, when the phonemes /k/, /æ/, /t/ are activated, multiple word forms that are connected to these phonemes become co-activated, including both *cat* and *can*.

Figure 1.2. How activation flows between semantically and phonologically related representations in the mental lexicon.



Evidence for this interconnectedness and spreading of activation comes from lexical priming studies. In a lexical priming task, participants are presented with a sequence of two words, and the relation between these words is manipulated. A priming effect ensues when the properties of the first word, the prime, influence the processing speed and/or accuracy of the second word, the

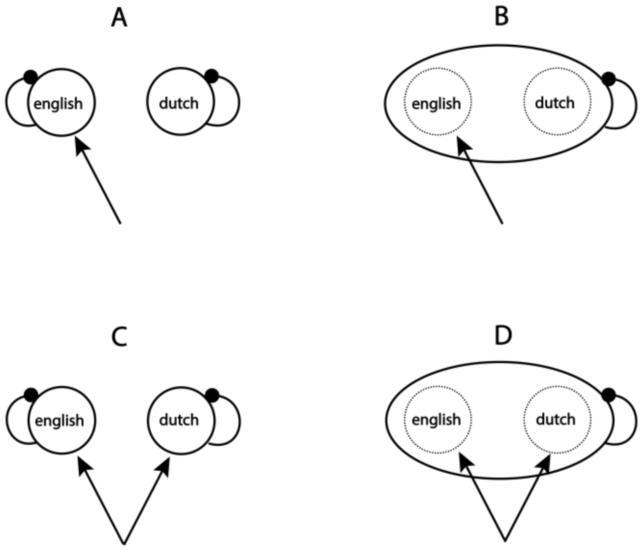
[2] From now on, we omit orthographical representations, as this thesis focuses on children (whose orthographic representations are not yet fully developed) and on phonological processing.

target. For example, when prime and target are semantically related (e.g., *dog* and *cat*), it has been found that the target is processed more quickly than when it is preceded by an unrelated word (e.g., *book*) (e.g., Meyer & Schvaneveldt, 1971). This suggests that the target's meaning representation was already pre-activated by the spreading of activation from the related prime, and, through resonating activation, likely also its form (see e.g., Jescheniak et al., 2006). Similarly, the processing of the target word has been found to be influenced by phonological or orthographic overlap with the prime (e.g., between *can* and *cat*) (e.g., Hamburger & Slowiaczek, 1996).

1.1.1. The Bilingual Lexicon

With regard to the bilingual lexicon, psycholinguistic studies have focused on both representation and processing (see e.g., Jiang, 2015, for an overview). With respect to representation, an important question is to what extent words from the two languages are represented in two separate networks or one integrated network. In an integrated lexicon, representations of words from both languages are connected if they overlap in form or meaning, and representations may even be shared. For example, semantic representations may be shared between translation equivalents (Dijkstra et al., 2019; Dijkstra & van Heuven, 2002; Shook & Marian, 2013). With respect to processing, an important question is to what extent the lexicon is (or lexicons are) accessed language-(non)selectively, that is, to what extent representations belonging to one or both languages may be activated regardless of the language that is being used in a specific situation. For example, in a strictly language-selective lexicon, only Dutch words would be activated when a bilingual is processing Dutch words. As discussed in e.g., van Heuven et al. (1998), if we assume binary options for both representation and processing, there are four possibilities for the organization of and access to the bilingual lexicon, illustrated in Figure 1.3: a) two separate lexicons with language-selective access, b) one integrated lexicon with language-selective access, c) two separate lexicons with language-nonselective access, d) one integrated lexicon with language-nonselective access. Whilst option b and c are logically possible, most research has revolved around options a and d (Dijkstra & van Heuven, 2018; van Heuven et al., 1998).

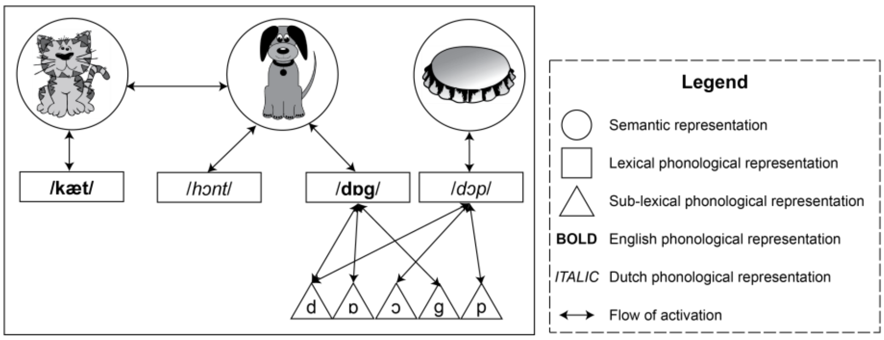
Figure 1.3. Four options for the bilingual lexicon, in terms of representation (separate or integrated) and processing (language-selective or language-nonselective) (van Heuven et al., 1998). The arrows indicate access to the lexicon; the black circles indicate inhibitory connections which are not further discussed in this chapter.



Note. Reprinted from: *Journal of memory and language, 39*(3), W. J. B. van Heuven, T. Dijkstra, and J. Grainger, Orthographic Neighborhood Effects in Bilingual Word Recognition, p. 459, Copyright (1998), with permission from Elsevier.

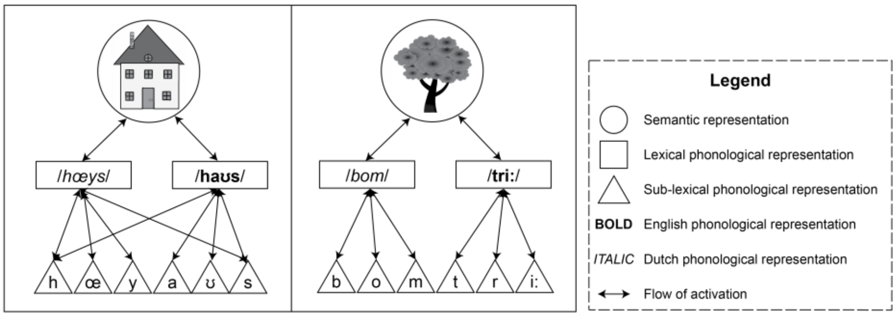
In the same way that priming studies have provided evidence for interconnectedness in the monolingual lexicon, priming has also been used to test the properties of the bilingual lexicon. For example, between-language semantic priming effects (e.g., between *cat* and *hond*, which means 'dog' in Dutch) or translation priming effects (e.g., *dog* and its Dutch translation *hond*) would suggest that semantic representations of different languages are connected or shared. Similar to how activation spreads between connected semantic representations within a language (e.g., between *cat* and *dog*), activation would then spread between words from different languages with connected or shared semantic representations; see Figure 1.4. In addition, between-language phonological priming effects (e.g., between *dog* and the Dutch word *dop*, meaning 'cap') would suggest that phoneme representations are shared and overlapping word forms from both languages can become co-activated. Indeed, between-language priming effects have been found in several studies with bilingual adults, such as translation priming effects (e.g., Basnight-Brown & Altarriba, 2007; Dimitropoulou et al., 2011b; Duyck & Warlop, 2009; Gollan et al., 1997), between-language semantic priming effects (e.g., Basnight-Brown & Altarriba, 2007; Schoonbaert et al., 2009), and between-language phonological priming effects (e.g., Dimitropoulou et al., 2011a; Jouravlev et al., 2014; Nakayama et al., 2012; Van Wijnendaele & Brysbaert, 2002).

Figure 1.4. How activation flows between semantic and phonological levels of representation in an integrated Dutch-English bilingual lexicon.



Other evidence in favor of an integrated bilingual lexicon with language-nonselective access comes from cognate processing studies. Cognates are translation equivalents with similar word forms across languages, such as *house* and *huis*, which means 'house' in Dutch. In an integrated lexicon, they would have both shared meaning representations and (largely) shared form (e.g., phoneme) representations; see Figure 1.5. As a result of activation resonating between these shared form and meaning representations during processing, cognate word form representations would become more strongly (co-)activated than words that overlap only in form or only in meaning. For example, in cognate comprehension, both cognate word forms would become co-activated through their shared sub-lexical representations, and both would activate the same semantic representation. In noncognate comprehension, different words may also become co-activated through shared sub-lexical representations, but these typically all have different meanings. For cognates, then, activation would flow back to the same co-activated word forms, reinforcing their activation levels, to a stronger extent than in noncognates. As a result, cognates are activated and processed more quickly and more accurately by bilinguals than noncognates (e.g., Costa et al., 2000; Dijkstra, 2005; Dijkstra et al., 2010; Hoshino & Kroll, 2008; Kroll et al., 2006; Lemhöfer et al., 2004). This *cognate facilitation effect* provides evidence for similar interconnectedness in the mental lexicon as between-language priming effects.

Figure 1.5. How activation flows between semantic and phonological levels of representation for cognate (left) and noncognate (right) translation equivalents in an integrated Dutch-English bilingual lexicon.



Importantly, both cognate processing studies and priming studies are aimed at capturing the flows of activation that are taking place within the lexicon during all word processing. Processing an unprimed word will lead to the same spreading of activation between representations, but unless it is a cognate or unless a form- or meaning-related word is processed soon after, this will not lead to any effects of lexical CLI.

Relatively recently, studies have revealed lexical CLI in children. For example, using a preferential looking paradigm, Von Holzen and Mani (2012) found two types of between-language priming effects in German-English bilingual toddlers. Specifically, when hearing an English prime that rhymed with a German target word (phonological priming, e.g., *slide* – *Kleid* 'dress'), children looked towards the target image (e.g., an image of a dress) more than when prime and target were unrelated. In addition, children's target image looking times were also affected when prime and target were indirectly related, namely when the German translation of the English prime rhymed with the German target (phonological priming effects through translation, e.g., *leg* – *Stein* 'stone', related via *Bein* 'leg'). Using similar methods, other toddler studies have also found between-language semantic priming effects (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Singh, 2014) and translation priming effects (Floccia et al., 2020). These findings show that, as in bilingual adults, semantic and phonological representations of both languages are shared or interactively connected in the lexicon of young simultaneous bilingual children.

In older bilingual children, evidence for an integrated lexicon comes from cognate processing studies. For example, German-English bilingual children have been found to respond more accurately and/or more quickly to cognates than to noncognate control words in picture naming (Poarch & van Hell, 2012) and in lexical decision (Schröter & Schroeder, 2016). Other studies found cognate effects in sentence reading by Dutch-Frisian bilingual children (Bosma & Nota, 2020), in translation recognition by Spanish-Basque bilingual children (Duñabeitia et al., 2016), in a receptive vocabulary test by Dutch-Frisian bilingual children (Bosma et al., 2019), and in a productive vocabulary test by German-Swedish children (Lindgren & Bohnacker, 2020). Altogether, these child studies suggest that bilingual children have an integrated lexicon with language-nonselective access and that lexical CLI may occur.

Nevertheless, studies examining lexical CLI in simultaneous bilingual children are limited in number as well as in other respects. First, there are gaps in the age groups that have been investigated: Between-language priming studies, which provide more insights into the internal organization of the lexicon than cognate studies, have only been conducted with toddlers. It remains unclear to what extent the same types of representations interact and whether they do so similarly in children of a later age. Second, most of these studies have focused on one level of representation (e.g., semantic representations). A more systematic investigation of multiple forms of between-language priming would provide more detailed insights into the workings of the bilingual lexicon regardless of age. Third, the preferential looking paradigms used in toddler studies are quite different from adult studies, which have mainly used reaction time (RT) measures, and it is not clear to what extent the effects are comparable. Finally, the available cognate studies with children, although more comparable with adult studies, have been limited in terms of the sources of variation they have studied, as discussed in the following sections.

1.2. Modulating Factors

The child studies discussed in the previous section suggest that, like bilingual adults, bilingual children have an integrated lexicon with language-nonselective access and that, like morpho-syntactic CLI, lexical CLI may occur as well. It does not, however, appear to occur to the same extent across individuals nor in all circumstances: Both the literature on the adult bilingual lexicon and the literature on lexical or morpho-syntactic CLI in bilingual children have shown that the strength of CLI can be modulated by several factors. For example, the adult literature has paid attention to the role of proficiency in bilinguals' second language (see e.g., van Hell & Tanner, 2012, for an overview), task effects (e.g., de Groot et al., 2002; Ferrand et al., 2011), and effects of language context, that is, whether one or more languages are being used in a specific situation (e.g., Elston-Güttler et al., 2005; Paulmann et al., 2006). The child literature has paid attention to individual children's linguistic and non-linguistic background (e.g., proficiency and exposure, but also age and socio-economic status; e.g., Foroodi-Nejad & Paradis, 2009; Hoff, 2003; Unsworth, 2008; van Dijk et al., 2021), as well as to the amount of overlap between languages (e.g., Hulk & Müller, 2000; van Dijk et al., 2021). The next sections subsequently discuss different types of modulating factors in more detail, namely individual-level factors, task- and context-level factors, and language-level factors.

1.2.1. Individual-Level Variation

Most research on the adult bilingual lexicon concerns second language learners. For these participants, there is usually a clear difference between their first language (L1) and second language (L2): Participants are more proficient in their L1 than in their L2, they have received more exposure in their L1, and they have started learning it (much) earlier than their L2. These differences between bilinguals' two languages have consequences for the strength of lexical CLI: The effect of L1 on the processing of L2 is typically stronger than the effect of L2 on L1, which may even be absent (e.g., Muntendam et al., 2022; van Hell & Dijkstra, 2002; van Hell & Tanner, 2012). When bilinguals are highly proficient in their L2, however, more symmetric effects have been found (e.g., Hoshino & Kroll, 2008; van Hell & Dijkstra, 2002).

Models of bilingual word processing such as the Bilingual Interactive Activation plus model (BIA+; Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019) account for L1-L2-asymmetries in terms of exposure, which tends to (be assumed to) correlate with proficiency in adult L2 learners (but see e.g., Chaouch-Orozco et al., 2021; de Bruin, 2019). More specifically, these models include effects of subjective frequency: The more often a bilingual is exposed to a specific word, the higher the resting-level activation of that word representation is in the lexicon. This leads to faster (co-)activation of that word during processing and more activation spreading to other word representations. Extrapolated to the language level, the more exposure to a particular language a bilingual receives, the higher the resting-level activation of the words from that language and the more influence these words have on the processing of words from their other language, resulting in stronger CLI effects.

When children grow up with two languages simultaneously, both languages are considered to be their L1 (see e.g., Hulk & Cornips, 2005). This does not necessarily mean, however, that they receive equal amounts of exposure or that they are highly proficient in both languages. Many child studies therefore use the concept of *language dominance*, to refer to the relative prominence of a language in an individual bilingual. Dominance is often operationalized using a relative proficiency or exposure measure, either categorically (e.g., Dutch-dominant vs. Greek-dominant) or continuously (e.g., from more Dutch-dominant to more Greek-dominant). Similar to the L1-L2-asymmetry in lexical CLI in adults, in bilingual children the influence from a more dominant language on a non-dominant language has been found to be stronger than the other way around, both in studies on lexical CLI (Bosma et al., 2019; Bosma & Nota, 2020; Poarch & van Hell, 2012; Singh, 2014; Von Holzen et al., 2019) and on morpho-syntactic CLI (e.g., Foroodi-Nejad & Paradis, 2009; van Dijk et al., 2021). In some studies, the non-dominant language was not found to affect processing in the dominant language at all (e.g., Argyri & Sorace, 2007; Singh, 2014; Von Holzen et al., 2019; Yip & Matthews, 2000).

However, not all studies found a relation between children's dominance and the strength of lexical CLI (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019) or morpho-syntactic CLI (e.g., Nicoladis, 2002). The fact that different studies operationalize dominance in diverse ways may contribute to apparent inconsistencies (see Unsworth et al., 2018; van Dijk et al., 2021), as the relationship between exposure and proficiency is not necessarily one-on-one (see e.g., Thordardottir, 2011). In addition, there are other individual-level factors that influence the development of the lexicon and language in general, such as age and socio-economic status (SES) (e.g., Hoff, 2003), as well as factors that influence children's performance on experimental tasks, such as working memory (e.g., Gangopadhyay et al., 2016; Marinis, 2010). Although many studies take these different individual-level factors into account, the wide variability within and between groups of bilingual children can make it difficult to draw strong conclusions with regard to dominance and CLI.

1.2.2. Task- and Context-Level Variation

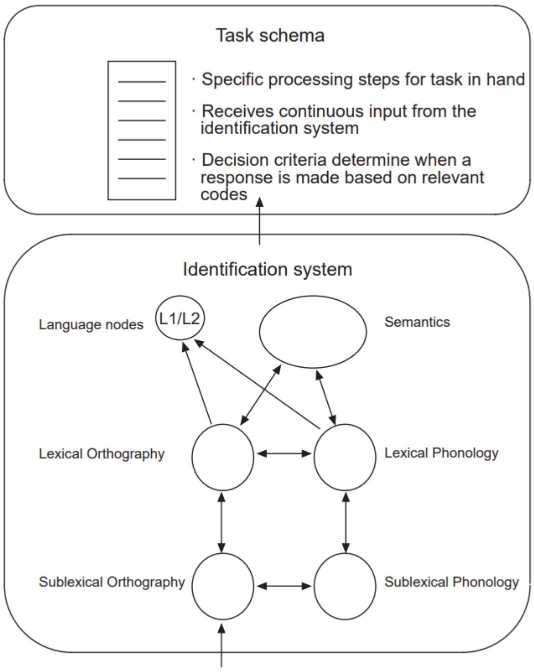
So far in this introduction, the bilingual lexicon has been described in terms of representation and processing. However, processing does not take place in isolation, but in a specific context and with a specific task or goal: Words are processed in production or in comprehension, in experimental tasks like picture naming, picture selection, or lexical decision, or in real-life conversations with one or more interlocutors speaking one or more languages, under all kinds of circumstances. An important question in the literature on bilingual word processing has been if and how these circumstances affect the degree to which lexical CLI may emerge.

This thesis specifically investigates task-level and context-level variation which may influence word processing in general and lexical CLI in particular. These two sources of variation are treated as separate but highly related, and their influence may be driven by the same mechanisms, as discussed below. Task-level variation refers to differences in modality and/or task demands. With respect to modality, it has been argued that comprehension only requires "good enough" processing, whereas in production this would not lead to successful results (see e.g., Ferreira et al., 2002; Ferreira & Patson, 2007; see also van Lieburg, 2023). Even when within the same modality, tasks may also have different demands. For example, a lexical decision task may be language-specific, where only words from one language require a 'yes'-response, or language-general, where words from either language are accepted. Both these tasks involve comprehension and hence the same modality, but they require different response strategies. In addition, tasks may be conducted in different language contexts, by which we refer to the languages that are present in a specific situation. For example, Green and Abutalebi (2013) distinguish single-language contexts (in which a bilingual uses only one of their languages), dual-language contexts (in which a bilingual uses both languages, for example with different interlocutors or in different tasks), and dense codeswitching contexts (in which a bilingual frequently and freely switches between their languages). These different contexts require different control processes, for example switching between languages or inhibiting a response in the non-target language.

The BIA+ model (Dijkstra & van Heuven, 2002), depicted in Figure 1.6, has been especially influential in how it incorporates task- and context-level factors, namely by implementing the so-called Task/Decision subsystem. This Task/Decision subsystem defines the schema (i.e., the series of subsequent steps in processing) that must be followed to perform a particular task. Once a word is processed within the lexicon, the Task/Decision subsystem creates a task-appropriate response. For example, if the task is to produce words in one language, first a meaning and both corresponding word forms are activated in the lexicon. Next, the target language word form is selected in the Task/Decision subsystem. The schema is constantly updated by incoming input. For example, in a language-specific lexical decision task, the appropriate response would be to respond 'yes' to real words and 'no' to nonwords. When non-target-language words are encountered, the schema needs to be updated: The appropriate response would be to respond 'yes' to real target-language words and 'no' to nonwords or non-target-language words. In other words, both task- and context-level factors influence how a word is processed by the Task/Decision subsystem.

Importantly, according to models such as BIA+ (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019), access to the lexicon itself is always language-nonselective: Regardless of target language, modality, task demands, or language context, words from both languages may become (co-)activated based on their form- or meaning-properties (e.g., Dijkstra & van Heuven, 2002; Kroll et al., 2006). As a result, lexical CLI may occur in different tasks and contexts (e.g., Dijkstra & van Hell, 2003; Lauro & Schwartz, 2017; Thierry & Wu, 2007). For example, Thierry and Wu (2007) had Chinese-English bilinguals read pairs of English words, for which they had to decide if they were semantically related or not. Even in this purely single-language context involving only English stimuli, the Chinese translations of the word pairs were accessed: If the Chinese translations of the English stimuli contained the same character, effects of this repetition were found in the participants' event-related brain potentials.

Figure 1.6. The Bilingual Interactive Activation plus (BIA+) model (Dijkstra & van Heuven, 2002).



Note. Reprinted from: T. Dijkstra and W. J. B. van Heuven, The architecture of the bilingual word recognition system: From identification to decision, *Bilingualism: Language and Cognition*, *5*(3), p. 182, 2002 © Cambridge University Press, reproduced with permission.

Despite language-nonselective access to the bilingual lexicon, the influence of task- and context-level variation on word processing (e.g., by the Task/Decision subsystem) can also have consequences for the strength of CLI. For example, some studies have found stronger CLI effects in dual-language contexts than in strictly single-language contexts (e.g., Elston-Güttler et al., 2005), although others did not find any differences (e.g., Paulmann et al., 2006). Some studies have even found inhibitory rather than facilitatory effects for cognates in dual-language contexts (e.g., Brenders et al., 2011; Poort & Rodd, 2017). Modality and/or specific task demands have also been found to modulate how lexical CLI manifests itself: De Groot et al. (2002) found cognate effects to be influenced by dominance (L1 vs. L2) in a lexical decision task (comprehension), but not in a word naming task (production) (see also Ferrand et al., 2011). Together, these findings show that task- and context-level factors interact with individual-level factors, fitting in with important assumptions from models such as BIA+. However, the full extent of these interactions and, for example, why context effects do not always seem to emerge in the same way, require more research.

In studies on CLI in bilingual children, especially morpho-syntactic CLI, task- and context-level variation have not been extensively studied. Modality, however, has recently received more attention. As discussed by van Dijk (2021), most studies into morpho-syntactic CLI focused on children's language production, but not on how morpho-syntactic properties of the two languages influence children's language comprehension. In two different studies, van Dijk and colleagues (van Dijk, 2021; van Dijk et al., 2022) found effects of CLI in children's real-time sentence processing in interaction with dominance, most likely with additional contributions of other individual-level factors such as cognitive control (van Dijk, 2021; see also e.g., Gross & Kaushanskaya, 2020). These results are interpreted as reflecting co-activation and inhibition of syntactic representations from their two languages. In addition, van Dijk (2021) argued that task demands affect how morpho-syntactic CLI emerges, with CLI in elicited sentence production tasks more often being the result of the burden these tasks place on children's working memory.

In sum, although processing within the lexicon is assumed to be language-nonselective under all circumstances, both the adult word processing literature and the child (morpho-syntactic) CLI literature suggest that different modalities and specific demands of different tasks as well as language context may influence processing in general and how CLI manifests in particular. According to the BIA+ model, such task- and context-level factors influence later stages of word processing, namely processing by the Task/Decision subsystem. The exact mechanisms behind these effects, however, remain a topic of discussion in the adult literature (see e.g., Bobb & Wodniecka, 2013) as well as child literature (e.g., Gross & Kaushanskaya, 2015). To complicate matters further, task- and context-level factors have also been found to interact with individual-level differences in dominance (see e.g., Bobb & Wodniecka, 2013, for a review) – although in the adult literature this is typically limited to comparing effects in L1 with L2. It is not yet clear to what extent these mechanisms and complex interactions play a role in bilingual children's word processing, especially when dominance is considered in more detail and with more variation on the individual level.

1.2.3. Language-Level Variation

The assumptions about the bilingual lexicon and bilingual word processing discussed so far do not focus on specific languages, but rather aim to generalize across language combinations. That is, in principle, all bilinguals are assumed to have an integrated lexicon with language-nonselective access and the same mechanisms (e.g., in the Task/Decision subsystem) are thought to account for individual differences and task- and context-level effects across bilinguals in the same manner. Still, empirical evidence, both from adults and children, often comes from limited language combinations. It is therefore not clear to what extent these assumptions are truly generalizable. In addition, and in part as a consequence of the limited language pairs that have hitherto been subject to investigation, it is not clear whether *language distance* influences bilingual word processing and more specifically modulates lexical CLI.

Languages can differ considerably in how similar they are to each other on different linguistic levels. For example, languages may be more or less distant from each other in terms of phono-lexical or morpho-syntactic features. Phono-lexical language distance refers to the number of cognates two languages share and/or how strong their form overlap is (see e.g., Blom et al., 2020; Schepens et al., 2012). Especially the latter can be expected to affect lexical CLI. For example, if two languages use the same script, words may share grapheme representations, whereas if different scripts are used, such shared representations are not possible. Similarly, if two languages have more similar phonological inventories, more phoneme representations may be shared. For example, English and Greek both have /θ/ and /ð/ phonemes, and these representations would be shared for English-Greek bilinguals, but not for Dutch-Greek bilinguals given that Dutch has neither. The more phonemes and/or graphemes overlap between words from different languages, the stronger the co-activation of these word forms would be assumed to be, leading to stronger lexical CLI such as cognate facilitation effects or form-related priming. Evidence for effects of the degree of form overlap has been found within languages in adults (e.g., Dijkstra et al., 2010) as well as in children. For example, Goriot et al. (2021) found an effect of phonological similarity (i.e., cognate-likeness) in school-aged Dutch L2 learners of English, who were more accurate on more cognate-like words in an English vocabulary task. In simultaneous bilingual Dutch-Frisian children, Bosma et al. (2019) found similar results, in interaction with dominance: Children with higher levels of Dutch exposure performed better on more similar cognates in a Frisian vocabulary task.

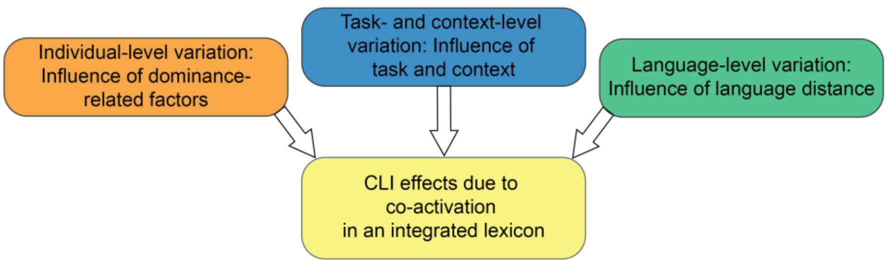
Between languages, studies have found that lexical CLI can happen in the form of both phonological priming and cognate effects, even if languages use different scripts (e.g., Dimitropoulou et al., 2011a; Nakayama et al., 2012), highlighting the generalizability of language-nonselective processing and phonologically driven co-activation in the bilingual lexicon. To our knowledge, however, no studies have directly compared the strength of effects between languages with more and less phono-lexical overlap.

In addition to phono-lexical overlap, language distance may also be operationalized as the degree to which languages share morpho-syntactic features, such as basic word order or morphological complexity. The role of morpho-syntactic similarities has been explored more widely in studies with bilingual children. For example, the degree of morpho-syntactic (surface) overlap has been found to influence the strength of morpho-syntactic CLI (e.g., Hulk & Müller, 2000; Müller & Hulk, 2001; but see van Dijk et al., 2021). In addition, morpho-syntactic overlap has been found to be related to the lexicon: In young bilingual children, the degree of morpho-syntactic similarity has been found to be related to receptive vocabulary size, whereas productive vocabulary size has been related to phono-lexical similarity (Floccia et al., 2018). In older children, receptive vocabulary size has been found to be related to language distance in terms of both morpho-syntactic and phono-lexical similarity (Blom et al., 2020). Together, adult and child studies suggest an interesting but unspecified relationship between bilingual word processing, phono-lexical similarity, and more general language distance.

1.3. Summary

This introduction has discussed how the bilingual lexicon is organized and accessed as modeled for bilingual adults (typically L2-learners), as well as individual-level, task- and context-level, and language-level variation that can influence bilingual word processing; see Figure 1.7. Evidence from many empirical studies on bilingual adults (see e.g., Dijkstra & van Heuven, 2018, for a review) indicates that the bilingual lexicon is integrated and accessed language-nonselectively, with activation spreading between connected form- and meaning representations. As a consequence, if words from a bilingual's two languages overlap in form and/or meaning, they can become co-activated during processing. This can result in lexical CLI in the form of between-language priming effects or cognate facilitation effects. Several studies have found similar effects in bilingual children (Bosma et al., 2019; Bosma & Nota, 2020; Duñabeitia et al., 2016; Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Poarch & van Hell, 2012; Schröter & Schroeder, 2016; Singh, 2014; Von Holzen et al., 2019; Von Holzen & Mani, 2012), although the internal organization of the lexicon still requires more empirical research, at least in older children.

Figure 1.7. How individual-level factors, task- and context-level factors, and language-level factors influence word processing in general and lexical CLI in particular.



As shown by both adult and child studies, different types of modulating factors influence lexical CLI in different ways, ranging from lexicon-internal to lexicon-external. By ‘lexicon-internal’ we specifically mean the degree to which representations are (co-)activated, influenced by individual-level dominance-related factors. The more active word representations are in the lexicon, the more they influence the processing of other words, resulting in stronger CLI. In adults, this has mostly been investigated by comparing effects in L1 vs. L2. In simultaneous bilingual children, where dominance varies more within and between children and operationalizations, more empirical research is needed on such lexicon-internal variation. By ‘lexicon-external’ we refer to task- and context-level variation. In line with the BIA+ model (Dijkstra & van Heuven, 2002), we assume that after word forms and meanings are activated within the lexicon, they are then further processed by the Task/Decision subsystem, which may select, ignore, or inhibit certain representations and responses depending on the specific task and context. Clarifying task- and context-level effects on CLI requires more research in general, irrespective of age, especially in interaction with individual differences. In bilingual children in particular, task- and context-level effects have rarely been studied beyond looking into different modalities.

Language-level variation is less well understood than the other levels that are included in this thesis. Lexical CLI seems to be generalizable over different language combinations, but languages can differ in multiple aspects that may modulate lexical CLI. For example, there may be lexicon-internal effects of word-level variation: The more similar languages sound, the more form (e.g., phoneme or grapheme) representations are shared and the more words are co-activated. In addition, the relation between morpho-syntactic overlap and children’s vocabulary acquisition suggests that other, lexicon-external mechanisms may also play a role. These still need to be explored.

In sum, investigating the role of individual-level, task- and context-level, and language-level factors in lexical CLI in bilingual children would lead to both a fuller as well as a clearer (i.e., less noisy) picture of the organization of and processing in the bilingual child’s lexicon, and provide more insights into the mechanisms underlying bilingual word processing in general.

1.4. Research Questions and Outline

This thesis investigates how the lexicon of simultaneous bilingual children is organized and accessed, focusing on the extent to which the two languages interact during processing. Specifically, it tests whether the main assumptions of the adult L2 literature apply to simultaneous bilingual children, namely that the bilingual lexicon is integrated and always accessed language-nonselectively, that lexicon-internal variation can lead to differences in the degree of (co-)activation of words from the two languages, and that lexicon-external factors affect how (co-)activated words are processed further. As discussed earlier in this introduction, in order to draw conclusions about the generalizability of these assumptions, empirical research with simultaneous bilingual children is needed. There are differences between bilingual adults and bilingual children, namely their chronological age and their age of onset, which we argued have the potential to affect the level of integration and language-nonselective processing in the lexicon. In addition, studying how lexical CLI in children interacts with the various factors that can modulate (bilingual) word processing contributes to a better understanding of the bilingual lexicon in general, especially as testing bilingual children forces us to take the wide variability between individuals into account.

To examine the extent to which lexical CLI takes place in simultaneous bilingual children, the studies discussed in this thesis use various methods in both language production and comprehension, ranging from more controlled psycholinguistic experiments, measuring reaction times and eye movements, to more naturalistic tasks and settings, measuring accuracy and vocabulary. They are not only aimed at discovering whether lexical CLI occurs in simultaneous bilingual children, but also at establishing the extent to which it occurs. We consider the role of several modulating factors, ranging from lexicon-internal processes to lexicon-external variation. In addition, this thesis includes data from children at different ages and speaking different language combinations. Following child bilingualism research, we furthermore take individual differences in proficiency and exposure into account in our examination of lexical CLI, and we also consider other individual-level factors such as age, working memory, and socio-economic status, especially where we compare groups.

The research questions are as follows:

- To what extent are different types of representations in the lexicon shared or connected between languages in simultaneous bilingual children? (Chapter 2)
- To what extent and in what manner is the strength of resulting CLI effects influenced by:
    - differences in individual children's language proficiency and/or exposure (Chapters 2, 3, 4, and 5);
    - differences in task-level variation between production and comprehension tasks (Chapters 3 and 4);
    - differences in language context, specifically whether tasks are conducted in a single-language or dual-language context (Chapter 4);
    - similarities between languages on a general language level, in interaction with the word level (Chapter 5)?

Chapter 2 focuses on the different types of representations within the bilingual lexicon that may be shared or connected between languages, namely sub-lexical phonological (i.e., phoneme) representations, lexical phonological (i.e., word form) representations, and semantic (i.e., meaning) representations. Following BIA+ (Dijkstra & van Heuven, 2002) and other models (e.g., Dijkstra et al., 2019; Shook & Marian, 2013), we assume that semantic representations are shared between translation equivalents and that sub-lexical phonological representations are shared between form-similar words, and that this can lead to co-activation of lexical phonological representations during processing. By means of a priming experiment, in which picture selection and eye-tracking methods were combined, we tested to what extent languages interacted at these levels of representation in the lexicon of simultaneous Dutch-Greek bilingual children. The children, aged between four and nine years old, were presented with Greek prime words and Dutch target words, for which they had to select the matching picture out of two options. By manipulating the overlap between prime and target, this study tested for different forms of priming, namely between-language (Greek-to-Dutch) phonological priming, translation priming, and phonological priming through translation, an indirect form of priming involving both semantic and phonological representations. Children's reaction times were recorded to assess their processing speed in the different conditions, and their eye movements were also measured to gain more fine-grained insights into the processing timeline. This allowed us to test if activation spreads between both semantic and phonological levels of representation within and between languages, similar to what has been found for bilingual adults and bilingual toddlers (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Singh, 2014; Von Holzen & Mani, 2012), leading to priming effects in all conditions. We also tested whether the strength of between-language priming effects was influenced by children's relative amount of exposure to the prime and target language. In line with both adult studies (e.g., Chaouch-Orozco et al., 2021) and child studies (e.g., Singh, 2014), we predicted that Greek-to-Dutch priming effects would be stronger for children with more exposure to Greek.

After investigating the internal organization of the lexicon and how it is accessed in Chapter 2, Chapters 3 and 4 focus more on the role of lexicon-external factors, namely task-level variation and language context, using cognate processing tasks. Whilst between-language priming is a suitable method for investigating the flows of activation within the lexicon, its use is limited to certain tasks and contexts. For example, both languages will almost by definition be used as stimuli, creating a dual-language context. Cognates, in contrast, can be used in both production and comprehension tasks, in single- and dual-language contexts, and in arguably more naturalistic situations than priming tasks. **Chapter 3** explores the robustness of lexical CLI across tasks with different demands, in bilingual children with varying language exposure. A comprehension task and a production task, both involving cognates and noncognates, were conducted during an online testing session. The participants were simultaneous Dutch-Greek bilingual children, aged between seven and eleven years old. Most children lived in the Netherlands, but several lived in Greece, allowing us to test a wider range in language exposure. Using online software and audio recordings, we measured the children's accuracy and reaction times in a lexical decision task, in which they indicated for cognates, noncognates, and pseudowords if they were real Greek words, and a picture naming task, in which they named pictures in Greek using cognate and noncognate words. In line with previous studies (Bosma et al., 2019; Bosma & Nota, 2020; Duñabeitia et al., 2016; Poarch & van Hell, 2012; Schröter & Schroeder, 2016) and the predictions from current models of the bilingual lexicon (e.g., Dijkstra et al., 2019; Dijkstra & van Heuven, 2002), we predicted that children would respond more quickly and more accurately to cognates than to noncognates in both tasks. Differences in modality and/or task demands, however, could influence how these effects manifest themselves (see e.g., de Groot et al., 2002). Similar to what we predicted for between-language priming in Chapter 2, we expected stronger cognate facilitation effects in Greek for children with more Dutch exposure.

Chapter 4 further builds on Chapter 3, by including the role of language context and by moving to a different population. The participants in this study were simultaneous Dutch-German bilinguals, of the same age as the children in Chapter 3, with approximately half living in the Netherlands and half in Germany. They performed the same lexical decision and picture naming tasks as in Chapter 3, which were again conducted online, in a single-language context and in a dual-language context. Similar to Chapter 3, we expected cognate facilitation effects and interactions with dominance in both tasks. Language context was manipulated using the language of communication with the experimenter and instructional videos, and by means of proficiency tasks which were administered in between blocks of the two cognate processing tasks. In the single-language context, all language use in the session was the same as the target language of the cognate tasks, which was either Dutch or German. In the dual-language context, the language of communication and of the proficiency tasks differed from the target language of the cognate tasks. By rotating between blocks of the different proficiency tasks and the cognate tasks, participants had to switch between their two languages approximately every five minutes. This allowed us to examine the extent to which language context influences the strength of lexical CLI. Based on findings from previous studies (e.g., Elston-Güttler et al., 2005; see also e.g., Gross & Kaushanskaya, 2020), we expected stronger CLI effects in the dual-language context than in the single-language context, as well as interactions between language context and language dominance. Furthermore, by moving to a different population, we further explored the generalizability of lexical CLI.

After looking into different language combinations in Chapters 3 and 4, **Chapter 5** directly compares the strength of lexical CLI across different language combinations. This study did not involve a psycholinguistic experiment, but tested children's performance on a productive vocabulary test. It tested whether children speaking closely related languages (Dutch-German and Dutch-English) scored more accurately in Dutch than children speaking more distant languages (Dutch-Spanish, Dutch-Greek, and Dutch-Turkish) and to what extent this was driven by lexical CLI, specifically the degree of phonological similarity (or cognate-likeness) of the items in the test with their translation equivalent in the children's other language. We expected cognate effects to emerge for all children, but stronger for children speaking more closely related languages than for children speaking more distant languages. Specifically, we argued that the larger number of cognates for closely related languages would lead to children being more aware of and/or more sensitive to cognates, resulting in stronger cognate facilitation effects. In line with the previous chapters, we also took into account several individual-level factors, with a focus on the role of proficiency. We expected proficiency to influence cognate facilitation in a similar way as exposure in the previous chapters, with stronger cognate effects in Dutch for children with a higher proficiency in their other language than for children with a lower proficiency.

Finally, **Chapter 6** provides a summary of Chapters 2 to 5 and brings the findings of these studies together to show how the bilingual child's lexicon is organized and accessed. Furthermore, it integrates these findings to uncover how the different modulating factors examined in this thesis influence bilingual word processing and interact with each other in doing so. This chapter also discusses various avenues for future research that seem promising in light of the findings from this thesis, as well as implications for education and parenting of bilingual children.

All chapters of this thesis can be read individually, which is why there is some redundancy between chapters.

Chapter 2: Cross-Linguistic Influence in the Simultaneous Bilingual Child's Lexicon: An Eye-Tracking and Primed Picture Selection Study

Abstract

In a between-language lexical priming study, we examined to what extent the two languages in a simultaneous bilingual child's lexicon interact, while taking individual differences in language exposure into account. Primary-school-aged Dutch-Greek bilinguals performed a primed picture selection task combined with eye-tracking. They matched pictures to auditorily presented Dutch target words preceded by Greek prime words. Their reaction times and eye movements were recorded. We tested for effects of between-language phonological priming, translation priming, and phonological priming through translation. Priming effects emerged in reaction times and eye movements in all three conditions, at different stages of processing, and unaffected by language exposure. These results extend previous findings for bilingual toddlers and bilingual adults. Processing similarities between these populations indicate that, across different stages of development, bilinguals have an integrated lexicon that is accessed in a language-nonselective way and is susceptible to interactions within and between different types of lexical representation.

Based on: Koutamanis, E., Kootstra, G. J., Dijkstra, T., & Unsworth, S. (2023). Cross-Linguistic Influence in the Simultaneous Bilingual Child's Lexicon: An Eye-Tracking and Primed Picture Selection Study. *Bilingualism: Language and Cognition*, 1-11. https://doi.org/10.1017/S136672892300055X

2.1. Introduction

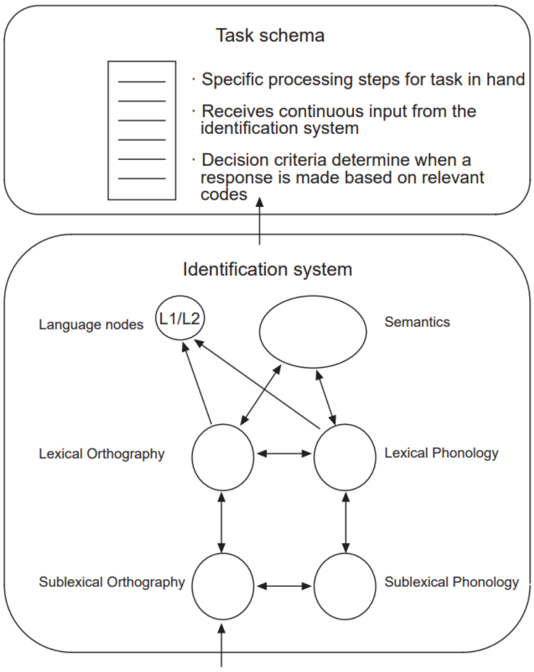
When bilingual children speak in one of their languages, they may be influenced by elements from their other language, such as word order or word choice preferences. In the field of child bilingualism, this is referred to as cross-linguistic influence (CLI). Most CLI research in bilingual children has focused on the morpho-syntactic level (see van Dijk et al., 2021, for a review). At the lexical level, interactions between languages are well established in bilingual adults, but they have been much less extensively studied in bilingual children. In this study, we focus on CLI at the lexical level in bilingual children. For example, when a Dutch-Greek bilingual child hears the Dutch word *koekje* 'cookie', she might think of her doll (Dutch: *pop*), because the Greek word for doll, *κούκλα* /'kukla/, sounds similar to *koekje* /'kukjə/. The presence of CLI at the lexical level would be consistent with the view that words from both languages are stored in one lexicon (i.e., an integrated lexicon rather than two separate lexicons), a view which is widely shared with respect to adults (see Dijkstra, 2005, for a review). In this study, we test to what extent bilingual children also make use of an integrated lexicon, by considering the interaction and co-activation of semantic and phonological codes in Greek and Dutch during auditory word comprehension.

Current models of (adult) bilingual word retrieval predict CLI at the lexical level as a consequence of two assumed properties of the bilingual mental lexicon: i) interconnected semantic, phonological, and/or orthographic representations of both languages, and ii) language-nonselective access to the lexicon (e.g., Dijkstra et al., 2019; Dijkstra & van Heuven, 2002; Shook & Marian, 2013). This means that representations can become activated and interact with each other regardless of the language they belong to. For example, in many models (Dijkstra et al., 2019; Dijkstra & van Heuven, 2002; Shook & Marian, 2013) semantic representations are largely shared between languages. When a word is encountered in one language, the translation equivalent also becomes activated via the shared semantic representation. This results in CLI at the level of semantic representations (e.g., Basnight-Brown & Altarriba, 2007; Dimitropoulou et al., 2011b; Duyck & Warlop, 2009; Gollan et al., 1997).

To explain CLI between words with similar phonology, such as the interaction between /'kukla/ and /'kukjə/ in our example, we turn to the influential Bilingual Interactive Activation plus (BIA+) model (Dijkstra & van

Heuven, 2002), depicted in Figure 2.1. Applied to auditory word comprehension, CLI occurs because sub-lexical phonological representations (i.e., phonemes) are shared between languages. When the phonemes corresponding to /'kukla/ become activated, multiple (partly) matching lexical phonological representations (i.e., word forms) from both languages become co-activated, so not only the Greek word form /'kukla/, but also the Dutch /'kukjə/. This results in CLI at the level of phonological representations (e.g., Dimitropoulou et al., 2011a; Jouravlev et al., 2014; Nakayama et al., 2012; Van Wijnendaele & Brysbaert, 2002).

Figure 2.1. The Bilingual Interactive Activation plus (BIA+) model (Dijkstra & van Heuven, 2002).



Note. Reprinted from: T. Dijkstra and W. J. B. van Heuven, The architecture of the bilingual word recognition system: From identification to decision, *Bilingualism: Language and Cognition*, *5*(3), p. 182, 2002 © Cambridge University Press, reproduced with permission.

The degree to which CLI at the lexical level emerges depends on several factors. The most well-studied factors relate to language dominance and include language proficiency and exposure. In the BIA+ (Dijkstra & van Heuven, 2002) and Multilink models (Dijkstra et al., 2019), more exposure to a language leads to a higher resting-level activation for words belonging to that language. The higher the resting-level activation, the faster words are (co-)activated, and the more influence they exert over other words. Indeed, in many adult studies, words from a more proficient language – usually the language in which participants have had most exposure – have been found to influence words from a less proficient language more than the other way around (see van Hell & Tanner, 2012, for a review).

In sum, bilingual word retrieval models assume that word forms and meanings are represented in an integrated lexicon with language-nonselective access. As a consequence, representations from different languages interact during processing. CLI can emerge when words share their meaning and/or overlap in their phonological form, and the degree to which CLI takes place is sensitive to factors relating to language dominance. Whilst these types of effects are well established in the adult literature (e.g., Dijkstra, 2005; van Hell & Tanner, 2012), CLI at the lexical level has only been investigated relatively recently in simultaneous bilingual children.

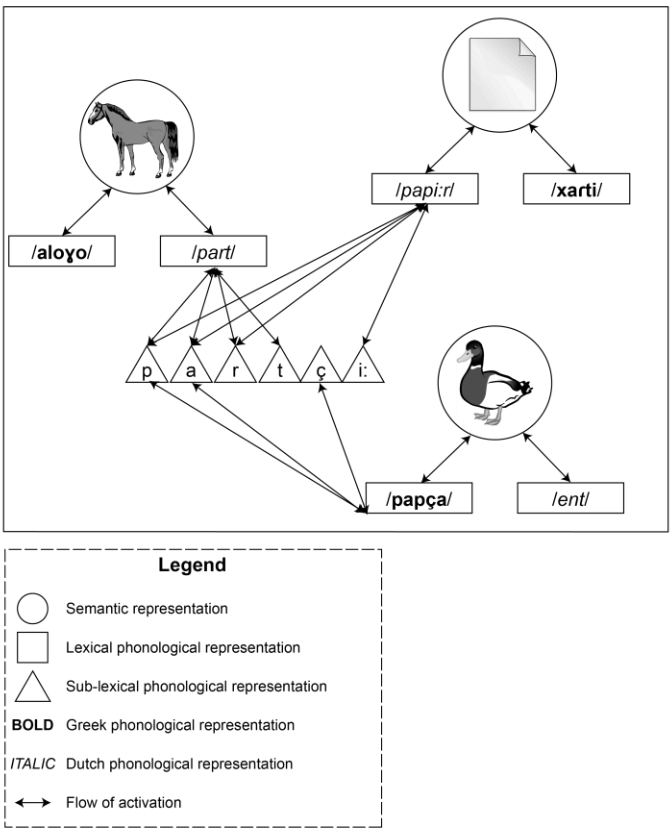
2.1.1. The Lexicon of Bilingual Children

Studies on lexical CLI in bilingual children have mostly used between-language lexical priming paradigms (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Poarch & van Hell, 2012; Singh, 2014; Von Holzen & Mani, 2012). In a lexical priming task, participants are presented with a sequence of two (related) words. A priming effect ensues when the properties of the first word (i.e., the prime) influence the processing of the second word (i.e., the target), and is seen as evidence for interactive connections between representations in the lexicon. For example, Von Holzen and Mani (2012) conducted a preferential looking study using between-language lexical priming with German-English bilingual toddlers. Children heard English primes followed by German targets and were subsequently shown two images, one of which corresponded to the target. In the phonological priming condition, where prime and target rhymed with each other (e.g., *slide* – *Kleid* 'dress'), a facilitatory priming effect was found: Children's looks to the target image increased compared to a control condition in which prime and target were unrelated. In addition, the authors observed an inhibitory effect of phonological priming through translation: When the German translation of the English prime rhymed with the German target (e.g., *leg* – *Stein* 'stone', related via *Bein* 'leg'), the proportion of looks to the target image decreased. These priming effects between words from different languages suggest that as for adults, in bilingual children words from both languages are represented in an integrated lexicon with language-nonselective access, where hearing a word in one language activates its translation, and form-similar words to both the prime and its translation become co-activated.

Other studies with bilingual toddlers have revealed different types of between-language priming, while also investigating the role of language dominance (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Singh, 2014). For example, using the same paradigm as Von Holzen and Mani (2012), Singh (2014) found between-language facilitatory semantic priming (e.g., *table* – *chair*) effects in English-Mandarin Chinese simultaneous bilingual toddlers. Furthermore, priming was influenced by dominance, operationalized as relative language exposure: Between-language priming was only found from the dominant to the non-dominant language. In a similar study, Jardak and Byers-Heinlein (2019) found between-language facilitatory semantic priming in French-English simultaneous bilingual toddlers. However, in their study, priming was unaffected by dominance, which was operationalized as relative vocabulary size, even though the authors' hypotheses were in fact based on exposure. Finally, in a study on bilingual toddlers from diverse language backgrounds, Floccia and colleagues (2020) found facilitatory translation priming (e.g., *cheese* – *fromage* 'cheese') and between-language semantic priming (e.g., *dog* – *chat* 'cat'), and in line with Jardak and Byers-Heinlein (2019), this was unaffected by dominance, operationalized as relative exposure.

Taken together, the available between-language priming studies suggest that, like bilingual adults, the lexicon of young simultaneous bilinguals is integrated, with shared semantic and sub-lexical phonological representations, and with language-nonselective access. The flow of activation between semantic, lexical phonological, and sub-lexical phonological representations in such a lexicon is presented in Figure 2.2. Because the available research on between-language lexical priming in children comes from bilingual toddlers only, it remains unclear to what extent languages in the lexicon interact at later stages of child development. In addition, because of practical limitations in testing such young children, most studies have focused on one type of representation and have used eye-tracking paradigms. As such, these studies are quite different from adult studies, which have mainly used reaction time (RT) measures, and it is not clear to what extent the effects are comparable. To address these gaps, the present study focused on school-aged children – a population in between toddlers and adults in terms of age – combining methods used in toddler studies, namely eye-tracking, and adult studies, namely RT measurements.

Figure 2.2. Flow of activation in an integrated Dutch-Greek bilingual lexicon. In comprehension, activation spreads from phonological representations derived from the input to semantic representations, and results in co-activation of various sub-lexical and lexical units.



2.1.2. Present Study

In order to investigate CLI at the lexical level in bilingual children, we conducted a between-language lexical priming study with Dutch-Greek simultaneous bilinguals aged between four and nine years old. Testing an older population than in previous child studies not only contributes to our understanding of the bilingual lexicon at different ages, but also allowed us to examine multiple types of lexical priming and use multiple measures in one study. We conducted an eye-tracking task, similar to the primed preferential looking tasks described above but also incorporating picture selection. Measuring both eye movements and RTs means that our study is comparable with both toddler and adult studies. In addition, we included a measure of language exposure, in line with previous research by Floccia and colleagues (2020) and Singh (2014), as well as the predictions following from the BIA+ model (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019).[3]

First, we tested for between-language phonological priming and translation priming effects from Greek to Dutch and predicted that such effects would take place in both types of priming. A phonological priming effect would suggest that auditory input co-activates corresponding word forms from both languages via shared sub-lexical phonological representations, as in the BIA+ model and our adaptation for auditory processing in children (Figure 2.2). A translation priming effect would obtain if translation equivalents are connected via a largely common meaning representation (Figure 2.2; see also Dijkstra et al., 2019; Dijkstra & van Heuven, 2002; Shook & Marian, 2013).

Second, we tested for effects of phonological priming through translation from Greek – via Dutch – to Dutch. Following Von Holzen and Mani (2012), we assumed that interactions between phonological and semantic

[3] Jardak and Byers-Heinlein (2019) used vocabulary rather than exposure as their measure of language dominance. To increase comparability with their study, we also repeated our analyses using a measure based on vocabulary rather than exposure. The overall results were the same (see Appendix A).

representations from both languages would result in such priming effects. Specifically, as in translation priming, encountering a word in one language would lead to activation of its translation equivalent; next, as in phonological priming, form-similar words to the translation equivalent would be activated via sub-lexical phonological representations. For example, encountering the Greek word *charti* would lead to activation of its Dutch translation *papier* (see Figure 2.2); next, form-similar words to *papier* would be activated, including the Dutch target word *paard*. (Both *charti* and *papier* translate to 'paper'; *paard* translates to 'horse', but note that these English translations were not available to the children.)

Although previous studies did not always find effects of children's language exposure, we predicted that individual differences on this variable would affect CLI. Following the BIA+ and Multilink models, where more exposure leads to higher resting-level activation, we predicted that words from a dominant language would be (co-)activated faster than words from a non-dominant language. Specifically, for children with higher proportions of Greek exposure relative to Dutch exposure, Greek words would be co-activated faster than Dutch words. As such, a stronger influence of Greek on Dutch would appear in the priming conditions for children with higher proportions of Greek exposure than for children with lower proportions of Greek exposure, in the form of faster responses and increased target looks at an earlier stage. These language exposure effects would be in line with previous studies on toddlers (Singh, 2014) and adults (e.g., Chaouch-Orozco et al., 2021).

2.2. Method

2.2.1. Participants

Participants were 24 bilingual Dutch-Greek children, who had all received substantial input in Greek and Dutch, defined as minimally half a day per week, since before the age of four and for the vast majority (n = 18) since birth. Children were aged between 4.6 and 9.2 years old (M = 6.9, SD = 1.6) and mostly came from higher socio-economic backgrounds, measured in terms of parental education: For 22 children, at least one parent had obtained a (applied) university degree. Two additional children had been tested, but their data was excluded; see Data Exclusion.

All children lived in the Netherlands. Some children had (had) exposure to languages other than Dutch and/or Greek, but this was either much earlier in their lives (at least 3.5 years prior to testing; *n* = 2) or limited to no more than an hour (of English) at school. All children had acquired Greek from at least one parent or caregiver in their home environment. In some cases (*n* = 5), both parents were native speakers of Greek and had migrated to the Netherlands at a later age, for instance for work or studies; for most (*n* = 16) this was the case for one parent and the other parent was a native speaker of Dutch. For three children, one parent was born in the Netherlands to Greek-speaking parents who had moved to the Netherlands themselves, while the other parent was Dutch (*n* = 1) or had moved to the Netherlands from Greece as an adult (*n* = 2). In addition to receiving input from family members, some children (*n* = 6) followed Greek language classes as an after-school activity.

Table 2.1. Overview of participant characteristics.

Background variable	*M*	*SD*	Range
Working Memory[a]:			
- Forward Digit Span Test score	93	13	64 – 112
- Backward Digit Span Test score	100	13	81 – 124
Dutch Proficiency:			
- Lexical proficiency score	70%	19%	28% – 96%
- Syntactic proficiency score	61%	26%	20% – 97%
Greek Proficiency:			
- Lexical proficiency score	44%	19%	4% – 88%
- Syntactic proficiency score	5%	10%	0% – 32%
Percentage Greek Exposure[b]	37%	14%	15% – 69%

[a] Scores are standard scores, with possible scores ranging from 47 to 153.
[b] Percentages reflect how much of children's language exposure around the time of testing was in Greek compared to Dutch.

Table 2.1 summarizes children's scores on a range of background variables: working memory (Dutch version of Alloway Working Memory Assessment – Forward and Backward Digit Span Tests: Alloway, 2012), Dutch lexical proficiency (LITMUS Cross-linguistic Lexical Task: Haman et al., 2015; van Wonderen & Unsworth, 2021), Greek lexical proficiency (adaptation of Greek Child Action and Object Test: Kambanaros et al., 2013), Dutch and Greek syntactic proficiency (LITMUS Sentence Repetition Task: Marinis &

Armon-Lotem, 2015) and relative current exposure (Bilingual Language Experience Calculator: Unsworth, 2013).

2.2.2. Materials

The stimuli consisted of pre-recorded prime and target words, and target and distractor images. The target words were 28 Dutch nouns. Each target was matched to one distractor image and four Greek prime words. Primes, targets, and distractors were noncognate nouns from word lists expected to be known by young Dutch children (Dunn et al., 2005; Mulder et al., 2009; Schlichting & Lutje Spelberg, 2002; Zink & Lejaegere, 2002), with a reported age of acquisition (AoA) below 8;0 (Brysbaert et al., 2014), and their Greek translations. The four Greek primes for each target were selected based on semantic and/or phonological overlap with the target; see Table 2.2. The prime in the control condition – as well as its translation – was semantically and phonologically unrelated to the Dutch target and its translation. The prime in the phonological priming condition overlapped with the target on, minimally, the phonemes in the onset and nucleus of the first syllable[4], and was semantically unrelated to the target. The prime in the translation priming condition was the translation equivalent of the target, and had minimal phonological (onset) overlap with the target. In the phonological-priming-through-translation condition, the prime's translation overlapped phonologically (based on word onset, as in the phonological priming condition) with the target (Greek-Dutch-Dutch phonological priming through translation, equivalent to Von Holzen & Mani, 2012).

Overall, we aimed to minimize differences in frequency (Dimitropoulou et al., 2010; Keuleers et al., 2010); age of acquisiton (AoA) (Brysbaert et al., 2014)[5], and length (in phonemes) between the sets of primes

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[4] We made some exceptions for phonemes that were similar, such as /ɑ/ and /a/.

[5] This large-scale database only includes Dutch words. For Greek primes, we used their Dutch translations to approximate their AoA. Although this does not

and targets. It was not possible to fully match items, for instance in translation priming where a Greek translation would often be longer than the Dutch target. For that reason, frequency, AoA, and length were included as covariates in the analyses (see Analysis). A list of all stimulus words with frequency, AoA, and length as well as measures of phonological (Levenshtein Distance) and semantic distance (Snaut: Mandera et al., 2017) between primes and targets is included as online Supplementary Materials (https://osf.io/q4h28/).

Table 2.2. Priming conditions per session, with examples.

Type of overlap	Condition	Example
None (control)	Unrelated priming	*spiti* 'house' – *paard* 'horse'
Phonological	Phonological priming	*papia* 'duck' – *paard* 'horse'
Semantic	Translation priming	*alogo* 'horse' – *paard* ' horse'
Phonological and semantic	Phonological priming through translation	*charti* 'paper' – (*papier* 'paper') – *paard* 'horse'

The final 28 Dutch target words and 112 Greek prime words were recorded by a female bilingual native speaker of Dutch and Greek. Prime-target combinations were divided over four blocks of 28 trials. Each target word appeared in a different condition (i.e., paired with a different prime) per block and each block contained seven items per condition.

The 28 target and 28 distractor images were full-color clip-art images, sized 512x512 pixels. Distractor images were similar to their matched targets in terms of color and visual complexity, based on the combined intuitions of four judges (the authors). Distractor images were semantically and phonologically (in both Dutch and Greek) unrelated to their matched prime and target words.

account for phonological aspects that may affect word acquisition, semantic and cultural aspects are likely relatively well accounted for, as all children were growing up in the Netherlands.

2.2.3. Procedure

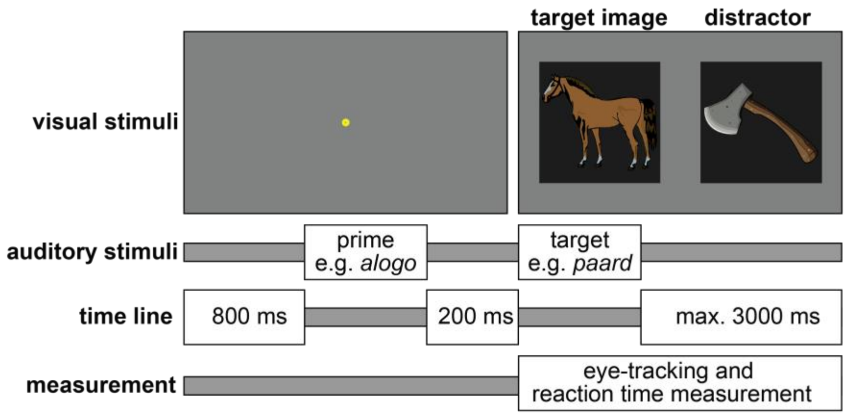
All children were tested individually, in a quiet room in their home, by a Greek-speaking experimenter. Parents signed informed consent forms prior to the testing session. A 15.6-inch, 1366x768-pixel laptop with a Tobii Pro X3-120 eye-tracker was placed on a table, and two response buttons were placed on either side of the laptop. The child was seated 60-70 cm from the laptop screen. Two 50x30 cm black screens were used to regulate light and block potential distractions. The main task was programmed in OpenSesame 3.2.5 (Mathôt et al., 2012), using the PyGaze plugin (Dalmaijer et al., 2014). Audio was played through headphones.

The task consisted of four blocks of 28 trials. Block order was rotated over participants. Block-internal item order was randomized per participant, with minimized semantic and phonological overlap between subsequent trials and maximally two subsequent trials of the same condition.

An experimental trial (Figure 2.3) started by showing a yellow fixation symbol on a gray background. After 800 ms, the prime word was played. Next, after prime offset and a 200 ms pause, the target word was played. Simultaneously, the fixation symbol was replaced by the target and distractor images side by side. The location of the target image (left or right side of the screen) was evenly divided within blocks, and counterbalanced between blocks for each target. From target word offset, participants had up to 3000 ms to select the corresponding image by pressing a response button (left-hand button for left-hand image; right-hand button for right-hand image). Accuracy and RT data were obtained through these button presses. Eye movements were recorded throughout the trial.

To increase children's engagement and conceal the purpose of the task, the task was embedded in a scavenger-hunt-themed game. It followed two characters who were lost in a museum and were trying to find each other by listing the items they had seen on their way (i.e., the prime and target words). By choosing the correct image, the participant helped the characters choose which way to go in the museum.

Figure 2.3. Timeline of a trial, with visual and auditory stimuli.



Each block started with eye-tracker recalibration and two (in the last block) to five (in the first block) practice trials. Greek proficiency tests were administered in between the blocks of the main task. Dutch proficiency tests and other background tests were administered in a separate session. A testing session lasted 60-70 minutes, including short breaks between the tasks if needed. Children received stickers and a Greek-language book for their participation.

2.2.4. Analysis

RT data and eye-tracking data were analyzed separately in R version 4.1.2 (R Core Team, 2021). Plots were created using the ggplot2 package version 3.3.5 (Wickham, 2016).

2.2.4.1. Reaction Time Analyses

RTs were analyzed in a linear mixed-effects regression model with the lmer function from the lme4 package version 1.1.27.1 (Bates et al., 2015). Only correct trials were analyzed (see Data Exclusion). RTs were log-transformed, approaching a normal distribution (Baayen & Milin, 2010). Treatment coding was applied to *Condition*, with the control condition as the reference level. The continuous predictor *Percentage Greek Exposure* and continuous item variables (*Frequency*, *AoA*, and *Length* of prime and target) were mean-centered.

The model included *Condition* and *Percentage Greek Exposure* as predictors for *logRT*, as well as the interaction between the predictors and random intercepts for *Participant* and *Target*. Several covariates were added to the model in a stepwise manner, namely item variables (*Frequency*, *AoA*, and *Length* of prime and target) and task variables (*Trial Number*, *Previous Trial Accuracy*, and *Previous Trial logRT*). The item variables were included because of differences between conditions, discussed above. The task variables that we included may influence RTs (see e.g., Lemhöfer et al., 2008) and were included to control for this influence as much as possible. To avoid overfitting, however, we only included those covariates that significantly improved the model, as was established through Likelihood Ratio Tests using the base anova function (R Core Team, 2021).

In the final model, *p*-values were obtained using Type 2 conditional *F*-tests with Kenward-Roger approximation for degrees of freedom (see Schaalje et al., 2002) as implemented in the Anova function of the car package version 3.0.12 (Fox & Weisberg, 2019). Post-hoc tests were carried out using the emmeans and emtrends functions of the emmeans package version 1.7.2 (Lenth, 2022), using the contrast method trt.vs.ctrl to compare the reference level to each priming condition.

2.2.4.2. Eye-Tracking Analyses

Following Von Holzen and Mani (2012), the eye-tracking data were analyzed with bootstrapped cluster-based permutation analyses (Maris & Oostenveld, 2007), using the eyetrackingR package version 0.2.0. (Forbes et al., 2021). Only correct trials were analyzed (see Data Exclusion). The dependent variable was the logit-adjusted proportion of gaze towards the target, averaged over bins of 30 ms, starting from target onset and ending after 1500 ms.[6] Because bootstrapped cluster-based permutation analysis contrasts two levels at a time,

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[6] As trial duration depended on RT, this time window was chosen to include the majority of the data (the end of the window corresponded approximately with the average RT + 1 SD) while discarding time bins with few observations.

we performed separate analyses for *Condition* and *Percentage Greek Exposure*, and recoded the latter predictor from a continuous variable to a binary variable, using a median split.

For *Condition*, we repeated the following procedure for each priming condition as the treatment level, with the control condition as the reference level. A linear regression model with *Condition* as a predictor for *gaze* was run on each time bin. For each cluster of one or more adjacent bins with a *t*-value of at least 2, the sum of *t*-values was calculated. Next, 1000 simulations were run in which this procedure was repeated on randomly shuffled data, and the largest summed *t*-value of each simulation was saved. The *p*-value of the original cluster was then obtained by comparing its summed *t*-value with the distribution of the simulated *t*-values: The effect of the predictor in a cluster was considered significant if the summed *t*-value of that cluster was larger than 95% of simulated summed *t*-values, corresponding to $p < .05$.

To analyze the effects of *Percentage Greek Exposure*, we first performed bootstrapped cluster-based permutation analyses to test for effects of *Percentage Greek Exposure* within each condition. If this revealed significant differences within a condition between participants with higher Greek exposure and participants with lower Greek exposure, follow-up models were run where we tested for differences between conditions (i.e., priming effects) within each subset of participants.

2.3. Results

2.3.1. Data Exclusion

In 3.5% of trials, responses were missing due to recording errors. Data from two children was excluded, because high error rates throughout the session indicated that children did not understand the task (error rates of 53% and 50%, compared to maximally 10% for the other 24 children). In addition, two different target words were excluded from two different children, because high error rates suggested that they were unfamiliar with the target word or image (i.e., three incorrect responses out of four). After participant and target word exclusion, error rates were ≤10% per participant and per target.

Only trials with correct responses within 2500 ms after target onset and within 2.5 SD from participant average were included in the RT and eye-tracking analyses. This resulted in exclusion of 7% of all valid trials after participant and target exclusion, or 4% of correct trials, leaving a total of 2680 trials. Finally, in the eye-tracking analyses, only trials with less than 25% trackloss were included. This resulted in exclusion of another 129 trials from different participants, leaving a total of 2551 trials. At the participant level, trackloss was always <25%.

2.3.2. Reaction Time Results

The descriptive RTs (after data exclusion) are presented in Table 2.3; see also Appendix B for a plot. The final model is presented in Table 2.4. There were main effects of *Condition* and *Percentage Greek Exposure*. For *Condition*, post-hoc comparisons revealed significant facilitatory effects of phonological priming ($t(2367) = -3.77$, $p < .001$) and translation priming ($t(2367) = -3.30$, $p = .003$), but no significant effect of phonological priming through translation ($t(2367) = -1.84$, $p = .17$). For *Percentage Greek Exposure*, RTs increased with higher proportions of Greek exposure. Put differently, participants with higher proportions of Dutch exposure responded faster. There was no significant interaction between *Percentage Greek Exposure* and *Condition*.

Table 2.3. Reaction time means and standard deviations per condition, in milliseconds.

Condition	RT in ms *M* (*SD*)
Unrelated priming	1131 (361)
Phonological priming	1079 (331)
Translation priming	1086 (344)
Phonological priming through translation	1098 (338)

Table 2.4. Parameter estimates and results from significance tests of the final model of between-language priming in bilingual children.

	Parameter estimates		Significance tests		
Predictor	*B*	*SE*	*F*	$df, df_{residual}$	*p*
(Intercept)	5.838	0.126			
Condition:			5.783	3, 2366.9	.001
- Phonological prime (vs. unrelated)	-0.049	0.013			
- Translation prime (vs. unrelated)	-0.043	0.013			
- Phonological prime through translation (vs. unrelated)	-0.024	0.013			
Percentage Greek Exposure	0.492	0.221	4.308	1, 22.1	.0498
Condition x Percentage Greek Exposure			0.278	3, 2367.1	.842
- Phonological prime x Percentage Greek Exposure	-0.057	0.096			
- Translation prime x Percentage Greek Exposure	-0.052	0.098			
- Phonological prime through translation x Percentage Greek Exposure	-0.087	0.097			
Trial Number	-0.000	0.000	11.201	1, 2367.7	.001
Previous Trial logRT	0.168	0.017	93.453	1, 2396.9	< .001

Note. The significance tests reported in this table apply to predictors (e.g., *Condition*), not the individual levels of factors (e.g., the different conditions). The parameter estimates apply to the individual levels.

2.3.3. Eye-Tracking Results

The eye-tracking analysis revealed a significant phonological priming effect between 300 and 540 ms after target onset (summed *t*-statistic = 27.19; $p = .016$), a significant translation priming effect between 480 and 780 ms (summed *t*-statistic: 30.32; $p = .013$), and a significant phonological priming effect through translation between 270 and 600 ms (summed *t*-statistic = -44.44; $p = .001$). As shown in Figure 2.4, in phonological priming and phonological priming through translation, gaze towards the target image decreased during the significant time windows. In general, these inhibitory priming effects took place while children were listening to the target word. The translation priming effect was facilitatory, with increased looks to the target compared to the control condition. *Percentage Greek Exposure* did not affect target gaze in any of the conditions.

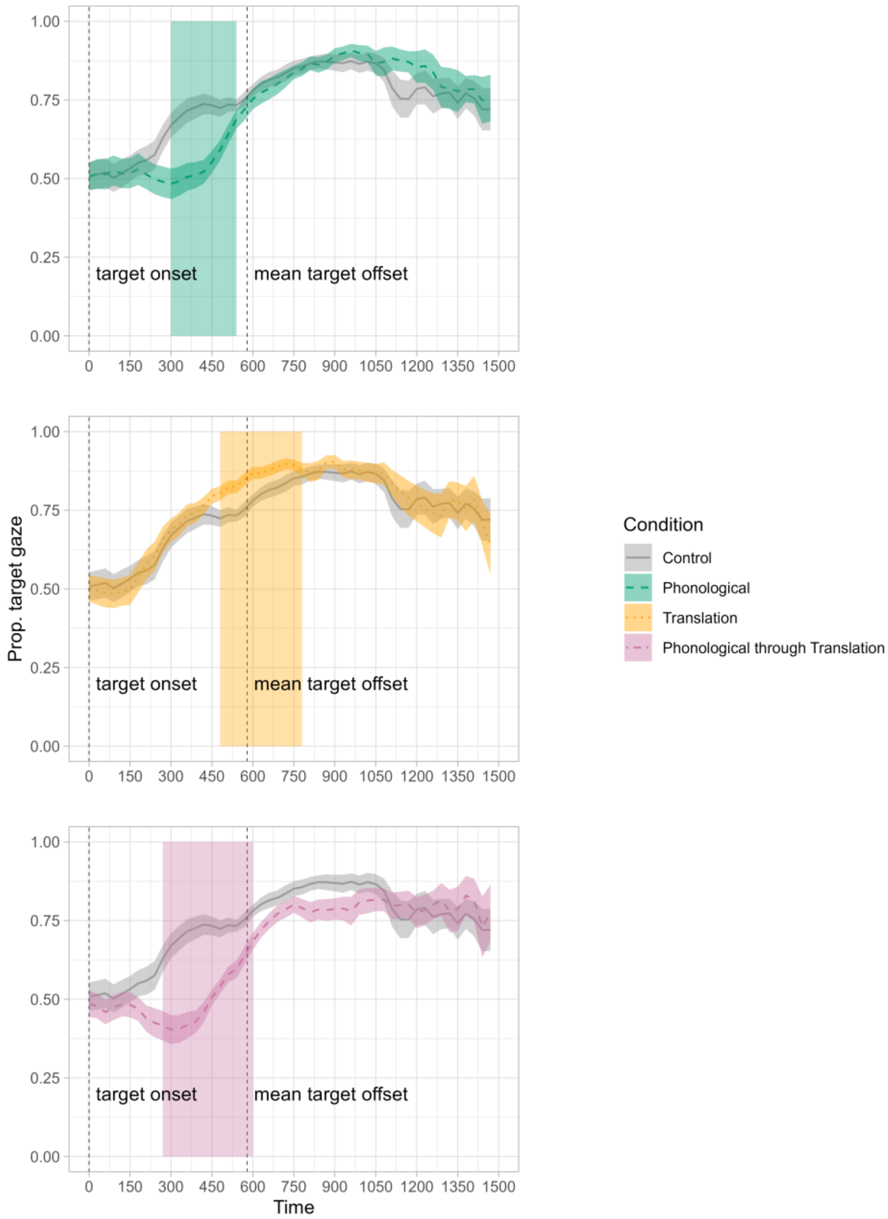
2.4. Discussion

This study investigated cross-linguistic influence (CLI) at the levels of semantic and phonological representations in the lexicon of school-aged simultaneous Dutch-Greek bilinguals. Children completed a primed picture selection task combined with eye-tracking, where both eye movements and RTs were measured. The task included between-language phonological priming, translation priming, and phonological-priming-through-translation conditions. In addition, we tested whether any priming effects were influenced by individual differences in language exposure.

As predicted, we found between-language phonological and translation priming effects in children's eye movements as well as their RTs. In line with our predictions, we found effects of phonological priming through translation, but only in children's eye movements. We discuss these findings in Section 2.4.1.

Our predictions for individual differences in priming behavior relating to language exposure were not supported: There was a main effect of exposure where children with more Dutch exposure (i.e., less Greek exposure) responded more quickly to the Dutch target, but we did not find any interaction effects between priming condition and relative exposure in this study. These results are discussed in Section 2.4.2.

Figure 2.4. Proportion of children's gaze towards the target over time per condition.



2.4.1. Cross-Linguistic Influence at Multiple Levels of Representation in the Lexicon

Overall, the observed between-language priming effects indicate that, like bilingual adults, bilingual children are in possession of a fully integrated lexicon. Form and meaning representations of words from both languages are connected interactively and access to the lexicon is language-nonselective.

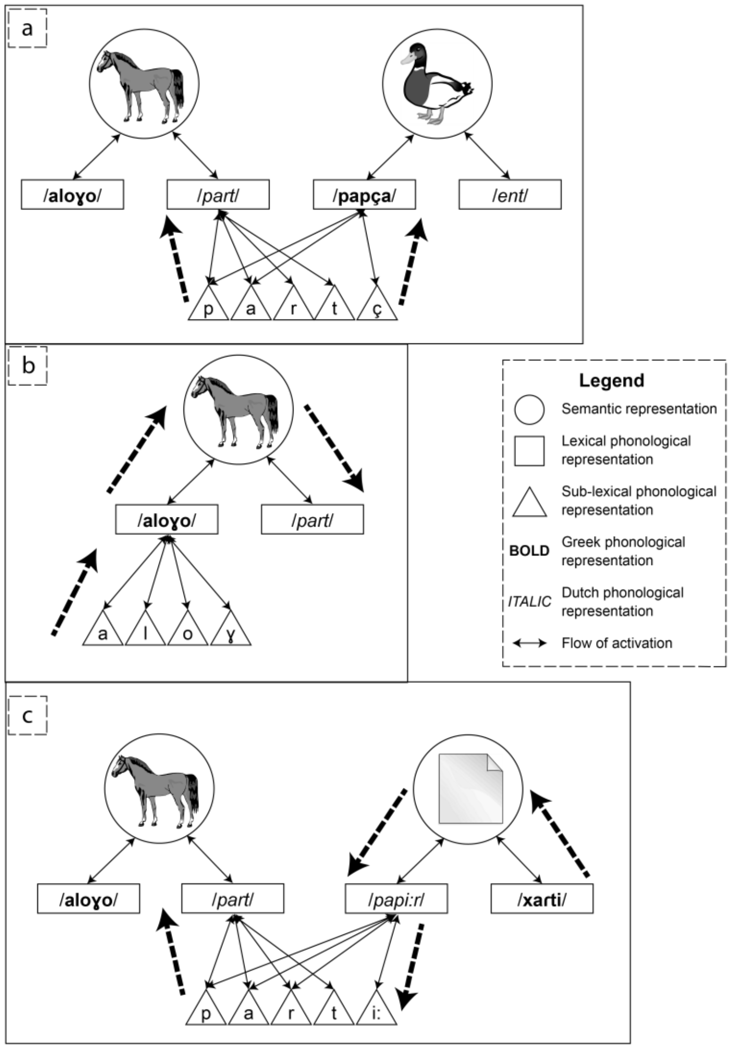
In the phonological priming condition, children's behavior reflected CLI at multiple phases of auditory processing. Early on in the trial, children looked towards the target image less after hearing a (Greek) prime that was phonologically related to the (Dutch) target. This effect largely overlapped with the auditory presentation of the target word. Such early inhibition effects are typically associated with competition between lexical phonological representations (Dufour, 2008): When sub-lexical phonological representations are activated, this subsequently activates all lexical phonological representations that (partly) match, and these words start to compete for selection. This inhibitory phonological priming effect between words from different languages provides clear evidence for language-nonselective access and language-nonselective competition in auditory word processing (see Figure 2.5, panel a). This is in line with previous research with bilingual adults for visual and auditory word processing (e.g., Spivey & Marian, 1999; Weber & Cutler, 2004) and with the predictions following from the BIA+ model (Dijkstra & van Heuven, 2002).

At the end of the trial, when children selected the target image, they did so more quickly after hearing a phonologically related prime than after hearing an unrelated prime. This facilitatory phonological priming effect may seem in contradiction with the inhibitory effect found earlier on, but it is in fact in line with studies showing that timing affects the direction of phonological priming effects. For example, Hermans and colleagues (1998) found that between-language phonological effects can be inhibitory as well as facilitatory, depending on stimulus onset asynchrony. More specifically, longer intervals between prime and target lead to facilitatory phonological priming effects and are more generally associated with processes other than phonological competition, which has been shown to emerge with shorter inter-stimulus intervals (Dufour, 2008). In our study, we did not directly manipulate stimulus timing, but our different measures nevertheless tapped into different phases of lexical processing. Specifically, whilst our eye-tracking measures reflected phonological competition, our RT measures suggested that phonological competitors remained at a higher level of activation after competition was resolved. As a result, they were ultimately processed faster as targets and the corresponding image was selected faster compared to when they were preceded by an unrelated prime. In sum, both the inhibitory and facilitatory phonological priming effects suggest that access to the bilingual lexicon is language-nonselective, and that words from both languages are co-activated.

In addition to CLI driven by phonological representations, our study also revealed CLI at the level of semantic representations. Children's behavior in the translation priming condition was in line with previous studies with bilingual toddlers (Floccia et al., 2020) and adults (e.g., Gollan et al., 1997): Upon hearing a target word that was the translation of the prime, children looked towards the target image more than when prime and target were unrelated, and they selected the target image more quickly. This facilitatory priming suggests that translation equivalents share semantic representations, as assumed in various models (Dijkstra et al., 2019; Dijkstra & van Heuven, 2002; Shook & Marian, 2013). Consequently, when the semantic representation of a word is activated, words that share the same semantic representation (i.e., translation equivalents) are processed more quickly, resulting in facilitatory priming (see Figure 2.5, panel b).

In the phonological-priming-through-translation condition, we investigated interactions between phonological and semantic representations from both languages. We found that children's eye movements towards the target image decreased early in the trial, in the same way they did in the phonological priming condition. These similar patterns suggest similar processes: A prime word's translation equivalent becomes activated via the shared semantic representation, and subsequently competes with phonologically related words from both languages (Figure 2.5, panel c). As also argued by Von Holzen and Mani (2012), such effects are only possible across languages in truly language-nonselective word processing, allowing interactions between semantic and phonological representations from both languages. These interactions between semantic and phonological representations also play a role in translation priming: As activation feeds back from the activated semantic representation to the phonological representations of the prime as well as its translation, translation priming is mostly likely not only driven by the higher activation of the semantic representation, as discussed above, but also the phonological representation (Figure 2.5, panel b).

Figure 2.5. Processes of activation spreading and co-activation in the bilingual lexicon causing phonological priming between Greek prime *papia* 'duck' and Dutch target *paard* 'horse' (panel a), translation priming between Greek prime *alogo* 'horse' and Dutch target *paard* 'horse' (panel b), and phonological priming through translation from Greek prime *charti* 'paper' – via Dutch *papier* 'paper' – to Dutch target *paard* 'horse' (panel c).



Unlike in phonological priming, there was no significant facilitatory effect of phonological priming through translation in children's RTs. Because there was a trend towards faster selection of the target image (Table 2.3), it is likely that the phonological competitors were activated as in phonological priming, but to a lesser degree because of the indirect nature of this form of priming, which depends on activation spreading across multiple representations (Figure 2.5, panel c). This is supported by findings from Amrhein and Knupsky (2007), who found facilitatory effects of phonological priming through translation to be weaker than effects of phonological priming in bilingual adults.

In sum, the different types of priming effects found in this study are in line with studies on bilingual toddlers (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Singh, 2014; Von Holzen & Mani, 2012) and with studies on bilingual adults (Amrhein & Knupsky, 2007; Basnight-Brown & Altarriba, 2007; Dimitropoulou et al., 2011a, 2011b; Duyck & Warlop, 2009; Gollan et al., 1997; Jouravlev et al., 2014; Nakayama et al., 2012; van Hell & Tanner, 2012; Van Wijnendaele & Brysbaert, 2002). Using both eye-tracking and RT measures, the combined evidence from the present study and previous literature suggests that highly similar processes take place in bilinguals at different stages of development, in an integrated bilingual lexicon with shared semantic and sub-lexical phonological representations.

2.4.2. Language Exposure

In addition to investigating CLI at multiple levels of representation in the lexicon, we examined the effects of relative language exposure. We found a main effect of language exposure in RTs, whereby children who received more Dutch exposure selected the target image faster than children who received less Dutch exposure. This suggests that exposure affects the resting-level activation of representations in the lexicon, in line with the BIA+ and Multilink models: For children who received more Dutch exposure, the Dutch target words had a higher resting-level activation and were therefore activated and processed more quickly by these children than by children who received less Dutch exposure. Contrary to our predictions, however, we did not find a relation between language exposure and priming effects – that is, effects of phonological priming, translation priming, and phonological priming through translation emerged regardless of children's relative exposure in our sample. Whilst the dominance effects we predicted are in line with the BIA+ and Multilink models and are often found in adult literature, previous child studies often did not find such effects either: To our knowledge, only Singh (2014) found effects of relative exposure in between-language priming in children. Floccia and colleagues (2020) did not find any effects, and neither did Jardak and Byers-Heinlein (2019), who, despite operationalizing language dominance in terms of vocabulary size[7], related their hypotheses and findings to language exposure.

A lack of exposure effects on priming may be explained in different ways. First of all, there may be developmental differences. Combining explanations by Floccia and colleagues (2020) and Jardak and Byers-Heinlein (2019), it is possible that, in children, semantic representations are not shared between translation equivalents, but merely connected. According to Jardak and Byers-Heinlein (2019), the connection between these semantic representations is strengthened – leading to stronger priming effects – with increased exposure to the concepts. Because exposure to a concept may come from either language, translation priming would not be affected by relative language exposure. However, as discussed by Floccia and colleagues (2020), in the age group we examined, semantic representations of translation equivalents are most likely shared, as in adults. Hence, an explanation along the lines of Jardak and Byers-Heinlein (2019) seems unlikely. Furthermore, their account cannot explain our null findings for exposure in phonological priming, nor is it clear why we should still find a main effect of exposure in RTs.

Alternatively, as proposed by Floccia and colleagues (2020), there may be an influence of exposure on lexical priming that may become apparent under certain circumstances only, and this may depend on the diversity within participant samples. We aimed for a diverse sample, but within boundaries: All children lived in the Netherlands and attended Dutch schools. There was quite

[7] To check whether inconsistencies among studies may stem from different operationalizations, we repeated our analyses with a proficiency measure rather than an exposure measure, but this did not change our most important outcomes (see Appendix A). Importantly, priming from Greek to Dutch was neither affected by children's Greek proficiency nor children's Greek exposure.

a range in how much Greek the children heard (15% – 69%), but on average they heard more Dutch than Greek (63%). The difference in resting-level activation between Dutch and Greek may have been greater than any differences between individual children's levels of activation in Greek, with the result that the former masked any differences in the latter.

Finally, the null results in most child studies so far may be an effect of smaller participant samples and generally noisier data compared to many adult studies. Much larger samples representing a large range in language exposure and/or proficiency would allow us to systematically and reliably investigate to what extent lexical CLI in bilingual children is affected by such individual differences. As collecting data from bilingual children often has many practical limitations, in practice this would be an opportunity for large-scale international collaborations between child bilingualism researchers, in line with the work of Visser and colleagues (2022) on infants.

2.4.3. Conclusion

The present study revealed cross-linguistic influence in the form of between-language priming effects in auditory lexical processing in four-to-nine-year-old simultaneous bilinguals with varying levels of language exposure, across multiple levels of representation in the lexicon. Using both eye-tracking and reaction times as measures for language processing in a picture selection task, we found between-language priming effects driven by phonological and semantic similarities, as well as indirect priming effects driven by interactions between phonology and semantics. Language exposure did not influence the strength of these priming effects, although it did affect overall processing speed.

Importantly, through our combination of language processing measures, it became evident that eye-tracking and reaction time measures tap into different aspects of lexical processing in which cross-linguistic influence occurs. We would recommend the use of multiple measures to fully understand processing during lexical priming in particular and word comprehension in general.

To our knowledge, this study is the first to investigate between-language priming in school-aged simultaneous bilingual children, considering both semantic and phonological representations as well as language exposure in one study. Altogether, these results provide evidence for an integrated bilingual lexicon in simultaneous bilingual children, fully shared at the levels of semantic and sub-lexical phonological representations, with a high degree of connectivity and interaction within and between these representations. Alongside evidence from studies with younger children and with adults, this shows that the lexicon of bilinguals is organized in a highly similar manner at earlier and later stages of development.

Appendix A

To check whether inconsistencies in dominance effects on lexical priming among toddler studies may stem from differences in the operationalization of dominance, we repeated our RT and eye-tracking analyses with *Greek Vocabulary* instead of *Percentage Greek Exposure*. Rather than using relative vocabulary size to categorize children's dominance, as in Jardak and Byers-Heinlein (2019), we included *Greek Vocabulary* as a continuous variable, similar to Nicoladis (2012): As children generally scored higher on Dutch vocabulary than on Greek vocabulary, a categorical dominance variable would not be informative. Similar to our hypotheses for *Percentage Greek Exposure*, we would expect a stronger influence from Greek on Dutch for children with higher Greek proficiency than for children with lower Greek proficiency.

The final model of *Condition* and *Greek Vocabulary* in RTs is presented in Table A1. There was a main effect of *Condition*. Similar to the analysis with *Percentage Greek Exposure*, there were significant facilitatory effects of phonological priming ($t(2367) = -3.79$, $p < .001$) and translation priming ($t(2367) = -3.32$, $p = .003$), but no significant effect of phonological priming through translation ($t(2367) = -1.85$, $p = .16$). There were no significant effects of *Greek Vocabulary*. The eye-tracking analyses revealed no effects of *Greek Vocabulary* either. This confirms that our main findings, where there was no interaction between *Percentage Greek Exposure* and priming, are not an artefact of our operationalization of dominance as relative exposure.

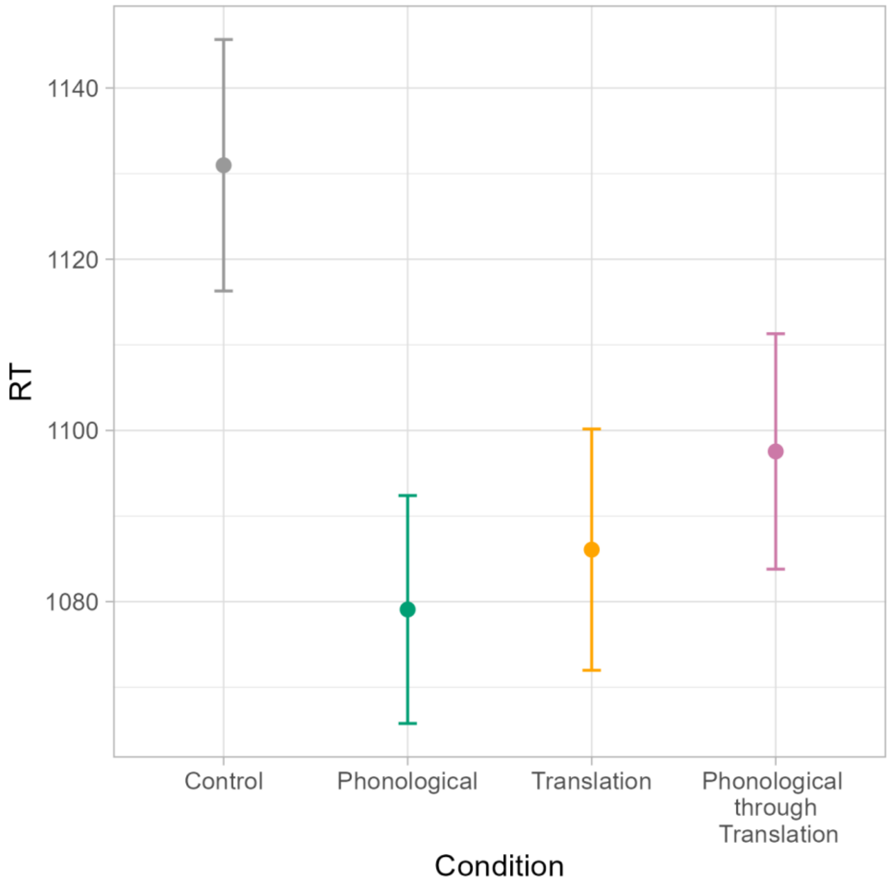
Table A1. Parameter estimates and results from significance tests of the final model of between-language priming in bilingual children.

Predictor	Parameter estimates		Significance tests		
	B	*SE*	*F*	*df*, $df_{residual}$	*p*
(Intercept)	5.835	0.127			
Condition:			5.794	3, 2366.9	.001
- Phonological prime (vs. unrelated)	-0.049	0.013			
- Translation prime (vs. unrelated)	-0.043	0.013			
- Phonological prime through translation (vs. unrelated)	-0.024	0.013			
Greek Vocabulary	-0.001	0.002	0.255	1, 22.0	.619
Condition x Greek Vocabulary			0.421	3, 2367.3	.738
- Phonological prime x Greek Vocabulary	0.000	0.001			
- Translation prime x Greek Vocabulary	0.000	0.001			
- Phonological prime through translation x Greek Vocabulary	0.001	0.001			
Trial Number	-0.000	0.000	11.279	1, 2367.7	.001
Previous Trial logRT	0.169	0.017	93.959	1, 2397.2	< .001

Note. The significance tests reported in this table apply to predictors (e.g., *Condition*), not the individual levels of factors (e.g., the different conditions). The parameter estimates apply to the individual levels.

Appendix B

Reaction times per condition.



Data availability statement

The data and analysis script used can be found on this project's entry on the Open Science Framework (link: https://osf.io/q4h28/) under a CC-By Attribution 4.0 International license.

Chapter 3: Shared Representations in Cognate Comprehension and Production: An Online Picture Naming and Lexical Decision Study with Bilingual Children

Abstract

The cognate facilitation effect, a classic example of cross-language interaction in the bilingual lexicon, has mostly been studied in adults. We examined the extent to which such effects occurred in simultaneous bilingual children's word processing, to what extent these were modulated by language dominance, and to what extent this differed between production and comprehension tasks with different demands. Simultaneous bilingual Dutch-Greek children, ranging from Dutch-dominant to Greek-dominant, performed auditory lexical decision and picture naming tasks in an online experiment. Cognate facilitation effects emerged in both tasks, but manifested themselves differently. In lexical decision, there was an interaction effect with language dominance in accuracy, while in picture naming there was a main effect in reaction times. These findings suggest that, similar to what has been found for adults, simultaneous bilingual children have an integrated lexicon, in which both languages are interactively connected. Effects may differ as a combined result of factors such as task demands and individual differences in language dominance. Importantly, despite such differences, our results show that cognate effects emerge across tasks and across a range of individual children's language dominance, indicating that shared representations within the bilingual lexicon are accessed during both word comprehension and production.

3.1. Introduction

Children who grow up with multiple languages sometimes use language differently from monolingual children. For example, a Dutch-Greek bilingual child may say *πένα* /ˈpɛna/ – which is Greek for 'fountain pen' – instead of *στυλό* /stilˈo/ 'pen', influenced by their knowledge of the Dutch word *pen* 'pen'. At the same time, the same child is less likely to struggle with a word like *xylofoon* 'xylophone' than their Dutch monolingual peers, because it is a Dutch-Greek cognate, that is, a word whose translation equivalents are pronounced very similarly: /ksiloˈfon/ in Dutch and /ksiˈlofono/ in Greek.

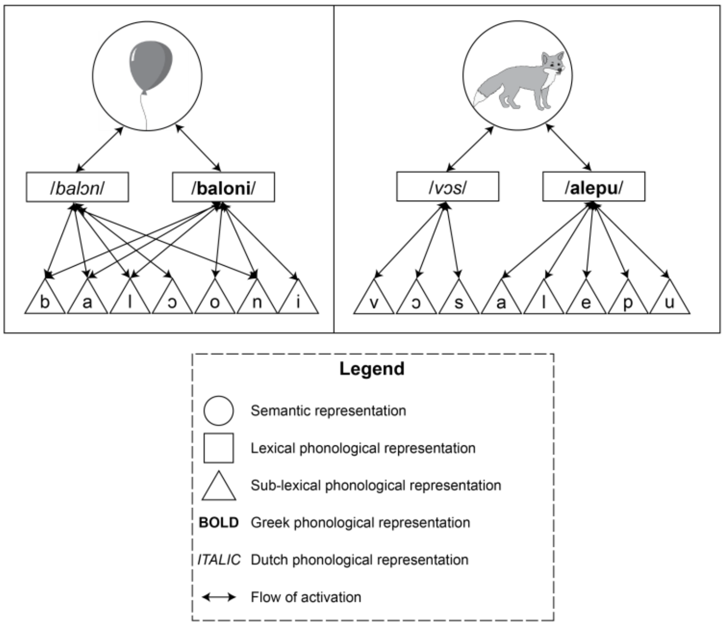
Situations in which cognates are processed more quickly or with more ease than other words – the so-called cognate facilitation effect – provide important insights into how the bilingual lexicon is organized and accessed. Specifically, such examples illustrate how the two languages in a bilingual lexicon are not stored and processed independently from each other, but are represented in a shared system with interactions between the languages. This view is supported by extensive research on bilingual adults (see e.g., Dijkstra & van Heuven, 2018, for a review). However, much less research has focused on the lexicon of simultaneous bilingual children. In the present study, we test to what extent the cognate facilitation effect does indeed obtain in simultaneous bilingual children. More specifically, we examine to what extent such effects are observed under different circumstances, by considering cognate comprehension and production in bilingual children with varying levels of language dominance.

3.1.1. Organization of and Access to the Bilingual Lexicon

3.1.1.1. Bilingual Adults

In the generally accepted view of the bilingual lexicon, the two languages are combined in an integrated lexicon that is accessed in a language-nonselective manner, that is, words from both languages may be activated at all times (e.g., Dijkstra & van Heuven, 2002, 2018). This assumption has several consequences for lexical processing in bilinguals. Because words from both languages are represented in a shared system, they can become co-activated during processing when they overlap enough in their semantic, phonological, and/or orthographic representations. For example, cognates such as the Dutch *ballon* /ba'lɔn/ 'balloon' and Greek *μπαλόνι* /ba'loni/ 'balloon' are assumed to have a shared semantic representation across languages and to share sub-lexical phonological representations for several phonemes (/b/, /a/, /l/, etc.); see Figure 3.1. When a cognate word is presented to a Greek-Dutch bilingual, activation is assumed to converge towards the same semantic and sub-lexical representations, leading to strong co-activation of both cognate members.

Figure 3.1. Representation and flow of activation in an integrated Greek-Dutch bilingual lexicon of a cognate (left) and a noncognate translation pair (right).



This is explained by interactive models of bilingual word processing, such as the Bilingual Interactive Activation plus (BIA+) model (Dijkstra & van Heuven, 2002). According to this model, a word that is presented to a bilingual activates all word forms that are similar to this input word, irrespective of the language they belong to. This activation resonates (i.e., flows back and forth) between form and meaning representations. As a result, in the case of cognates, activation spreads between translation equivalents via both shared semantic and sub-lexical representations. In contrast, co-activation of translation equivalents without form overlap (like Dutch *vos* /vɔs/ 'fox' and Greek *αλεπού* /ale'pu/ 'fox') would be limited to convergence at the semantic level (Dijkstra et al., 2019; Dijkstra & van Heuven, 2002; Shook & Marian, 2013); see Figure 3.1. The stronger resonance between cognate members induces a faster activation and recognition of cognates relative to noncognates. Words without any meaning or form overlap (like Dutch *bril* /brɪl/ 'glasses' and Greek *σπίτι* /'spiti/ 'house') would not result in any co-activation in the integrated bilingual lexicon.

To the extent that the same flow of activation is assumed to take place between the same representations in production and in comprehension (see e.g., Menenti et al., 2011; Pickering & Garrod, 2013; Zwitserlood, 1994), cognate facilitation effects are predicted to occur in both modalities (e.g., Dijkstra & van Heuven, 2018). The main difference between the modalities lies in which representation is activated first. In (auditory) cognate comprehension, sub-lexical phonological representations are activated based on the input. The sub-lexical representations activate corresponding word forms, including the two translation equivalents, which themselves both activate their shared semantic representation. In cognate production, a semantic representation is activated first. From there, the two corresponding word forms (i.e., the translation equivalents) are activated, and in turn their (partially overlapping) sub-lexical phonological representations. In both modalities, the resonating activation increases the activation levels of the two co-activated word forms, leading to faster cognate comprehension and production than noncognate comprehension and production. Indeed, studies with bilingual adults have found cognates to be processed more quickly and/or more accurately in both comprehension (e.g., Dijkstra, 2005; Dijkstra et al., 2010; Lemhöfer et al., 2004) and production (e.g., Costa et al., 2000; Hoshino & Kroll, 2008; Kroll et al., 2006).

The strength of cognate facilitation effects can be modulated by several factors, including individual differences in language dominance and differences in task demands (de Groot et al., 2002; Dijkstra et al., 2010; Muntendam et al., 2022; Poort & Rodd, 2017; van Hell & Dijkstra, 2002; van Hell & Tanner, 2012). Variation in dominance is typically accounted for in processing models in terms of language exposure. According to BIA+ (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019), for example, language exposure affects the ease with which a representation in the lexicon is activated: More exposure to a word in a language leads to a higher resting-level of activation for that word, which in turns leads to faster activation and a stronger influence on the processing of other words. Many empirical studies with bilingual adults have found cognate effects to be stronger in a non-dominant language than in a dominant (usually native) language, in which cognate effects are usually smaller or even absent (e.g., Muntendam et al., 2022; van Hell & Dijkstra, 2002; van Hell & Tanner, 2012).

Differences in result patterns can also arise due to task demands, which can differ widely among experimental tasks and during natural interactions. The BIA+ model (Dijkstra & van Heuven, 2002) accounts for such effects by implementing a separate Task/Decision subsystem, which takes input from the lexicon and creates a task-appropriate response. For example, in lexical decision, a commonly used comprehension task, the Task/Decision subsystem takes an activated word form and its meaning as input to decide whether the word requires a 'yes'-response (for real words in the target language) or a 'no'-response (for nonwords or words from the non-target language). This is quite different from a task-appropriate response in picture naming, a commonly used production task. In picture naming, after a meaning and its corresponding word forms have been activated, the target language word form needs to be selected and phonologically encoded, and articulatory processes need to be set in motion. So while the same representations are assumed to be activated in the lexicon in production and comprehension, they are processed differently by the Task/Decision subsystem. Studies have found that differences between tasks and task demands modulate which factors play a role in word processing (see e.g., de Groot et al., 2002; Ferrand et al., 2011). Importantly, this includes cognate status (e.g., de Groot et al., 2002; Dijkstra et al., 2010; Poort & Rodd, 2017). For example, de Groot and colleagues (2002) observed the dominance asymmetry described above in a lexical decision task, whereas a cognate effect emerged regardless of language dominance in a word naming task. In other words, interactions between task effects and dominance effects may affect empirical outcomes.

In sum, models of the bilingual lexicon assume that the two languages are represented in an integrated system, which is accessed in a language-nonselective manner, and in which activation spreads between connections during lexical processing. Cognates are processed with more ease than noncognates as a result of shared semantic and sub-lexical representations and activation resonating between these representations. The strength of such cognate facilitation is influenced by language dominance and is subject to specific task demands. The empirical evidence for models of the bilingual lexicon is largely based on research involving bilingual adults. As we will see in the next section, there is a small but growing body of evidence pointing to a similar integrated lexicon in simultaneous bilingual children, although it is not yet clear to what extent the role of modulating factors is the same as in adults.

3.1.1.2. Simultaneous Bilingual Children

As for bilingual adult research, it is an important question for bilingual child research if the bilingual lexicon is integrated and if representations are shared. Children and adults not only differ in chronological age, but also typically in age of acquisition: Whereas most studies with adults focus on late second language learners, for bilingual children both languages are acquired more or less simultaneously, while they are both still developing. As such, empirical research needs to establish to what extent bilingual word processing is similar between these groups.

Studies on cognate processing in bilingual children have made use of several spoken word production and (visual) comprehension tasks. For example, Poarch and van Hell (2012) conducted picture naming tasks with simultaneous German-English bilingual children. When the picture was named with a cognate word, it was named more accurately and more quickly than when it was a noncognate control word. These cognate facilitation effects were found in both languages. Schröter and Schroeder (2016) found similar effects in an orthographic lexical decision task with simultaneous and early German-English bilingual children: Children responded more accurately and more quickly to cognates than to noncognates. Although the accuracy effect was only significant in English, reaction time effects appeared in both languages, similar to Poarch and van Hell (2012). In other studies, the degree of orthographic overlap between translation equivalents was manipulated on a continuous scale. More similar (i.e., cognate-like) translation equivalents were processed more quickly in sentence reading by Dutch-Frisian bilingual children (Bosma & Nota, 2020) and in translation recognition by Spanish-Basque bilingual children (Duñabeitia et al., 2016), and were recognized to a greater extent in a word recognition task by German-English bilingual toddlers (Von Holzen et al., 2019). In a receptive vocabulary test, the form-similarity of translation equivalents affected the performance of Dutch-Frisian bilingual children (Bosma et al., 2019). The findings from these various cognate processing studies all support the hypothesis of an integrated bilingual lexicon in children.

In addition to these cognate production and visual word comprehension studies, there have been auditory comprehension studies examining the bilingual child's lexicon. These were often focused on between-language lexical priming rather than cognate comprehension. In lexical priming, two (related) words are presented in sequence whilst participants' processing is monitored. A priming effect obtains when properties of the first word (i.e., the prime) influence the processing of the second word (i.e., the target), for instance when they are semantically related. Such a priming effect is taken as evidence for connections between representations in the lexicon, so when words from different languages prime each other, this is evidence that they are represented in a shared system. In simultaneous bilingual toddlers, lexical priming studies (all involving noncognates) have found evidence for connections between phonologically similar words from different languages (Von Holzen & Mani, 2012) as well as semantically related words (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Singh, 2014) and translation equivalents (Floccia et al., 2020; Von Holzen & Mani, 2012). Recently, similar between-language phonological and translation priming effects have been found in older bilingual children (Koutamanis et al., Chapter 2). In line with the findings from cognate processing studies, these between-language priming effects with noncognates are in support of models of an integrated bilingual lexicon in children.

Many of the aforementioned studies included some measure of language dominance. For example, in their cognate production study, Poarch and van Hell (2012) found differences between child second language learners, who were more dominant in their first language, and simultaneous bilinguals, who were more balanced. For simultaneous bilinguals, effects emerged in both languages, but for child second language learners, effects were found only in the weaker language (i.e., children's second language). Similarly, in sentence reading, Bosma and Nota (2020) found cognate effects in simultaneous Frisian-Dutch bilingual children only in Frisian, which was the language to which they had had less exposure in reading, and Bosma and colleagues (2019) found stronger cognate facilitation for children with less exposure to the target language at home than for children with more exposure to the target language. In their toddler word recognition study, Von Holzen et al. (2019) also only found cognate effects in English, which was the language to which the children had had less exposure. For between-language lexical priming, Singh (2014) only found effects from simultaneous bilingual toddlers' dominant language to their non-dominant language (where dominance was operationalized in terms of exposure). In contrast, other priming studies, which were highly similar in design, found no such dominance effects (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Koutamanis et al., Chapter 2).

Unlike language dominance, task-related factors and their influence on cognate processing have rarely been considered in simultaneous bilingual child research. Many studies have included multiple participant groups or multiple outcomes (e.g., accuracy and reaction times), but not multiple tasks. This lack of triangulation not only decreases comparability between child and adult studies, but also makes it unclear to what extent findings within child research are generalizable across tasks and, due to possible interactions between task- and participant-related factors (as in de Groot et al., 2002), across children with different degrees of language dominance.

3.1.2. Present Study

To test the extent to which the two languages in bilingual children's lexicon interact similarly across tasks and across children varying in language dominance, we conducted two cognate processing tasks with the same group of Greek-Dutch simultaneous bilingual children. The tasks were chosen to increase comparability with adult studies, namely (auditory) lexical decision, a commonly used comprehension task in adults (e.g., Lagrou et al., 2011; Muntendam et al., 2022), and picture naming, a commonly used production task in child and adult studies (e.g., Costa et al., 2000; Hoshino & Kroll, 2008; Poarch & van Hell, 2012). We used auditory lexical decision rather than visual lexical decision to avoid effects of children's literacy skills unrelated to dominance and to avoid effects of having two different alphabets. In both tasks, we measured accuracy as well as reaction times.

Participants were Dutch-Greek simultaneous bilinguals, aged between seven and eleven years old. To secure a sample of children whose dominance patterns varied, we included children living in the Netherlands and children living in Greece. As both tasks were conducted in Greek, language dominance was measured in terms of relative language exposure to Dutch. This operationalization allowed us to test the predictions following from the BIA+ model (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019), namely that more exposure to a language leads to more influence of that language on word processing in the other language.

We assumed that models of the bilingual lexicon based on adult studies are also applicable to the lexicon of bilingual children – specifically, we assumed that activation spreading between shared sub-lexical and semantic representations in the lexicon leads to cognate facilitation in both comprehension and production. We predicted cognate facilitation effects in both lexical decision and picture naming, in accuracy as well as in reaction times, in line with earlier studies with children (Bosma et al., 2019; Bosma & Nota, 2020; Duñabeitia et al., 2016; Poarch & van Hell, 2012; Schröter & Schroeder, 2016) and adults (e.g., Costa et al., 2000; Dijkstra et al., 2010; Hoshino & Kroll, 2008; Lemhöfer et al., 2004), although the way cognate effects manifest in different tasks may differ (de Groot et al., 2002).

In addition, we predicted cognate facilitation effects to be modulated by language dominance in both tasks. Specifically, in line with the BIA+ model (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019), we assumed that the more dominant a language is in the lexicon, the more influence it exerts over the other language. As a consequence, we predicted stronger cognate facilitation effects for children who received more exposure to the non-target language Dutch, as has been found in several studies with children (Bosma et al., 2019; Bosma & Nota, 2020; Poarch & van Hell, 2012; Singh, 2014) and adults (Muntendam et al., 2022; van Hell & Dijkstra, 2002; van Hell & Tanner, 2012).

3.2. Method

3.2.1. Participants

Participants were 27 Dutch-Greek bilingual children (15 girls, 12 boys), aged between 7.1 and 10.8 years old ($M = 9.0$, $SD = 1.2$), living either in the Netherlands ($n = 22$) or in Greece ($n = 5$). All children had received substantial exposure to both Greek and Dutch, defined as minimally half a day per week, since before the age of three and for the majority (*n* = 21) since birth. No children had received substantial exposure to any other languages than Dutch or German for at least 3.5 years prior to testing. All children had at least one parent who had completed (applied) university, indicating a higher socio-economic status.

Table 3.1 summarizes children's scores on a range of background variables: working memory (Dutch version of Alloway Working Memory Assessment: Forward and Backward Digit Span Tests; Alloway, 2012), Dutch lexical proficiency (LITMUS Cross-linguistic Lexical Task; Haman et al., 2015; van Wonderen & Unsworth, 2021), Greek lexical proficiency (adaptation of Greek Child Action and Object Test; Kambanaros et al., 2013), and Dutch and Greek syntactic proficiency (LITMUS Sentence Repetition Task; Marinis & Armon-Lotem, 2015). In addition, we measured children's current relative language exposure (Bilingual Language Experience Calculator; Unsworth, 2013). The resulting percentage reflects how much of children's language exposure around the time of testing was in Dutch compared to Greek. Table 3.2 shows how the various proficiency and exposure measures are correlated. All proficiency measures correlated moderately or strongly with language exposure. Dutch lexical proficiency and Dutch syntactic proficiency correlated strongly with each other, as did Greek lexical proficiency and Greek syntactic proficiency. Dutch lexical proficiency was weakly correlated with Greek syntactic proficiency.

Participant information, stimulus lists, data, and analysis scripts for this study can be retrieved from http://tinyurl.com/EKChapter3OSF.

Table 3.1. Overview of participant characteristics.

Background variable	*M*	*SD*	Range
Working Memory[a]:			
- Forward Digit Span Test score	93	14	61 – 127
- Backward Digit Span Test score	98	11	74 – 114
Dutch Proficiency:			
- Lexical proficiency score	76%	17%	26% – 96%
- Syntactic proficiency score	70%	25%	10% – 100%
Greek Proficiency:			
- Lexical proficiency score	60%	25%	5% – 92%,
- Syntactic proficiency score	21%	22%	0% – 75%
Percentage Dutch Exposure[b]	60%	23%	14% – 95%

[a] Scores are standard scores, with possible scores ranging from 47 to 153. [b] Percentages reflect how much of children's language exposure around the time of testing was in Dutch compared to Greek.

Table 3.2. Correlations between proficiency scores and exposure.

	1	2	3	4	5
1. Percentage Dutch Exposure	–				
2. Dutch lexical proficiency score	0.75***	–			
3. Dutch syntactic proficiency score	0.65***	0.85***	–		
4. Greek lexical proficiency score	-0.78***	-0.38	-0.34	–	
5. Greek syntactic proficiency score	-0.71***	-0.47*	-0.34	0.79***	–

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

3.2.2. Materials

3.2.2.1. Lexical Decision

The lexical decision stimuli consisted of 108 Greek words and 108 pseudowords. The real words were nouns selected from word lists for young Dutch children (Dunn et al., 2005; Mulder et al., 2009; Schlichting & Lutje Spelberg, 2002; Zink & Lejaegere, 2002) and translated into Greek, with a reported age of acquisition (AoA) below 8;0 (Brysbaert et al., 2014).[8] The pseudowords were taken from Revithiadou and Lengeris (2016) and followed Greek phonotactics and stress patterns.

The real words included 36 cognates, 36 matched noncognates, and 36 fillers. The noncognates were matched to the cognates based on frequency (Dimitropoulou et al., 2010), AoA (Brysbaert et al., 2014), concreteness (Brysbaert et al., 2014), onset phoneme category, and length (in syllables) (ps > .05). The fillers were non-matched noncognate words.

Items were divided into eight blocks: four consisting of 30 items (five cognates, five matched noncognates, five fillers, and 15 pseudowords) and four of 24 items (four cognates, four matched noncognates, four fillers, and 12 pseudowords). Each block was preceded by four practice items (one cognate, one noncognate, and two pseudowords), except for two 30-item blocks, which were preceded by twelve practice items (three cognates, three noncognates, and six pseudowords). These two blocks were each administered as the first block in a testing session (see Procedure).

Block-internal stimulus order was pseudorandomized for each participant, with no more than two subsequent trials from the same condition.

[8] This large-scale AoA database only includes Dutch words. Although using Greek translations does not account for phonological aspects that may affect word acquisition, semantic and cultural aspects are likely relatively well accounted for, as most children were growing up in the Netherlands.

All individual stimulus order lists were checked manually for form or meaning overlap between subsequent trials, to avoid unwanted interactions with phonological or semantic priming. In addition to the matching between cognates and noncognates, we also checked that the different blocks and sessions did not differ from each other in terms of cognate frequency, AoA, onset phoneme category, and length (*p*s > .05).

All (pseudo)words were recorded by a female native speaker of Greek.

3.2.2.2. Picture Naming

The picture naming stimuli consisted of 144 full-color drawings, depicting various objects. The target words corresponding to these pictures (36 cognates, 36 matched noncognates, and 72 fillers) were selected and matched using the same criteria as the lexical decision task, but different words were used in the two tasks. Pictures were selected from Multipic (Duñabeitia et al., 2018) and Rossion and Pourtois (2004), complemented with clip-art images in similar styles if no suitable option was available. All pictures were pre-tested for naming consistency by adult native speakers of Greek and adapted if necessary.

The 144 pictures were divided over four blocks of 36 items, each containing nine items with cognates as target words, nine with matched noncognates as target words, and 18 fillers. Each block was preceded by four practice items: two cognates and two noncognates. Block-internal stimulus order randomization and block matching were performed in the same way as in the lexical decision task.

3.2.3. Procedure

All children were tested individually, while at home, over two sessions one to three weeks apart. Testing took place online using Radboud Online Linguistic Experiment Generator (ROLEG), an in-house online platform.[9]

[9] Because of COVID-19-related restrictions, testing could not take place face-to-face.

After signing informed consent forms, caregivers received a link to access the experiments via a browser. They were instructed to help the child set up, but leave the room as soon as the experiment was running. Instructions for all tasks were embedded in short animation videos shown in the experiments. An experimenter was also present via a video call to give feedback and additional instructions where needed.

The two sessions were conducted by two different experimenters. Because the data in this study were collected as part of a larger project into not only cognate effects, dominance, and task demands, but also language context, the experimenters spoke different languages: The experimenter in the first session was a native speaker of Greek, and the experimenter in the second session was a native speaker of Dutch. The target language of the main tasks in both sessions was Greek. The instructional videos used the same language as the experimenter of the session. However, because of the relatively small Dutch-Greek sample and relatively high data loss (see Data Exclusion), language context was ultimately not included in the present study. Information on how we checked for potential confounds with language context is given under Language Context.

Stimuli were distributed across sessions, each containing four lexical decision blocks and two picture naming blocks. A lexical decision trial started with a 50 ms beep and 250 ms pause[10], after which the item was played. Participants responded by pressing a key on their keyboard: For real Greek words, a key on the side of their dominant hand had to be pressed, and for pseudowords, a key on the side of their non-dominant hand had to be pressed. These keys were labeled with stickers: a smiley face for real words and a frowny face for pseudowords. A new trial started after a keypress. Accuracy and reaction times (RTs) were recorded in ROLEG.

A picture naming trial also started with a 50 ms beep sound, followed by a 250 ms pause. Subsequently, the image appeared on the screen for participants to name in Greek. After 2000 ms, the image disappeared and a new trial started. Accuracy and RTs were obtained from audio recordings (see

[10] Exact timing differed depending on participants' computer and internet connection.

Scoring), which were made on a separate recording device in the participant's home.

To increase children's engagement and motivation, the tasks were embedded in an overarching story, told through the instructional videos. There were two stories: In one story, an inventor was trying to fix a talking robot, and in the other, aliens were trying to speak with an astronaut who visited their planet. In the lexical decision blocks, children were asked to check if the robot or alien was saying words correctly in Greek, and in the picture naming blocks their task was to teach the robot or alien new Greek words. Which story was told in which session was counterbalanced between participants. Proficiency tasks and other background tasks were administered between the blocks containing the main tasks and were also embedded in the overarching story. Each testing session lasted approximately 60-70 minutes.

3.2.4. Scoring

While accuracy and RTs were automatically recorded for the lexical decision task, the picture naming data were scored manually. Audio recordings of the picture naming task were annotated by a native speaker of Greek, who labeled the onset of the beeps, which served as auditory markers of stimulus onset, and of the participants' responses in Praat (Boersma & Weenink, 2022). The time between beep onset and response onset was the RT. A subset of data (10% of participants) was annotated by a second scorer. Inter-rater reliability was 0.82, indicating excellent agreement between the scorers (Hallgren, 2012).

Picture naming accuracy was based on transcriptions from the same scorers, following a lenient scoring scheme and a strict scoring scheme. Lenient scores were used in accuracy analysis and for participant and target word exclusion in RT analysis; strict scores were used for RT analysis (see Analysis and Data Exclusion). In the lenient scoring scheme, a response was scored as correct if it contained the target word or a derived form such as a plural or diminutive.[11] Late responses, after the beep indicating the start of the next trial,

[11] For two matched noncognates, the target word was changed post-hoc. Because the intended target word was never produced, but many children used a

were also scored as correct under the lenient scoring scheme. Cognates that were pronounced in the non-target language (e.g., *kangoeroe* /ˈkɑnχəru/ instead of *καγκουρό* /kaŋguˈɾo/) were coded as 'other', that is, they were excluded from lenient accuracy scores. In the strict scoring scheme, false starts and late responses were scored as incorrect (i.e., they were excluded from RT analysis; see Data Exclusion), as RTs for these responses would not be valid. Non-target language pronunciations of cognates were also scored as incorrect under the strict scoring scheme.

3.2.5. Analysis

Accuracy scores and RTs of both tasks were analyzed separately. Accuracy was analyzed with mixed effects logistic regression models, and RTs were analyzed with linear mixed effects models, using the glmer and lmer functions respectively from the lme4 package version 1.1-27.1 (Bates et al., 2015). RTs were log-transformed, approaching a normal distribution (Baayen & Milin, 2010). In the RT models, *p*-values were obtained using Type 2 conditional *F*-tests with Kenward-Roger approximation for degrees of freedom as implemented in the Anova function of the package car (Fox & Weisberg, 2019). Orthogonal sum-to-zero contrast coding was applied to *Cognate Status*. *Percentage Dutch Exposure* was mean-centered.

All models contained the predictors *Cognate Status* and *Percentage Dutch Exposure*, interactions between these predictors, and random intercepts for *Participant* and *Target Word*. Next, task-related covariates, known to influence response outcomes (e.g., Lemhöfer et al., 2008), namely *Trial Number, Previous Trial Accuracy*, and *Previous Trial logRT* were added to the models in a stepwise manner as a control. Only those covariates that significantly

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synonym, the synonym was scored as correct. A third matched noncognate was swapped with a filler, because the picture was unclear to most children. These changes did not affect matching between cognates and matched noncognates; see http://tinyurl.com/EKChapter3OSF.

improved the model were included, as was established through Likelihood Ratio Tests using the anova function in the base package (R Core Team, 2020).

3.3. Results

3.3.1. Data Exclusion

3.3.1.1. Lexical Decision

Lexical decision data were available for all 27 children. First, responses with RTs below 700 ms or above 2200 ms were excluded from both accuracy and RT analysis. This resulted in exclusion of 9.5% of all responses or 8.3% of correct responses. The rate of exclusions may be higher than what is typically considered normal, due to the testing circumstances. We chose relatively strict limits based on visual inspection of the data, to counteract the noisiness of the raw data: Stimuli were presented online, with timing differences depending on participants' computer and internet connection. As such, responses that were visibly faster or slower than the majority were deemed more likely to reflect measurement errors. Next, participants with accuracy scores below 80% on pseudowords were excluded (n = 5), as this indicated that they had a bias for 'yes'-responses. For RT analysis only, we excluded participants with accuracy scores below 80% on cognates and matched noncognates (n = 5), and items with mean accuracy below 80% (n = 13, six cognates). Item exclusion did not affect the matching between cognates and noncognates (ps > .05). Next, for RT analysis, all remaining incorrect responses were excluded. Finally, for both accuracy analysis and RT analysis, we calculated mean RTs per participant per testing session based on their remaining trials, and excluded responses above or below 2.5 SD of this participant mean (1.9% for accuracy analysis; 2.1% for RT analysis), leaving a total of 1322 trials (22 participants) in the final dataset for accuracy analysis and 827 trials (17 participants) for RT analysis.

3.3.1.2. Picture Naming

Because we did not receive audio recordings from all children, picture naming data were available for 23 out of the 27 tested children. For the accuracy analysis, data was excluded for children who responded in fewer than 50% of trials (n = 12), because it was not clear if these low response rates were caused by technical issues, by lack of understanding the task or by lack of knowing the word. As such, these children's accuracy rates based on given responses may be misleading. This left a total of 695 trials (11 participants) in the final dataset for accuracy analysis. For the RT analysis, we first excluded responses from all 23 available participants if RTs were faster than 1300 ms or slower than 2800 ms. This resulted in exclusion of 16.7% of correct trials. Similar to lexical decision, data exclusion was based on visual inspection of the data, for the same reasons. A further complication for this task was that the RTs were calculated using audio recordings made on different devices and under different circumstances, which may have inflated the rate of measurement error. While this meant that for this task in particular, there was likely a loss of statistical power, we prioritized careful consideration of the data and filtering out as much noise as possible over maximizing the number of observations. After excluding individual data points, participants with (lenient) accuracy scores below 70% of their given responses on cognates and matched noncognates were excluded from analysis (n = 4), as well as items with mean (lenient) accuracy below 50% of given responses (n = 4). Item exclusion did not affect the matching between cognates and noncognates (ps > .05). Next, all remaining responses that were incorrect under the strict scoring scheme were excluded. Finally, we calculated mean RTs per participant per testing session based on their remaining trials, and excluded responses above or below 2.5 SD of this participant mean (0.4%), leaving 486 trials (19 participants) in the final dataset for RT analysis.

3.3.1.3. Language Context

Because we collapsed data from two sessions that differed in language of communication (language context), the data were checked for potential confounds. Specifically, after excluding data following the criteria outlined above, we checked whether potential effects of *Percentage Dutch Exposure* or *Cognate Status* may be confounded with effects of language context. For *Cognate Status*, there were no differences between the number of included observations per condition per context (lexical decision accuracy: $\chi^2(1) = 0.17$, $p = .68$; lexical decision RTs: $\chi^2(1) = 1.19$, $p = .27$; picture naming accuracy: $\chi^2(1) = 0.001$, $p = .97$; picture naming RTs: $\chi^2(1) = 0.42$, $p = .52$). As such, we had no reason to believe that potential effects of *Cognate Status* would be confounded with any language context effects.

Regarding *Percentage Dutch Exposure*, we found differences between the two contexts in the number of observations included per child (lexical decision accuracy: $\chi^2(21) = 74.09$, $p < .001$; lexical decision RTs: $\chi^2(16) = 32.33$, $p = .009$; picture naming accuracy: $\chi^2(10) = 35.05$, $p < .001$; picture naming RTs: $\chi^2(18) = 48.13$, $p < .001$). Additional t-tests revealed no differences between contexts in terms of *Percentage Dutch Exposure* for lexical decision accuracy ($t(1311) = -0.41$, $p = .68$), lexical decision RTs ($t(787.41) = -0.55$, $p = .58$), and picture naming RTs ($t(404.21) = -1.31$, $p = .19$). As such, we had no reason to believe that potential effects of *Percentage Dutch Exposure* would be confounded with language context. In picture naming accuracy, however, average *Percentage Dutch Exposure* was lower in the single-language context, where the experimenter spoke Greek, than in the dual-language context, where the experimenter spoke Dutch ($t(690.63) = -3.22$, $p = .001$). Because of this difference, we repeated the analysis for picture naming accuracy including *Language Context* as a covariate. This did not change the general outcomes (see Appendix C in comparison with Picture Naming Results).

3.3.2. Lexical Decision Results

Descriptive lexical decision results per condition for children with higher and lower percentages of Dutch exposure (based on a median split, for illustrative purposes) are presented in Table 3.3.

Table 3.3. Mean lexical decision accuracy and reaction times in milliseconds (standard deviations between parentheses) per condition, for children with higher and lower percentages of Dutch exposure.

	Accuracy	Reaction Times
Cognates	0.86 (0.35)	1206 (260)
- Higher Dutch exposure	0.86 (0.35)	1205 (239)
- Lower Dutch exposure	0.86 (0.35)	1208 (278)
Noncognates	0.86 (0.34)	1203 (288)
- Higher Dutch exposure	0.80 (0.40)	1204 (276)
- Lower Dutch exposure	0.92 (0.26)	1203 (299)

The best-fitting models for accuracy and RTs on the lexical decision task are presented in Table 3.4. The accuracy analysis revealed a main effect of *Percentage Dutch Exposure*, as well as an interaction between *Cognate Status* and *Percentage Dutch Exposure*. As illustrated in Figure 3.2, *Percentage Dutch Exposure* had a stronger effect on noncognate accuracy than on cognate accuracy. As such, the more Dutch-dominant children were, the stronger the cognate facilitation effect that emerged. For more balanced or Greek-dominant children, accuracy on cognates was lower than accuracy on noncognates.

The RT analysis revealed no significant effects.

Figure 3.2. Interaction between *Percentage Dutch Exposure* and *Cognate Status*.

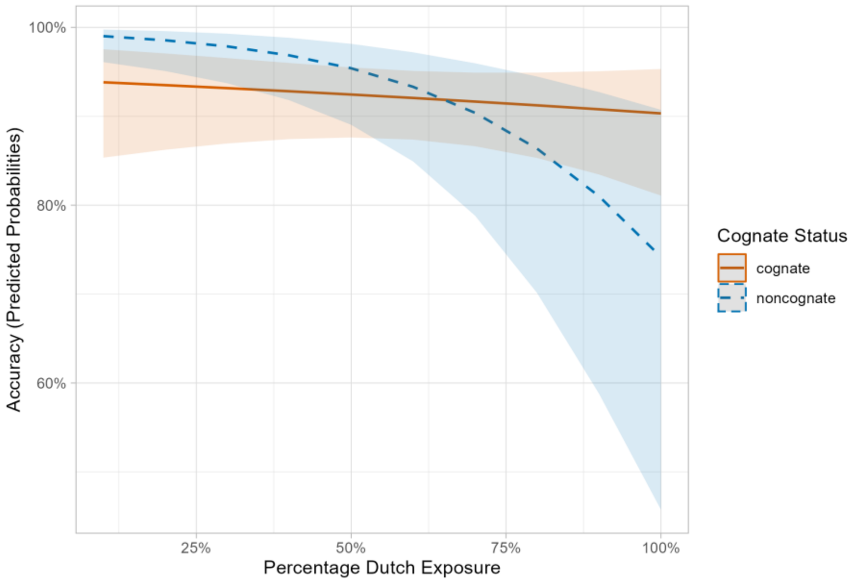


Table 3.4. Parameter estimates and significance tests of accuracy and reaction times in the lexical decision task.

	Accuracy				
Predictor	*B*	*SE*	*z*	*p*	
(Intercept)	2.574	0.264	9.765	< .001	
Cognate Status	-0.232	0.390	-0.594	.552	
Percentage Dutch Exposure	-2.247	0.790	-2.843	.004	
Percentage Dutch Exposure x Cognate Status	3.412	0.851	4.011	< .001	
	Reaction Times				
	Parameter estimates		Significance tests		
Predictor	*B*	*SE*	*F*	*df*	*p*
(Intercept)	7.075	0.022			
Cognate Status	0.007	0.016	0.174	1,56.2	.678
Percentage Dutch Exposure	0.037	0.094	0.146	1,14.9	.707
Percentage Dutch Exposure x Cognate Status	0.029	0.062	0.218	1,764.2	.641

3.3.3. Picture Naming Results

Descriptive picture naming results per condition for children with higher and lower percentages of Dutch exposure (based on a median split, for illustrative purposes) are presented in Table 3.5.

Table 3.5. Mean picture naming accuracy and reaction times (standard deviations between parentheses) per condition, for children with higher and lower percentages of Dutch exposure.

	Accuracy	Reaction Times
Cognates	0.87 (0.33)	1945 (342)
- Higher Dutch exposure	0.79 (0.41)	1927 (347)
- Lower Dutch exposure	0.94 (0.25)	1967 (335)
Noncognates	0.85 (0.36)	2071 (337)
- Higher Dutch exposure	0.70 (0.46)	2053 (340)
- Lower Dutch exposure	0.93 (0.25)	2084 (335)

The final models for the picture naming data are presented in Table 3.6. The accuracy analysis revealed a main effect of *Percentage Dutch Exposure*: Children responded more accurately if they received less Dutch (i.e., more Greek) exposure. The RT analysis revealed a main effect of *Cognate Status*, where cognates were named more quickly than noncognates.

Table 3.6. Parameter estimates and significance tests of accuracy and reaction times in the picture naming task.

	Accuracy				
Predictor	*B*	*SE*	*z*	*p*	
(Intercept)	2.536	0.471	5.386	< .001	
Cognate Status	0.353	0.511	0.691	.489	
Percentage Dutch Exposure	-4.484	1.723	-2.602	.009	
Percentage Dutch Exposure x Cognate Status	2.070	1.576	1.314	.189	
	Reaction Times				
	Parameter estimates		Significance tests		
Predictor	*B*	*SE*	*F*	*df*	*p*
(Intercept)	7.586	0.023			
Cognate Status	-0.058	0.019	9.523	1,62.4	.003
Percentage Dutch Exposure	-0.040	0.095	0.206	1,16.2	.656
Percentage Dutch Exposure x Cognate Status	-0.028	0.056	0.252	1,448.6	.616

3.4. Discussion

In this study, we investigated to what extent cognate facilitation effects are robust across tasks and in children with differing degrees of language dominance. We aimed to build upon earlier evidence for an integrated lexicon in simultaneous bilingual children, by testing for effects of co-activation of cognate members in both comprehension and production, in tasks with different task demands, while taking individual differences in language dominance into account.

Primary-school-aged Dutch-Greek simultaneous bilinguals performed two Greek cognate processing tasks, namely an auditory lexical decision task and a picture naming task. As predicted, cognates were processed with more ease than noncognate control words in both tasks, although these cognate effects manifested themselves in different ways. In lexical decision, there was an effect in accuracy, in interaction with children's language dominance. In picture naming, cognate facilitation emerged in reaction times and we found no influence of children's language dominance, although there was a main effect of dominance on accuracy in both tasks. In the next sections, we first discuss our findings separately for each task, before comparing the results and demands of the two tasks.

3.4.1. Lexical Decision

Our findings for children's accuracy on the auditory lexical decision task were largely in line with our hypotheses. Overall, accuracy was higher for children with less Dutch (i.e., more Greek) exposure. The correlations between exposure and Greek lexical proficiency in this study (see Table 3.2) suggest that children with more Greek exposure had larger Greek lexicons, and Greek words had higher resting-level activation, in line with BIA+ (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019). Importantly, for strongly Dutch-dominant children, language exposure and cognate status interacted as predicted by these models: Dutch-dominant children responded more accurately to cognates than to noncognates, and this cognate facilitation effect increased with percentage of Dutch exposure. This indicates that they were able to use their Dutch knowledge in a Greek comprehension task and suggests that shared sub-lexical and semantic representations lead to increased activation of cognate word forms. Specifically, it suggests that both the Greek target word form representation and the Dutch translation of the target word became co-activated because of their correspondence to the auditory input. The Greek target was further activated by activation resonating from the Dutch word form via their shared sub-lexical and semantic representations, leading to more accurate comprehension. Importantly, the higher the resting-level activation of Dutch words, the more easily these words became (co-)activated and the more influence they exerted during the processing of Greek words. This resulted in stronger cognate facilitation, similar to previous studies on bilingual children (Bosma et al., 2019; Bosma & Nota, 2020; Poarch & van Hell, 2012; Singh, 2014) and adults (e.g., Muntendam et al., 2022; van Hell & Dijkstra, 2002; van Hell & Tanner, 2012).

In contrast, more balanced or Greek-dominant children tended to respond less accurately to cognates than to noncognates. Such negative cognate effects may result from inhibition at the Task/Decision subsystem of the lexicon, as in Brenders et al. (2011). In their lexical decision study with child second language learners, Brenders and colleagues (2011) found negative cognate effects triggered by the presence of false friends, that is, words that share their forms but not their meanings across languages. Apparently, the processing of such ambiguous word forms led to competition between responses, which extended to the processing of cognates. Negative effects have also been found in studies examining between-language interactions in morphosyntax. For example, in a study by van Dijk (2021; van Dijk et al., 2022), Turkish-Dutch simultaneous bilingual children processed ambiguous sentences, whose preferred interpretation differed between Dutch and Turkish. In Dutch sentence processing, the more Turkish-dominant children were, the more they inhibited the Turkish-like interpretation. In our study, similar competition and inhibition processes appear to have occurred, possibly caused by language distance. Like Dutch and Turkish (in van Dijk, 2021; van Dijk et al., 2022); see also Muntendam et al., 2022), Dutch and Greek are not closely related and do not share many cognates. As such, Dutch-Greek children do not often directly benefit from their Dutch lexical knowledge when processing Greek and may generally inhibit responses triggered by the activation of Dutch representation (see also Green & Abutalebi, 2013; Radman et al., 2021). This response inhibition would then result in similar behavior as in Brenders et al. (2011).

In sum, in lexical decision, cognate effects emerged either as facilitation in accuracy (in children's non-dominant language) or as inhibition (in children's more dominant language). Both types of effects suggest that, in cognate comprehension, the two similar word forms become active and interact with each other. The consequences of this interaction depend on the children's language dominance, but both facilitatory and inhibitory cognate effects are likely to result from an integrated lexicon with language-nonselective processing. In contrast to accuracy, children's reaction times revealed no cognate facilitation effects. The differences between accuracy and reaction times in this study may be explained as a combined consequence of participant sample characteristics and task demands – a point we return to after our discussion of the picture naming results.

3.4.2. Picture Naming

Corroborating our findings from lexical decision accuracy, cognate effects emerged in picture naming reaction times: In trials where children named the picture correctly, they did so more quickly when it was a cognate than when it was a noncognate. This supports the assumption that the same representations are activated in similar ways in production as in comprehension, and is in line with our hypotheses and with previous child studies (e.g., Poarch & van Hell, 2012) and adult studies (e.g., Costa et al., 2000; Hoshino & Kroll, 2008). In addition, as in lexical decision, there was a main effect of language dominance on picture naming accuracy: The more Greek-dominant children were, the more often they correctly named the picture, indicating that increased Greek exposure led to a more developed Greek vocabulary and higher resting levels of activation of Greek words in the lexicon.

Contrary to our predictions, and differently from what we found for comprehension, the cognate facilitation effect in picture naming was not influenced by language dominance. In addition, there were no cognate effects in picture naming accuracy, unlike in previous studies (e.g., Poarch & van Hell, 2012). We discuss the differences between lexical decision and picture naming regarding dominance effects and regarding accuracy and reaction time effects in the next section.

3.4.3. Task Comparison

The finding of cognate effects across two quite different tasks in different modalities suggests that such effects are robust in the simultaneous bilingual child's lexicon, similar to the (usually sequential) bilingual adult's lexicon. Nevertheless, there were differences between the outcomes for comprehension and production, even though they were conducted with the same participants and contained comparable target words. This suggests that our findings were influenced by task demands. An important difference between the two tasks is to what extent a fully specified mental representation of an item is required in order to respond successfully. A "good enough" representation of a word form will often still result in correct comprehension, but not in correct production – a difference that is exaggerated in the lexical decision task and picture naming task. For example, if a participant does not know if the Greek word for 'fox' is /ale'pu/ or /ane'pu/, they would likely still be able to respond correctly to it in lexical decision, whereas in a task like picture naming, the word must be produced completely and correctly. As such, for the picture naming task, we only analyzed trials in which a response was given, and only responses with target-like pronunciation were scored as correct. For these well-acquired words, accuracy was high (see Table 3.5), possibly not leaving much room for further improvement: Additional activation coming from cognate translation equivalents did not have a significant effect on accuracy. Although it did affect RTs, the lack of interaction with dominance again suggests that there was not enough room to further improve processing speed.

Our lexical decision results, on the other hand, provide insight into the processing of a wider range of words. It is likely that not all Greek target words were equally familiar to the children and consequently not all responses were equally certain, especially as, on average, the children in our sample had higher proficiency scores and received more exposure in Dutch than in Greek (see Table 3.1). As such, there was more space for additional activation from cognate translation equivalents to improve accuracy, depending on individual differences in dominance. In principle, we would have expected the same processes to have an effect on children's RTs, as in e.g., Brenders et al. (2011), but we found no significant effects in our study. Interestingly, differences between outcome measures have been found in previous studies as well. For example, in their lexical decision with German-English bilinguals, Schröter and Schroeder (2016) found differences between accuracy and reaction time patterns in German, which was the societal and likely dominant language, but not in English. Their findings suggest that language dominance modulated the extent to which cognate effects occurred in accuracy or in RTs. Our findings further suggest that such differences may be modulated by both dominance and task demands, in line with de Groot et al. (2002).

These complex interactions between various task-related factors and sample characteristics also potentially explain inconsistent findings regarding language dominance from previous studies with simultaneous bilingual children. In addition to differences between participant samples, whether dominance effects occur may be the result of differences in stimuli and exact task demands.

Although we used a large number of items in both tasks in the present study, our sample size was limited and the fact that data was collected online unfortunately contributed to further data loss. Future studies with larger samples and/or more controlled lab settings are needed to reach a more detailed understanding of the interplay between item (e.g., cognate) effects, dominance effects, and task effects in the simultaneous bilingual child's lexicon.

3.4.4. Conclusion

The present findings support models of an integrated bilingual lexicon with language-nonselective access in a similar way to what has been found for bilingual adults and in line with an emerging body of evidence with bilingual children. The present study therefore builds on evidence from earlier toddler, child, and adult studies, suggesting that simultaneous and sequential bilinguals do not have qualitatively different lexicons and showing that bilinguals have an integrated lexicon at multiple – and possibly all – stages of development. In such a lexicon, activation resonates between shared (sub-lexical) form and meaning representations, resulting in cognate effects in both comprehension and production.

The present study is one of the few child studies looking into such effects in simultaneous bilingual children speaking less closely-related languages, testing for cognate effects in auditory comprehension, and including both cognate comprehension and production. Our results suggest that, similar to what has been found for adults, the manifestation of cognate effects is task-sensitive, that is, task demands influence whether effects emerge in accuracy or reaction times and to what extent they are affected by dominance. Importantly, despite such differences, our results show that cognate effects emerge across tasks and across a range of individual children's language dominance, indicating that shared representations within the integrated bilingual lexicon are accessed during both word comprehension and production.

Appendix C

Parameter estimates of accuracy in the picture naming task, with *Language Context* as a covariate.

Predictor	*B*	*SE*	*z*	*p*
(Intercept)	2.542	0.472	5.384	< .001
Cognate Status	0.354	0.511	0.693	.488
Percentage Dutch Exposure	-4.499	1.726	-2.607	.009
Language Context	0.109	0.503	0.217	.828
Percentage Dutch Exposure x Cognate Status	2.087	1.578	1.323	.186

Chapter 4: Cognate Facilitation in Single- and Dual-Language Contexts in Bilingual Children's Word Processing

Abstract

We examined the extent to which cognate facilitation effects occurred in simultaneous bilingual children's production and comprehension and how these were modulated by language dominance and language context. Bilingual Dutch-German children, ranging from Dutch-dominant to German-dominant, performed picture naming and auditory lexical decision tasks in single-language and dual-language contexts. Language context was manipulated with respect to the language of communication (with the experimenter and in instructional videos) and by means of proficiency tasks. Cognate facilitation effects emerged in both production and comprehension and interacted with both dominance and context. In a single-language context, stronger cognate facilitation effects were found for picture naming in children's less dominant language, in line with previous studies on individual differences in lexical activation. In the dual-language context, this pattern was reversed, suggesting inhibition of the dominant language at the decision level. Similar effects were observed in lexical decision. These findings provide evidence for an integrated bilingual lexicon in simultaneous bilingual children and shed more light on the complex interplay between lexicon-internal and lexicon-external factors modulating the extent of lexical cross-linguistic influence more generally.

Based on: Koutamanis, E., Kootstra, G. J., Dijkstra, T., Unsworth, S. (2023). Cognate Facilitation in Single- and Dual-Language Contexts in Bilingual Children's Word Processing. *Linguistic Approaches to Bilingualism*. https://doi.org/10.1075/lab.23009.kou

4.1. Introduction

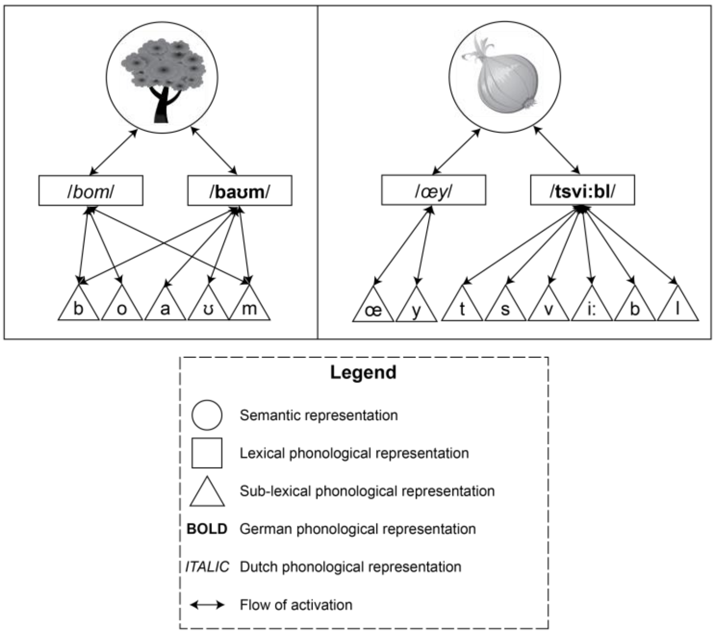
Cognates – translation equivalents with similar word forms (e.g., German *Baum* 'tree' and Dutch *boom* 'tree') – are known to be processed faster by bilinguals than noncognates (e.g., German *Zwiebel* 'onion' and Dutch *ui* 'onion'), both in production and in comprehension. This cognate facilitation effect, like other forms of lexical cross-linguistic influence, is considered evidence that bilinguals have one integrated lexicon containing words from both languages (e.g., Dijkstra & van Heuven, 2018). This view of the bilingual lexicon is commonly accepted for adults, and emerging evidence suggests that the same processes occur in simultaneous bilingual children (e.g., Bosma & Nota, 2020; Duñabeitia et al., 2016; Koutamanis et al., Chapter 3; Poarch & van Hell, 2012; Schröter & Schroeder, 2016).

Studies with bilingual adults have shown that cognate effects are modulated by factors like language dominance and language context (e.g., Elston-Güttler et al., 2005; Muntendam et al., 2022; Poort & Rodd, 2017; van Hell & Dijkstra, 2002; van Hell & Tanner, 2012). It is not clear to what extent these factors influence performance in simultaneous bilingual children: Whilst dominance is often included in child studies, not much is known about the role of language context or interactions between these factors. The present study examines to what extent language dominance and language context influence word processing in simultaneous bilingual children.

4.1.1. The Bilingual Lexicon

With respect to word representation, most models assume that the bilingual lexicon is integrated. This means that word meaning representations and word forms from both languages are stored in one, interconnected system (e.g., Dijkstra et al., 2019; Dijkstra & van Heuven, 2002). Words from both languages may share representations if there is semantic, phonological, and/or orthographic overlap. For example, translation equivalents are often modeled to share their semantic representation (Dijkstra et al., 2019; Dijkstra & van Heuven, 2002; Shook & Marian, 2013) and cognates additionally share certain form representations. Following the Bilingual Interactive Activation plus (BIA+) model (Dijkstra & van Heuven, 2002), we assume that cognates share some of their phonemic (i.e., sub-lexical phonological) or graphemic (i.e., sub-lexical orthographic) representations[12]; see Figure 4.1.

Figure 4.1. Representation and flow of activation in an integrated Dutch-German bilingual lexicon of a cognate (left) and a noncognate translation pair (right).



In word processing, the integrated bilingual lexicon is accessed in a language-nonselective manner (e.g., Dijkstra & van Heuven, 2002; Kroll et al., 2006). This implies that representations may become activated, irrespective of the language they belong to, and that words from both languages can become co-activated if there is enough form and/or meaning overlap. For example,

[12] The successor to the BIA+ model, Multilink (Dijkstra et al., 2019), does not specify sub-lexical representations. Instead, lexical representations are directly (co-)activated from the input.

when a Dutch-German bilingual hears the Dutch word *boom*, the corresponding phonemes are activated. As these are largely shared between *boom* and *Baum*, both word form representations become co-activated; see Figure 4.1. Similarly, in production, activation of the shared semantic representation (tree) leads to co-activation of the two connected word forms.

Importantly, co-activation is not limited to cognates, but also occurs when words have only form overlap (e.g., German *Winkel* 'angle' and Dutch *winkel* 'store') or meaning overlap (e.g., *Zwiebel* 'onion' and *ui* 'onion'). For the cognate facilitation effect to occur, a final assumption is required, namely that activation resonates (i.e., flows back and forth) between form and meaning representations (e.g., Dijkstra & van Heuven, 2002). As cognates share multiple representations, this resonance reinforces their activation levels, leading to cognates being activated more quickly than noncognates. Indeed, many studies, especially with adults, have found cognates to be processed more quickly than noncognates in production (e.g., Costa et al., 2000; Kroll et al., 2006) and comprehension (e.g., Dijkstra et al., 2010; Lemhöfer et al., 2004).

In children, the organization of and processing in the bilingual lexicon has historically been studied less. More recently, however, several studies have found cognate facilitation effects in simultaneous bilingual children (Bosma et al., 2019; Bosma & Nota, 2020; Duñabeitia et al., 2016; Koutamanis et al., Chapter 3; Poarch & van Hell, 2012; Schröter & Schroeder, 2016). For example, Poarch and van Hell (2012) conducted picture naming tasks with German-English bilingual children and found that pictures depicting cognates were named more quickly and accurately than noncognates, in both languages. Other studies found similar cognate facilitation effects in bilingual children's comprehension, namely word recognition (Duñabeitia et al., 2016; Schröter & Schroeder, 2016), receptive vocabulary (Bosma et al., 2019), and sentence reading (Bosma & Nota, 2020).

More evidence for an integrated lexicon with language-nonselective access in simultaneous bilingual children comes from between-language lexical priming studies (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Koutamanis et al., Chapter 2; Singh, 2014; Von Holzen & Mani, 2012). In such studies, children are presented with a sequence of two (noncognate) words, one from each of their languages, and the relationship between the words is manipulated. For example, several studies found that words were processed faster when preceded by their translation equivalent compared to an unrelated word (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Koutamanis et al., Chapter 2), thus providing evidence for an integrated lexicon. Hearing the first word pre-activated the corresponding form and meaning representations. As translation equivalents share semantic representations, activation then resonated to the corresponding word form representation in the other language. When this second word was subsequently presented to the children, its increased activation facilitated processing.

In sum, evidence from both children and adults supports the view that that the bilingual lexicon is integrated, containing representations of words from both languages in one interconnected system. Access to the integrated bilingual lexicon is assumed to be inherently language-nonselective. In the next section, we discuss how the strength of resulting effects can be modulated by language dominance.

4.1.2. Language Dominance

Language dominance refers to the relative prominence of a language in an individual bilingual speaker. It is often operationalized using a relative proficiency or exposure measure, in a categorical (e.g., Dutch-dominant vs. German-dominant) or continuous (e.g., more Dutch-dominant to more German-dominant) manner. A continuous view on dominance is in line with models of the bilingual lexicon such as BIA+ (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019). According to these models, the more frequently a person is exposed to a specific word, the higher the resting-level activation of the corresponding representations. Words with higher resting-level activation are more easily (co-)activated and therefore exert more influence over the processing of other words. Extrapolated to the language level, the more exposure to a particular language a bilingual receives, the higher the resting-level activation of the words from that language and the more influence these words have on the processing of words from the non-dominant language.

Returning to our earlier example, if a German-dominant bilingual hears the Dutch word *boom* 'tree', the level of activation of the co-activated *Baum* 'tree' will be high and will strongly reinforce the activation of *boom*. In contrast, for a Dutch-dominant bilingual, the activation of *Baum* will remain relatively low, with less activation resonating between representations, and ultimately little to no effect of *Baum* on the processing of *boom*. Indeed, many studies with adults (e.g., Muntendam et al., 2022; van Hell & Dijkstra, 2002; van Hell & Tanner, 2012) and children (Bosma et al., 2019; Bosma & Nota, 2020; Poarch & van Hell, 2012; Singh, 2014) have found stronger effects in speakers' non-dominant language than in their dominant language. In addition to such lexicon-internal processes, the cognate facilitation effect may be influenced by lexicon-external factors, such as language context.

4.1.3. Language Context

According to Green and Abutalebi (2013), naturalistic interactions often take place in one of three types of language context: single-language, dual-language, and dense codeswitching. In single-language contexts, only one language is used, for instance because the interlocutor is monolingual. Dual-language contexts may occur when a bilingual has multiple interlocutors speaking different languages and therefore frequently switches languages depending on the addressee. Dense codeswitching contexts, in which there is frequent and free switching, may occur when all interlocutors understand the same multiple languages.

Language context affects bilinguals' language processing. For example, dual-language contexts are cognitively demanding for bilingual adults, as they involve multiple cognitive control processes, such as interference suppression and selective response inhibition (Green & Abutalebi, 2013; see e.g., Misra et al., 2012). Similarly, Gross and Kaushanskaya (2020) found effects of language context, modulated by several cognitive control abilities, in Spanish-English bilingual children between four and seven years old. Children with lower cognitive control abilities had more difficulty in maintaining the target language in interactions in dual-language contexts than in single-language contexts, producing more codeswitches and blends (see also Gross & Kaushanskaya, 2018).

Language context effects have been found to interact with dominance (see e.g., Bobb & Wodniecka, 2013, for a review). For example, in dual-language contexts, inhibiting a dominant language and then again overcoming this inhibition has been argued to be especially cognitively demanding, leading to longer processing times when switching from a non-dominant language to a dominant language than the other way around (see e.g., Bobb & Wodniecka, 2013; Misra et al., 2012; but see Gade et al., 2021, for a meta-analysis not finding robust evidence for such effects). It has also been suggested that a dominant language may be more globally inhibited depending on task and context (e.g., Gollan & Ferreira, 2009; Gross & Kaushanskaya, 2015).

Using a different perspective on language context, studies have also found effects on the strength of cognate facilitation (e.g., Brenders et al., 2011; Poort & Rodd, 2017). These studies manipulated the stimulus list composition, that is, which languages are used as stimuli. According to the BIA+ model (Dijkstra & van Heuven, 2002), stimulus list composition influences later stages of word processing. After words have been activated in the lexicon, they are further processed by the Task/Decision subsystem to create a task-appropriate response (Dijkstra & van Heuven, 2002). For example, in a single-language lexical decision task, the appropriate response would be 'yes' to a real word and 'no' to a pseudoword. If the stimulus list also contains words from the non-target language, the Task/Decision subsystem adapts: In this case, the response would be 'yes' to a target-language word and 'no' to a non-target-language word. Interestingly, Poort and Rodd (2017) found that, after encountering a non-target-language word, bilingual adults responded more slowly to cognates than to noncognates. Similarly, Brenders et al. (2011) found that child second-language learners processed cognates faster than noncognates, but not when the stimulus list included interlingual homographs ('false friends'). Apparently, in the presence of non-target-language words and/or interlingual homographs, more processing time is needed to decide to which language cognates belong and which response is required.

Stimulus list composition may be viewed as a more local operationalization of language context, which could provide insights into the mechanisms behind the more global language context effects as in Gross and Kaushanskaya (2020). However, whilst Green and Abutalebi's (2013) view on language context was developed around language production in naturalistic interactions, studies into stimulus list composition have mostly involved (cognate and/or interlingual homograph) word recognition in strictly experimental settings. There have been (adult) studies bringing the two perspectives together. For example, Elston-Güttler and colleagues (2005) investigated to what extent between-language priming was influenced by global language context, that is, language use throughout the entire experimental session. German-English bilinguals performed a priming task in English after watching a twenty-minute film in either English or German, creating either a single-language (English) or a dual-language context. In the priming task, participants read sentences containing interlingual homographs and then performed lexical decision trials. In critical trials, the German interpretation of the interlingual homograph was related to the lexical decision item (e.g., *gift*, which means 'poison' in German, and *poison*). Priming effects between these words emerged only for participants in the dual-language context, and only in the first half of the experiment. According to Elston-Güttler et al. (2005), this suggests that the Task/Decision subsystem gradually shifted towards (globally) inhibiting or ignoring German word meanings, after the switch from the German film to the English task. In the single-language session, German was inhibited from the start of the task, leading to no between-language priming effects.

To our knowledge, there have not yet been any studies systematically investigating the role of (global) language context on cognate processing in simultaneous bilingual children. Importantly, effects of language context would not imply that access to the lexicon is language-selective: Studies with adults have found evidence for interactions between the languages even in fully single-language contexts (Dijkstra & van Hell, 2003; Lauro & Schwartz, 2017; Paulmann et al., 2006; Thierry & Wu, 2007), and most aforementioned cognate processing studies with children have taken place in (mostly) single-language contexts as well. Rather, comparing lexical cross-linguistic influence in multiple language contexts can provide insight into control processes occurring after words have become activated in the lexicon.

4.1.4. Present Study

We investigated the effect of global language context on word processing by simultaneous bilingual children with varying language dominance. Dutch-German bilingual children performed picture naming and auditory lexical decision tasks containing cognates and noncognates. Both tasks were conducted twice: first in a single-language context, and later in a dual-language context; see Table 4.1. In the single-language context, the target language of the experimental tasks was also the context language used throughout the session; in the dual-language context, the context language was different from the target language, so participants had to switch. We increased the frequency of language switches compared to Elston-Güttler et al. (2005), as context effects were short-lived in their study. In our study, the context language was used in instructional videos shown throughout the experiment, in communication between experimenter and participant, and in proficiency tasks conducted in between blocks of the main tasks (see Procedure).

Table 4.1. Study design.

	Single-language context	Dual-language context
Main tasks	Picture Naming Task Lexical Decision Task	Picture Naming Task Lexical Decision Task
Context language, i.e., language of: - instructional videos - communication - proficiency tasks	Same language as main tasks (i.e., target language)	Different language than main tasks (i.e., other language)[a]

[a] For the children who performed the main tasks in Dutch, the context language of the dual-language session was German. For the children who performed the main tasks in German, the context language of the dual-language session was Dutch.

To fully understand the effect of language context on cognate processing, we also took children's language dominance into account (following e.g., Gross & Kaushanskaya, 2020). Dominance effects and context effects stem from different processes – respectively, lexicon-internal differences in activation and lexicon-external (specifically, decision-level) differences in inhibition. As both processes can influence the strength of cognate facilitation effects, it is possible that, for example, dominance effects might obscure language context effects or vice versa. This is precisely why we investigated language context in interaction with dominance. In line with the BIA+ model (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019), dominance was operationalized in terms of relative exposure.

To ensure that our sample covered a range from Dutch-dominant to German-dominant children, we recruited in the Netherlands and in Germany. Half of the children performed the tasks in Dutch and half in German, with both subgroups containing children from both countries (see Appendix D for details). This resulted in a wide range of target language dominance, allowing us to test to what extent cognate effects and language context effects were influenced by dominance.

In line with research on bilingual adults (e.g., Costa et al., 2000; Dijkstra et al., 2010; Lemhöfer et al., 2004) and children (Bosma et al., 2019; Bosma & Nota, 2020; Duñabeitia et al., 2016; Koutamanis et al., Chapter 3; Poarch & van Hell, 2012; Schröter & Schroeder, 2016) and models of the bilingual lexicon (e.g., Dijkstra et al., 2019; Dijkstra & van Heuven, 2002), we predicted cognate facilitation effects in both tasks. Furthermore, we predicted that language context and dominance would influence these effects. In line with the BIA+ model (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019), cognate effects were expected to be stronger in children's less dominant language, as a result of individual differences in the resting-level activation of words from both languages. Specifically, more exposure to words from one language would lead to higher resting-level activation, which in turn would lead to faster activation during processing and more influence on word processing in the other language. In line with Elston-Güttler et al. (2005), cognate effects were expected to be stronger in the dual-language context, which would suggest contextual differences in the strength of decision-level inhibition of words from the two languages. We also predicted interactions between language context and dominance, as a result of different possible mechanisms. Language context may affect global inhibition, as in Elston-Güttler et al. (2005; see also e.g., Gollan & Ferreira, 2009). In the dual-language context, then, we would expect that children would not be, in terms of Elston-Güttler and colleagues (2005), 'zoomed in' on either language. As such, in the dual-language context, both languages would be highly likely to influence each other, regardless of language dominance, whereas we would expect dominance effects in the single-language context. At the same time, the switching between languages across the tasks in the dual-language context may also lead to a relatively strong inhibition of the dominant language (see e.g., Misra et al., 2012), resulting in weaker influence of the dominant language on the non-dominant language and smaller cognate effects.

4.2. Method

4.2.1. Participants

The participants were 63 Dutch-German bilingual children (37 girls, 26 boys), aged between 7.1 and 10.6 years old (*M* = 8.7, *SD* = 1.1), living either in the Netherlands (*n* = 36) or in Germany (*n* = 27). All children had received substantial exposure to both German and Dutch, defined as minimally half a day per week, since before age three and for the majority (*n* = 50) since birth. No children had received substantial exposure to any other languages than Dutch or German for at least 3.5 years prior to testing. Most children (*n* = 59) had at least one parent who had completed (applied) university, indicating a higher socio-economic status.

Table 4.2 summarizes children's scores on a range of background variables: working memory (Dutch version of Alloway Working Memory Assessment: Forward and Backward Digit Span Tests; Alloway, 2012), Dutch and German lexical proficiency (LITMUS Cross-linguistic Lexical Task; Haman et al., 2015; Rinker & Gagarina, 2017; van Wonderen & Unsworth, 2021) and Dutch and German syntactic proficiency (LITMUS Sentence Repetition Task; Marinis & Armon-Lotem, 2015). Children's current relative exposure to Dutch was assessed using the Bilingual Language Experience Calculator (Unsworth, 2013). Details of the proficiency tasks can be found in Section 4.2.2.3: Background Tasks.

Table 4.3 shows how the various proficiency and exposure measures are correlated. Dutch and German lexical proficiency correlated moderately to strongly with language exposure. There was a weaker correlation between language exposure and Dutch syntactic proficiency. In addition, Dutch lexical and syntactic proficiency were moderately correlated.

Table 4.2. Overview of participant characteristics.

Background variable	*M*	*SD*	Range
Working Memory[a]:			
- Forward Digit Span Test score	96	16	65 – 130
- Backward Digit Span Test score	100	13	68 – 127
Dutch Proficiency:			
- Lexical proficiency score	84%	15%	21% – 100%
- Syntactic proficiency score	85%	18%	3% – 100%
German Proficiency:			
- Lexical proficiency score	82%	13%	32% – 98%
- Syntactic proficiency score	71%	27%	3% – 100%
Percentage Dutch Exposure[b]	57%	21%	16% – 92%

[a] Scores are standard scores, with possible scores ranging from 47 to 153.
[b] Percentages reflect how much of children's language exposure around the time of testing was in Dutch compared to German.

Table 4.3. Correlations between proficiency scores and exposure.

	1	2	3	4	5
1. Percentage Dutch Exposure	–				
2. Dutch lexical proficiency score	0.73***	–			
3. Dutch syntactic proficiency score	0.43***	0.67***	–		
4. German lexical proficiency score	-0.59***	-0.24	0.03	–	
5. German syntactic proficiency score	0.04	-0.09	-0.04	0.02	–

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

4.2.2. Materials

4.2.2.1. Picture Naming

The picture naming stimuli consisted of 144 full-color drawings, corresponding to nouns selected from word lists for young Dutch children (Dunn et al., 2005; Mulder et al., 2009; Schlichting & Lutje Spelberg, 2002; Zink & Lejaegere, 2002), and their German translations.

The 144 target words corresponding to the pictures consisted of 36 cognates, 36 matched noncognates, and 72 fillers (see https://osf.io/9agup/ for the full stimulus list). Noncognates were matched to cognates based on frequency (Keuleers et al., 2010), AoA (in Dutch; Brysbaert et al., 2014), concreteness (Brysbaert et al., 2014), onset phoneme category, and length (in syllables) (*p*s > .05). The fillers were non-matched noncognate words, meaning that they could differ from the cognates on these features. The same images were used for both target language subgroups (Dutch and German), but some items were matched noncognates in one target language and fillers in the other.

Images were selected from Multipic (Duñabeitia et al., 2018) and Rossion and Pourtois (2004), complemented with clip-art images in similar styles if no suitable option was available from either database. We consulted with adult native speakers of Dutch and German to find which picture would be most recognizable for children and whether any adaptations were necessary. Based on these judgments, we added or removed details in order to make the images more recognizable (e.g., soap bubbles around a sponge) and added arrows and circles to indicate specific parts of the images (e.g., for body parts like ankle).

The selected and adapted set of images was pre-tested for naming consistency by five native speakers of German and five native speakers of Dutch (all women, aged between 22 and 64). They were presented with the pictures in an online questionnaire and were asked to type one word describing the picture. If alternative responses were given (especially to the cognates and matched noncognates), we checked whether these responses differed from the target response in cognate status, length, onset phoneme, and frequency. Based on this pre-test, we made some final changes to the images to optimize the naming consistency. For example, as some German adults named a picture of a train as

Bahn 'rail' or 'railways', we added a circle around the train. Other alternative responses were deemed unlikely to be used by children, such as *brachiosaurus* instead of the more general *dinosaurus*.

Within target languages, the stimuli were evenly divided over the single- and dual-language sessions, so that each picture was shown only once, either in the single-language session or in the dual-language session. Within sessions, they were divided into two blocks of 36 items: nine cognates, their nine matched noncognates, and 18 fillers. Each block was preceded by four practice items: two cognates and two noncognates. Blocks and sessions did not differ from each other in terms of frequency, AoA, onset phoneme category, and length of the cognates (*ps* > .05). Block-internal stimulus order was pseudorandomized for each participant, with no more than two subsequent trials from the same condition.[13] All individual stimulus order lists were checked for form or meaning overlap between subsequent trials, to avoid unwanted interactions with phonological or semantic priming.

4.2.2.2. Lexical Decision

The lexical decision stimuli consisted of 216 pre-recorded Dutch (pseudo)words and 216 German (pseudo)words, pre-recorded by female native speakers of Dutch and German, respectively. In both target languages, there were 36 cognates, 36 matched noncognates, 36 fillers, and 108 pseudowords (see https://osf.io/9agup/). The real words were selected and matched following the same criteria as in the picture naming task, but different words were used between the two tasks. Translation equivalents were used between the target languages.

The pseudowords were created with Wuggy (Keuleers & Brysbaert, 2010), based on words not used in the experiment. Adult native speakers were

[13] To increase comparability between target language subgroups and sessions, the same set of pseudorandomized stimulus orders was used across sessions and across groups, although they contained different items.

consulted to ensure that no homophones of any real words were included. Onset phoneme category and length (in syllables) of pseudowords were kept as similar as possible to the cognates.

Similar to picture naming, the stimuli were divided over the sessions, so that each stimulus was used only once, and further divided into blocks: two blocks of 30 items (five cognates, their five matched noncognates, five fillers, and 15 pseudowords) and two blocks of 24 items (four cognates, their four matched noncognates, four fillers, and 12 pseudowords). The first 30-item block was preceded by twelve practice items (three cognates, three noncognates, and six pseudowords); the other blocks were preceded by four practice items (one cognate, one noncognate, and two pseudowords). Block matching, block-internal stimulus order randomization, and session matching were performed in the same way as in the picture naming task.

4.2.2.3. Background Tasks

The proficiency tasks were used to assess participants' proficiency in both languages and to increase our manipulation of language context. For this second purpose, the proficiency tasks were administered in between the blocks of the main tasks (see Procedure). All proficiency tasks were production tasks.

Lexical proficiency was measured using adapted versions of the production subsets of the LITMUS Cross-linguistic Lexical Task in Dutch (CLT-NL; Haman et al., 2015; van Wonderen & Unsworth, 2021) and in German (CLT-DE; Haman et al., 2015; Rinker & Gagarina, 2017). These picture naming vocabulary tasks consisted of full-color drawings depicting (in our adaptation) 40 nouns and 40 verbs. The CLTs were administered and scored according to the guidelines by Bohnacker et al. (2016).

Syntactic proficiency was measured using the Dutch and German versions of the LITMUS Sentence Repetition Task (SRT-NL and SRT-DE; Marinis & Armon-Lotem, 2015). In the SRT, participants hear 30 pre-recorded sentences, varying in syntactic complexity, that they need to repeat verbatim after hearing them once. For the current experiment, we divided both SRTs into three blocks of 10 sentences.

4.2.2.4. Overlap Between Tasks

As Dutch and German are closely related, there are many (near-)cognates and false friends between the two languages, and there was a relatively small number of strict noncognates that could be used as matched noncognates and fillers in our main tasks. We did not repeat any items between the main tasks, but a small amount of overlap between the main tasks on the one hand and the proficiency tasks on the other hand was unavoidable. To ensure reliable measurements and avoid priming effects between tasks, main task items were assigned to a session such that overlap with the proficiency tasks of that session was avoided. For example, if a noun or its translation appeared in the CLT-NL, which was administered in the sessions with Dutch as the context language, that noun could only be used in the main tasks of the sessions with German as the context language.

For two picture naming items, within-session overlap could not be avoided. In those cases, to avoid priming effects in the main task, the items were always presented in a picture naming block before the proficiency tasks.

4.2.3. Procedure

All children were tested individually, in their homes, over two sessions of 60-70 minutes each: first the single-language session, followed by the dual-language session after one to three weeks. Testing took place online using Radboud Online Linguistic Experiment Generator (ROLEG), an in-house testing platform.[14] After signing informed consent forms, caregivers received a link to access the experiment. They were instructed to help the child set up, but leave the room during the session. Instructions for all tasks were embedded in short animation videos shown throughout the session. An experimenter was also present via a video call to give feedback and additional instructions where

[14] Because of COVID-19-related restrictions, testing could not take place face-to-face.

needed. The two sessions were conducted by two different experimenters, who were native speakers of the context language of the session.

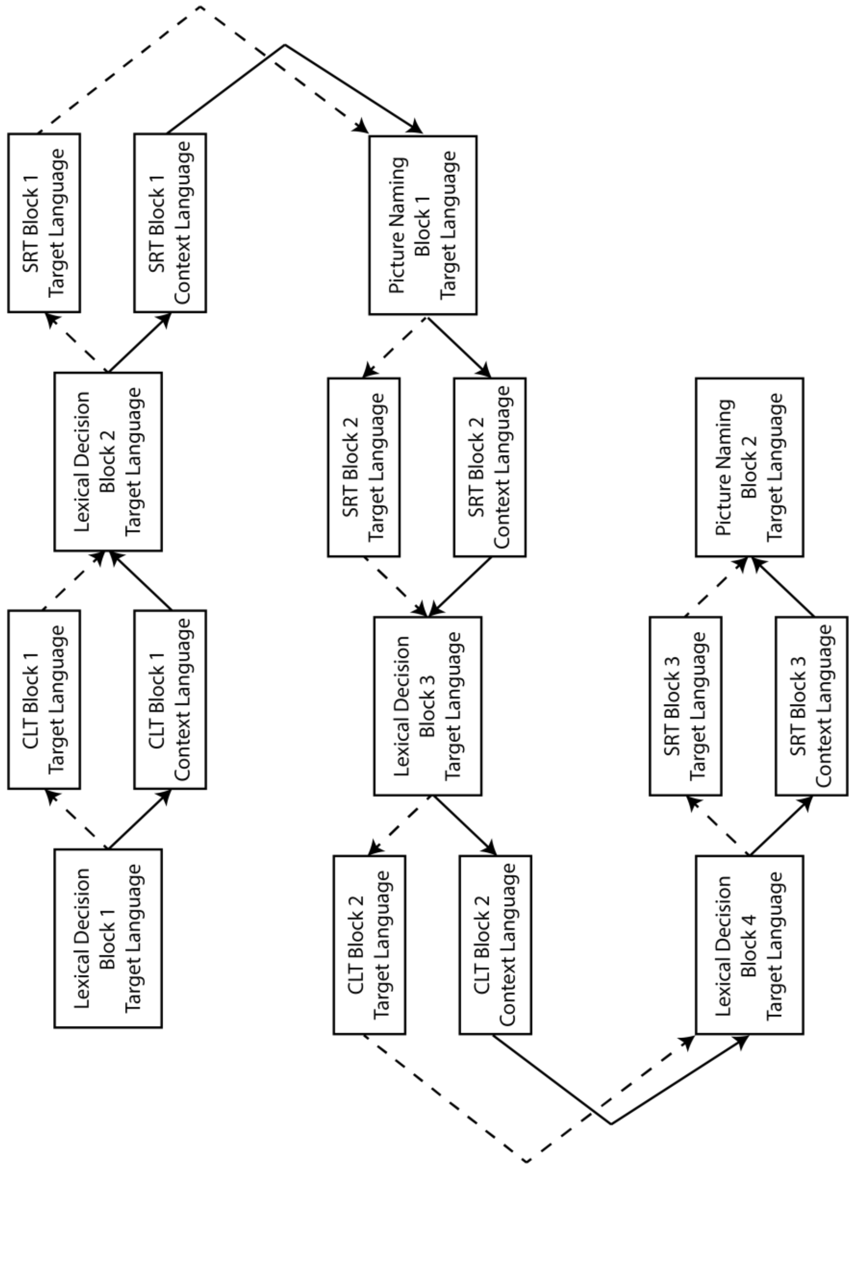
To maintain the context language throughout the session, the different tasks were administered in a fast rotation. All main tasks and proficiency tasks had been divided into two or more blocks. As the context effects in Elston-Güttler et al. (2005) were quite short-lived, the blocks in our study were aimed to last approximately five minutes each. The order between these blocks was such that participants switched back and forth between main tasks and proficiency tasks, between production and comprehension tasks, and, in the dual-language sessions, between languages; see Figure 4.2.

A picture naming trial started with a 50 ms beep sound, followed by a 250 ms pause.[15] Then, the image appeared on the screen for participants to name. After 2000 ms, the image disappeared and a new trial started. Accuracy and reaction times (RTs) were obtained from audio recordings (see Scoring), which were made on a separate recording device on the participant's end.

A lexical decision trial also started with a 50 ms beep and 250 ms pause, after which the item was played. Participants responded by pressing a key on their keyboard: For real words, they pressed a key labeled with a smiley face, and for pseudowords, a key with a frowny face. The smiley-face key was always on the side of their dominant hand, the frowny face on the side of their non-dominant hand. A new trial started after a keypress. Accuracy and RTs were recorded in ROLEG.

[15] Exact timing differed depending on participants' computer and internet connection.

Figure 4.2. Order between blocks of different tasks. Dashed arrows indicate the order in the single-language sessions, solid arrows indicate the order in the dual-language sessions.



To increase children's engagement, the tasks were embedded in an overarching story, told through the instructional videos. There were two stories: In one story, an inventor was trying to fix a talking robot, and in the other, aliens were trying to speak with an astronaut who visited their planet. In the dual-language sessions, the robot or aliens would use a language (i.e., the target language) that the inventor or astronaut did not know very well, so they needed the child's help. In the lexical decision blocks, the child checked if the robot or alien was speaking correctly in the target language, and in picture naming, they taught the robot or alien new target-language words. In the single-language sessions, all characters spoke the same language as the target language, so the child helped for other reasons (e.g., the inventor could not properly hear the robot, or the aliens were too shy to learn words from the astronaut). Which story was told in which session was counterbalanced between participants. The proficiency tasks and other background tasks were also embedded in the overarching story.

4.2.4. Scoring

While lexical decision accuracy and RTs were automatically recorded, the picture naming data were scored manually using audio recordings. Two (near-)native speakers of both Dutch and German transcribed children's responses and labeled the onset of the beeps (auditory markers of stimulus onset) and of the response in Praat (Boersma & Weenink, 2022). The time between beep onset and response onset was the RT. All data from the same participant was annotated by the same scorer. A subset (10% of participants) was annotated by both scorers. Inter-rater reliability was 0.85, indicating excellent agreement between the scorers (Hallgren, 2012).

Picture naming accuracy was based on the scorers' transcriptions, following a lenient scoring scheme and a strict scoring scheme. Lenient scores were used in accuracy analysis, strict scores for RT analysis. In the lenient scoring scheme, a response was correct if it contained the target word or a derived form such as a plural or diminutive.[16] Late responses, after the beep indicating the start of the next trial, were also correct. Cognates that were pronounced in the non-target language (e.g., *kangoeroe* /ˈkɑnɣəru/ instead of *Känguru* /ˈkɛŋguʁu/) were coded as 'other'. In the strict scoring scheme, false starts and late responses were incorrect, as well as non-target language pronunciations of cognates.

4.2.5. Analysis

Accuracy scores and RTs of both tasks were analyzed separately, in mixed effects logistic regression models and linear mixed effects models, respectively, using the glmer and lmer functions from the lme4 package version 1.1-27.1 (Bates et al., 2015). We used the Anova function of the package car (Fox & Weisberg, 2019) to obtain *p*-values in the RT-models, using Type 2 conditional *F*-tests with Kenward-Roger approximation for degrees of freedom as implemented in the function. RTs were log-transformed, approaching a normal distribution (Baayen & Milin, 2010). Orthogonal sum-to-zero contrast coding was applied to the categorical predictors *Cognate Status* (noncognate vs. cognate) and *Language Context* (single-language vs. dual-language). Our dominance measure, *Other-Language Exposure*, reflected children's relative exposure to the non-target language: For children performing the tasks in Dutch, it reflected their percentage of current exposure to German; for children performing the tasks in German, it reflected their exposure to Dutch. This continuous predictor (from fully dominant in the target language to fully dominant in the other language) was mean-centered.

[16] For one Dutch cognate, the target word was changed post-hoc. Because the intended target word was produced much less often than a synonym, which was also a cognate, the synonym was scored as correct. Four Dutch and five German matched noncognates were swapped with fillers, because the pictures were unclear to most children. These changes did not affect matching between cognates and matched noncognates; see https://osf.io/9agup/.

Prior to the main analyses, we ran preliminary analyses to test for differences in cognate processing between children who performed the task in Dutch and those who performed the task in German (for details, see Appendix D). If the preliminary analyses revealed no interactions between *Cognate Status* and *Target Language* (Dutch vs. German), they were pooled together for the main analyses. As the main aim of the present study was to examine cognate processing, effects of *Target Language* that did not involve *Cognate Status* were not considered directly relevant for our research questions or for the decision to pool the groups together. Such effects are discussed in Appendix D.

In the main analyses, we tested for effects of *Cognate Status*, *Language Context*, *Other-Language Exposure*, and their interactions. The models also contained random intercepts for *Participant* and *Target Word*. Task-related covariates were added in a stepwise manner, namely *Trial Number*, *Previous Trial Accuracy*, and *Previous Trial logRT*. These variables were included to control for their potential influence on response outcomes as much as possible (see e.g., Lemhöfer et al., 2008). To avoid overfitting, however, only those covariates that significantly improved the model were included, as was established through Likelihood Ratio Tests using the anova function in the base package (R Core Team, 2020).

4.3. Results

4.3.1. Data Exclusion

4.3.1.1. Picture Naming

Because we did not receive audio recordings from all children, picture naming data were available for 55 of the 63 tested children. For accuracy analysis, data was excluded for children who responded in fewer than 50% of trials (n = 7). For RT analysis, we first excluded responses that were faster than 1300 ms or slower than 2800 ms (25.5% of correct cognate and matched noncognate trials). The rate of exclusions may be higher than what is typically considered normal, in part due to the testing circumstances. We chose relatively strict limits based on visual inspection of the data, to counteract the noisiness of the raw data: Stimuli were presented online, with timing differences depending on participants' computer and internet connection, and the RTs were deduced from audio recordings made on different devices and under different circumstances. As such, responses that were visibly faster or slower than the majority were deemed more likely to reflect measurement errors. Next, participants with (lenient) accuracy below 70% of their given responses on cognates and matched noncognates were excluded from analysis ($n = 2$), as well as items with mean (lenient) accuracy below 50% of given responses ($n = 3$). Item exclusion did not affect the matching between cognates and noncognates ($ps > .05$). Next, all remaining responses that were incorrect under the strict scoring scheme were excluded. Finally, we calculated mean RTs per participant per testing session based on their remaining trials, and excluded responses above or below 2.5 SD of this participant mean (1.5%). Based on these data exclusion measures, data from 48 and 53 children was included in the picture naming accuracy and RT analyses, respectively.

4.3.1.2. Lexical Decision

Lexical decision data were available for all 63 children. First, responses with RTs below 700 ms or above 2200 ms were excluded from both accuracy and RT analysis, again based on visual inspection of the data. This resulted in exclusion of 7.3% of all responses to cognates and matched noncognates and 6.4% of correct responses. Next, participants with accuracy scores below 80% on pseudowords were excluded ($n = 2$), as this indicated that they had a bias for 'yes'-responses. All remaining participants had accuracy scores above 80% on cognates and matched noncognates. For RT analysis only, we excluded items with mean accuracy below 80% ($n = 8$, four cognates), as well as all remaining incorrect responses. Item exclusion did not affect the matching between cognates and noncognates ($ps > .05$). Finally, for both accuracy analysis and RT analysis, we calculated mean RTs per participant per testing session based on their remaining trials, and excluded responses above or below 2.5 SD of this participant mean (1.4% for accuracy analysis; 1.4% for RT analysis). Based on these data exclusion measures, data from 61 children was included in both lexical decision analyses.

The results of the preliminary analyses, which revealed no significant interactions between *Cognate Status* and *Target Language*, can be found in Appendix D.

4.3.2. Picture Naming Results

Descriptive picture naming results per condition per session, for children with higher and lower percentages of other-language exposure (based on a median split, for illustrative purposes), are presented in Table 4.4.

Table 4.4. Mean picture naming accuracy and reaction times (standard deviations between parentheses) per condition per session, for children with higher and lower percentages of other-language exposure.

	Single-language session	Dual-language session	Single-language session	Dual-language session
	Accuracy		Reaction Times	
Cognates	0.94 (0.24)	0.96 (0.19)	1859 (337)	1880 (325)
- Higher other-language exposure	0.93 (0.26)	0.97 (0.18)	1897 (326)	1921 (315)
- Lower other-language exposure	0.95 (0.22)	0.96 (0.21)	1822 (344)	1836 (329)
Noncognates	0.76 (0.43)	0.88 (0.33)	1916 (371)	1940 (347)
- Higher other-language exposure	0.73 (0.44)	0.85 (0.35)	2004 (356)	1956 (322)
- Lower other-language exposure	0.78 (0.42)	0.89 (0.31)	1847 (368)	1925 (368)

The best-fitting models are presented in Table 4.5. The accuracy analysis revealed a main effect of *Cognate Status*, with more accurate responses to cognates than to noncognates, and a main effect of *Language Context*, with more accurate responses in the dual-language context than in the single-language context. The RT analysis revealed main effects of *Cognate Status* and *Other-Language Exposure*, as well as interactions between *Other-Language Exposure*, *Cognate Status*, and *Language Context*. Children responded more quickly to cognates than to noncognates, and overall faster when they were more dominant in the target language. In the single-language session, the cognate facilitation effect increased with *Other-Language Exposure*; see Figure 4.3 (left). For example, among the children performing the task in Dutch, the more German-dominant children showed a larger cognate facilitation effect. In the dual-language session, this pattern was more or less reversed: The cognate facilitation effect decreased with *Other-Language Exposure*, that is, the cognate facilitation effect was stronger for more target-language-dominant children; see Figure 4.3 (right).

Figure 4.3. Interaction between *Other-Language Exposure*, *Language Context*, and *Cognate Status.*

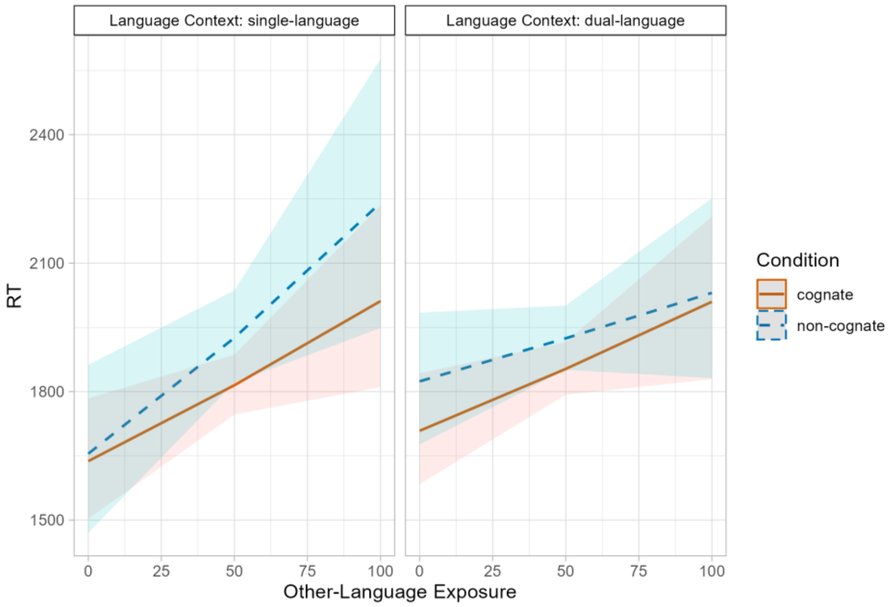


Table 4.5. Parameter estimates and significance tests of accuracy and reaction times in the picture naming task.

Predictor	Accuracy				
	B	*SE*	*z*	*p*	
(Intercept)	2.858	0.194	14.701	<.001	
Cognate Status	1.713	0.294	5.829	<.001	
Other-Language Exposure	-1.187	0.719	-1.651	.099	
Language Context	0.653	0.276	2.365	.018	
Other-Language Exposure x Cognate Status	1.537	0.817	1.881	.060	
Cognate Status x Language Context	-0.583	0.552	-1.055	.291	
Other-Language Exposure x Language Context	0.386	0.812	0.476	.634	
Other-Language Exposure x Cognate Status x Language Context	2.395	1.624	1.475	.140	
	Reaction Times				
	Parameter estimates		Significance tests		
Predictor	*B*	*SE*	*F*	*df*	*p*
(Intercept)	7.512	0.018			
Cognate Status	-0.047	0.011	18.739	1,125.7	<.001
Other-Language Exposure	0.195	0.081	5.503	1,52.5	.023
Language Context	0.017	0.010	3.748	1,234.0	.054
Other-Language Exposure x Cognate Status	-0.021	0.039	0.224	1,1864.0	.636
Cognate Status x Language Context	0.012	0.020	0.373	1,186.7	.542
Other-Language Exposure x Language Context	-0.119	0.040	6.957	1,1893.5	.008
Other-Language Exposure x Cognate Status x Language Context	0.153	0.077	3.905	1,1854.9	.048
Trial Number	0.0004	0.0002	3.829	1,394.3	.051

4.3.3. Lexical Decision Results

Descriptive lexical decision results per condition per session, for children with higher and lower percentages of other-language exposure (based on a median split, for illustrative purposes), are presented in Table 4.6.

Table 4.6. Mean lexical decision accuracy and reaction times (standard deviations between parentheses) per condition per session, for children with higher and lower percentages of other-language exposure.

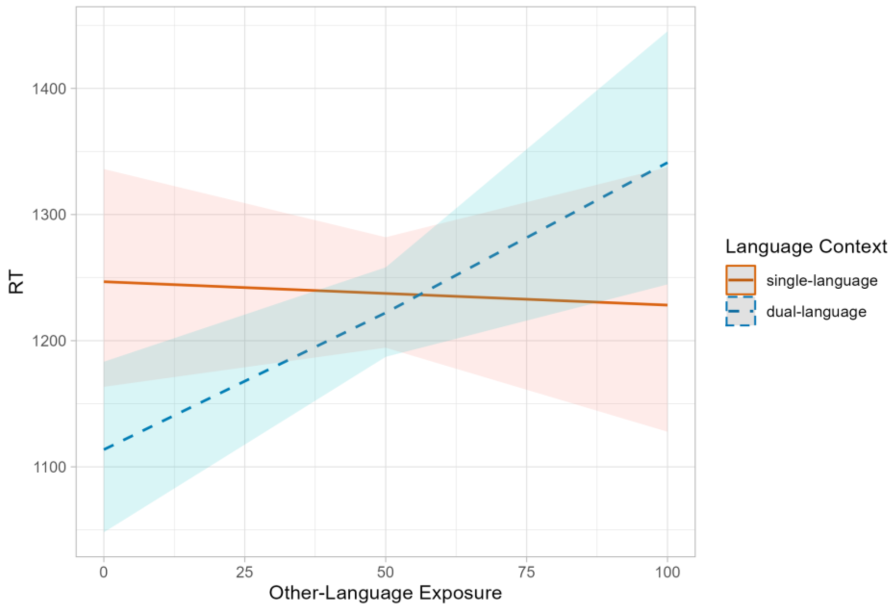
	Single-language session	Dual-language session	Single-language session	Dual-language session
	Accuracy		Reaction Times	
Cognates	0.95 (0.22)	0.94 (0.24)	1254 (282)	1236 (299)
- Higher other-language exposure	0.94 (0.24)	0.92 (0.27)	1254 (282)	1269 (303)
- Lower other-language exposure	0.96 (0.20)	0.96 (0.20)	1253 (282)	1204 (291)
Noncognates	0.95 (0.22)	0.93 (0.26)	1299 (286)	1267 (291)
- Higher other-language exposure	0.94 (0.24)	0.91 (0.29)	1285 (277)	1288 (286)
- Lower other-language exposure	0.96 (0.19)	0.95 (0.22)	1314 (295)	1246 (295)

The best-fitting models are presented in Table 4.7. The accuracy analysis revealed a main effect of *Other-Language Exposure*, where more target-language-dominant children responded correctly more often. The RT analysis revealed significant effects of *Cognate Status* and *Language Context*, and a significant interaction between *Other-Language Exposure* and *Language Context*. Children responded more quickly to cognates than to noncognates, and more quickly in the dual-language context than in the single-language context. As illustrated in Figure 4.4, *Other-Language Exposure* did not affect RTs in the single-language context, but in the dual-language context, children with more other-language exposure (i.e., less target-language-dominant children) responded more slowly than children with less other-language exposure (i.e., more target-language-dominant children).

Table 4.7. Parameter estimates and significance tests of accuracy and reaction times in the lexical decision task.

	Accuracy				
Predictor	*B*	*SE*	*z*	*p*	
(Intercept)	3.098	0.283	10.937	<.001	
Cognate Status	0.086	0.275	0.314	.754	
Other-Language Exposure	-1.666	0.518	-3.218	.001	
Language Context	-0.354	0.226	-1.569	.117	
Other-Language Exposure x Cognate Status	-0.215	0.688	-0.313	.754	
Cognate Status x Language Context	0.126	0.449	0.280	.780	
Other-Language Exposure x Language Context	-0.571	0.705	-0.810	.418	
Other-Language Exposure x Cognate Status x Language Context	-0.109	1.408	-0.077	.938	
Previous Trial Accuracy	0.490	0.237	2.068	.039	
	Reaction Times				
	Parameter estimates		Significance tests		
Predictor	*B*	*SE*	*F*	*df*	*p*
(Intercept)	7.006	0.048			
Cognate Status	-0.028	0.012	5.043	1,113.8	.027
Other-Language Exposure	0.059	0.063	0.956	1,60.0	.332
Language Context	-0.028	0.010	8.431	1,501.2	.004
Other-Language Exposure x Cognate Status	0.052	0.032	2.719	1,3525.9	.099
Cognate Status x Language Context	0.003	0.020	0.023	1,208.6	.880
Other-Language Exposure x Language Context	0.175	0.032	29.317	1,3524.7	<.001
Other-Language Exposure x Cognate Status x Language Context	0.052	0.064	0.657	1,3524.6	.418
Previous Trial logRT	0.020	0.006	10.670	1,3508.7	.001
Previous Trial Accuracy	-0.028	0.013	4.506	1,3496.4	.034

Figure 4.4. Interaction between *Other-Language Exposure* and *Language Context.*



4.4. Discussion

The aim of this study was to establish to what extent lexical cross-linguistic influence occurs in simultaneous bilingual children and is modulated by lexicon-internal and lexicon-external variation. Specifically, we investigated the effect of global language context, which is considered a lexicon-external effect, on cognate processing, in interaction with individual children's language dominance, which is assumed to lead to lexicon-internal variation in activation. Dutch-German simultaneous bilingual children, ranging from more Dutch-dominant to more German-dominant, performed cognate production (picture naming) and comprehension (auditory lexical decision) tasks in single-language and dual-language contexts. In the single-language context, all language use matched the target language of the cognate processing tasks, which was Dutch for half of the children and German for the other half. In the dual-language context, the other, non-target language was used in instructional videos, in communication between participant and experimenter, and in proficiency tests run in between blocks of the main tasks, so participants switched between their languages frequently between blocks and activities.

4.4.1. Cognate Facilitation

Compared to noncognate control words, cognates were generally processed more accurately and more quickly in both production and comprehension, as predicted, which indicates that children were tapping into knowledge of both languages while performing the tasks. There was one exception: In the lexical decision task, accuracy did not differ significantly between cognates and noncognates. As scores were high (around 95%) for both cognates and noncognates, this suggests a ceiling effect (similar to findings by Schröter and Schroeder; 2016), where performance could not be further improved by any increased activation in the lexicon.

The cognate facilitation effects in all other outcomes are in line with many studies on bilingual adults (see e.g., Dijkstra & van Heuven, 2018, for a review) and with models such as BIA+ (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019), which assume that cognates have shared semantic and sub-lexical representations and that activation resonates between representations. Importantly, our findings add to a growing body of evidence that, like adults, bilingual children have an integrated lexicon with language-nonselective access, in which words from both languages can become co-activated and influence each other's processing (Bosma et al., 2019; Bosma & Nota, 2020; Duñabeitia et al., 2016; Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Koutamanis et al., Chapter 2, Chapter 3; Poarch & van Hell, 2012; Schröter & Schroeder, 2016; Singh, 2014; Von Holzen & Mani, 2012). Moreover, as our study was conducted online, using a testing platform designed for linguistic experiments and using instructional videos embedded in an overarching story, our results show that cognate facilitation effects in bilingual children are robust and that they can be replicated under different circumstances. At the same time, cognate processing was influenced by language dominance and language context, which we discuss below.

4.4.2. Language Dominance

Main effects of language dominance were found in both tasks. Specifically, the more exposure children had to the target language (and thus the less exposure to the other language), the more accurately (in lexical decision) or quickly (in picture naming) they responded. According to BIA+ (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019), increased exposure leads to higher resting-level activation. As such, words from the more dominant language would be activated more quickly, leading to faster responses and fewer errors. In addition to increased activation, the dominance effects may also be (partly) explained through better representation. Exposure and lexical proficiency were moderately to strongly correlated in our sample (see Table 4.3), so children with more exposure were also more likely to have the target words well-represented in their lexicon, similarly leading to faster and more accurate responses.

In the picture naming task, dominance modulated the cognate facilitation effect in RTs in interaction with language context. In this section, we focus on the findings in the single-language context – the dual-language context is discussed in the next section. In the single-language context, a clear dominance effect emerged, in line with our predictions: The more dominant children were in the other language, the stronger the cognate facilitation effect in the target language. Similar patterns have been found in bilingual adults (e.g., Muntendam et al., 2022; van Hell & Dijkstra, 2002; van Hell & Tanner, 2012) as well as children (Bosma et al., 2019; Bosma & Nota, 2020; Poarch & van Hell, 2012; Singh, 2014): Cognate effects often emerge in participants' non-dominant language but not (or to a much lesser extent) in their dominant language. During non-dominant-language processing, dominant-language words are relatively easily co-activated and therefore have a strong influence. During dominant-language processing, however, the low resting-level activation of non-dominant language words leads to less co-activation and less influence, including weaker cognate facilitation effects.

Our results build on existing evidence that dominance affects lexical cross-linguistic influence in simultaneous bilingual children in similar ways as in bilingual adults. These findings are in line with predictions from models such as BIA+ (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019). In addition to these lexicon-internal effects, our study also tested for lexicon-external effects of language context. We discuss our findings in the next section.

4.4.3. Language Context

As predicted, language context and dominance interacted in their influence on the cognate facilitation effect, namely in the three-way interaction in picture naming RTs. The results in the dual-language context were different from Elston-Güttler et al. (2005): If children would not be 'zoomed in' on either language, both languages could influence each other and the resulting cognate facilitation effect would be unaffected by dominance. The results, however, revealed weaker cognate effects for children with more other-language exposure – the opposite pattern of the dominance effects discussed above. This effect may be explained as decision-level inhibition, in line with Dijkstra and van Heuven (2002) and Green and Abutalebi (2013), as well as literature on language switching (see e.g., Bobb & Wodniecka, 2013; Misra et al., 2012). Specifically, if these children had just performed a background task in their more dominant language, performing the picture naming task in their non-dominant language required inhibition of the dominant language in the Task/Decision subsystem. Previous studies have found that inhibition of a dominant language is particularly effortful and therefore often strong (e.g., Misra et al., 2012; but see Gade et al., 2021). Indeed, it appears that the more dominant the other language was for a child, the more strongly it was inhibited, resulting in a weaker influence and small or null cognate effects.

Interestingly, cognate effects were not necessarily stronger in the dual-language context. This is different from what we predicted based on e.g., Elston-Güttler et al. (2005) and Gross and Kaushanskaya (2020). Differences between studies may be partly explained by several methodological differences, such as stimulus type and manipulation of language context. For example, Paulmann et al. (2006) conducted a highly similar experiment to Elston-Güttler et al. (2005), but with words presented in isolation rather than in sentences, and found no language context effects. In addition, our findings highlight the importance of taking dominance into account. For children who were dominant in the target language, results resembled Elston-Güttler et al. (2005): Cognate effects were stronger in picture naming in the dual-language context than in the single-language context. For more balanced bilinguals, on the other hand, language context had less of an effect, more similar to Paulmann et al. (2006). Together, these findings suggest that bilingual word processing is indeed influenced by language context, but the extent to which cognate facilitation or other types of cross-linguistic influence are affected is modulated by both participant characteristics and task-related differences.

We also found effects of language context that did not involve cognate status. There were main effects where children responded more accurately (in picture naming) or quickly (in lexical decision) in the dual-language context. Dual-language contexts are typically more cognitively demanding (Green & Abutalebi, 2013), so this pattern was unexpected. A limitation of the present study was that we did not counterbalance the two types of language context: To avoid influence from the dual-language context on the single-language context, the first session was always the single-language session. In the dual-language session, then, children may have been more used to the specific tasks and types of materials than in the first session. In other words, the main effect of language context may have been an unintended learning effect.

In addition, there was an interaction effect between context and dominance in lexical decision RTs. Language exposure did not affect children's lexical decision RTs in the single-language context, but it did in the dual-language context: The more dominant children were in the other language, the more slowly they responded. This pattern provides further support for our explanation of the picture naming results in terms of decision-level inhibition, as it suggests that the dominant language was inhibited in order to perform the task in the non-dominant target language. Unlike in picture naming, this decision-level inhibition did not modulate the cognate effect, which may be the result of differences in task demands (see e.g., Koutamanis et al., Chapter 3).

A limitation of the present study was that a straightforward comparison of both tasks is complicated, because they differ on multiple dimensions. Future studies may further explore the effects of task demands on decision-level language inhibition in simultaneous bilingual children by directly comparing language processing in dual-language contexts in multiple production and comprehension tasks. Other potential limitations of the present study include the high SES backgrounds of the participants and the high degree of similarity with many cognates between the languages they spoke. We also did not look into children's cognitive control and/or (non-linguistic) switching abilities, for instance in relation to the type of language context they are exposed to at home. Future studies may aim to include children with more varied backgrounds, both on the level of SES and on the level of language distance, and look further into children's home environment and/or cognitive control.

4.4.4. Conclusion

This study revealed cognate effects in simultaneous bilingual children across a range of language dominance, in two tasks, with two outcome measures, in two contexts, in an online experiment. This underscores the robustness of cognate facilitation in bilingual children, similar to bilingual adults, and indicates that bilinguals have an integrated lexicon with language-nonselective access, which can lead to cross-linguistic influence, in principle under all circumstances.

This study is one of the first to include both language dominance and language context in a cognate processing study with simultaneous bilingual children. Our findings for dominance fit in with models like BIA+ (Dijkstra & van Heuven, 2002) and Multilink (Dijkstra et al., 2019): The more dominant a language, the more active it is in the lexicon, resulting in a greater influence, for example in cognate processing. Our manipulation of language context was largely based on Elston-Güttler et al. (2005; see also Paulmann et al., 2006), forming a bridge between more ecologically valid studies on language context in naturalistic interactions (Green & Abutalebi, 2013; Gross & Kaushanskaya, 2020) and more experimental, lab-based studies on stimulus list effects (Brenders et al., 2011; Poort & Rodd, 2017). Our results suggest that similar mechanisms may be at play in both global and local language context effects, including decision-level inhibition or cognitive control. Future studies may systematically compare single- and dual-language contexts on global and local levels to further examine the relationship between these different ways of operationalizing language context. Importantly, we found that effects of language context on cognate processing depend on children's language dominance and possibly on task demands, highlighting the complex interplay between lexicon-internal and lexicon-external factors on the extent to which cross-linguistic influence can be found in an integrated bilingual lexicon.

Appendix D

Participants Target Language Subgroups

Of the 63 Dutch-German bilingual children in this study, 31 children performed the main tasks in Dutch and 32 in German. To create comparable groups, target language assignment was based on participant characteristics that were known prior to testing: *Age*, *SES* (socio-economic status), *Country of Residence*, and *Type of Exposure*. *Country of Residence* and *Type of Exposure* were taken as an a priori estimation of language exposure outside and within the home, respectively. During the testing sessions, participants' language background, exposure, and linguistic and cognitive skills were further evaluated; see Table D1 and Table D2 for an overview per target language subgroup.

The target language subgroups differed on the percentage of *Other-Language Exposure* as measured using our more detailed assessment (Unsworth, 2013). This variable was only included in analyses where the two groups were pooled together. In addition, there were differences between the groups on language proficiency, so in the analyses where the two groups were compared, proficiency variables were included as covariates (see Preliminary Analyses).

Table D1. Overview of participant characteristics per target language subgroup and comparison between the groups.

Background variable	German target language subgroup *n* = 32	Dutch target language subgroup *n* = 31	Comparison
Socio-Economic Status[a]:			
- One or both parents higher education	*n* = 29	*n* = 30	$\chi^2(1) = 0.23$, $p = .63$
- Both parents lower education	*n* = 3	*n* = 1	
Country of Residence:			
- The Netherlands	*n* = 18	*n* = 18	$\chi^2(1) < 0.001$,
- Germany	*n* = 14	*n* = 13	$p > .99$
Type of Exposure:			
- One Parent One Language	*n* = 22	*n* = 22	$\chi^2(2) = 0.73$, $p = .69$
- Minority Language at Home	*n* = 6	*n* = 7	
- other	*n* = 4	*n* = 2	

[a] Measured in terms of parental education. Higher education here means at least a (applied) university degree.

Table D2. Overview of participant characteristics per target language subgroup and comparison between the groups.

Background variable	German target language subgroup $n = 32$			Dutch target language subgroup $n = 31$			Comparison
	M	*SD*	Range	*M*	*SD*	Range	
Age	8.7	1.1	7.1 – 10.5	8.7	1.1	7.1 – 10.6	$t(61) = 0.07$, $p = .95$
Working Memory							
- Forward Digit Span Test score	94	16	71 – 130	97	16	65 – 130	$t(58.87) = 0.82$, $p = .41$
- Backward Digit Span Test score	102	13	69 – 127	98	13	68 – 124	$t(58.97) = -1.01$, $p = .32$
Dutch Proficiency:							
- Lexical proficiency score	80%	18%	21% – 98%	88%	9%	51% – 100%	$t(47.22) = 2.37$, $p = .02$
- Syntactic proficiency score	80%	23%	3% – 100%	89%	10%	60% – 100%	$t(42.96) = 2.02$, $p = .05$
German Proficiency:							
- Lexical proficiency score	82%	17%	32% – 98%	82%	8%	66% – 94%	$t(45.63) = -0.08$, $p = .94$
- Syntactic proficiency score	72%	24%	3% – 100%	69%	30%	7% – 100%	$t(57.29) = -0.55$, $p = .58$
Percentage Other-Language Exposure	52%	24%	16% – 88%	37%	16%	8% – 75%	$t(54.25) = -2.90$, $p = .01$

Preliminary Analyses

We ran preliminary analyses to test for differences in cognate processing between the children who performed the task in Dutch and those who performed the task in German. Mixed effects logistic regression models and linear mixed effects models were created using the glmer and lmer functions from the lme4 package version 1.1-27.1 (Bates et al., 2015). We used the Anova function of the package car (Fox & Weisberg, 2019) to obtain *p*-values in the RT-models, using Type 2 conditional *F*-tests with Kenward-Roger approximation for degrees of freedom as implemented in the function. RTs were log-transformed, approaching a normal distribution (Baayen & Milin, 2010). Orthogonal sum-to-zero contrast coding was applied to the categorical predictors *Cognate Status* (noncognate vs. cognate), *Language Context* (single-language vs. dual-language) and *Target Language* (Dutch vs. German).

Models included the predictors *Cognate Status*, *Language Context*, and *Target Language*, interactions between these predictors, and random intercepts for *Participant* and *Target Word*. Because there were differences between the two target language subgroups in their Dutch and German proficiency, proficiency scores were added to the models as covariates. The covariates were added in a stepwise manner. To avoid overfitting, only those covariates that significantly improved the model were included, as was established through Likelihood Ratio Tests using the anova function in the base package (R Core Team, 2020).

Preliminary Results Picture Naming

Descriptive picture naming results per condition per session per target language subgroup are presented in Table D3.

Table D3. Mean picture naming accuracy and reaction times (standard deviations between parentheses) per condition per target language subgroup.

	German target language subgroup		Dutch target language subgroup	
	Single-language session	Dual-language session	Single-language session	Dual-language session
	Accuracy			
Cognates	0.92 (0.27)	0.95 (0.22)	0.95 (0.21)	0.97 (0.17)
Noncognates	0.71 (0.45)	0.87 (0.34)	0.80 (0.40)	0.88 (0.32)
	Reaction Times			
Cognates	1943 (320)	1902 (314)	1778 (333)	1862 (333)
Noncognates	2033 (358)	1957 (323)	1826 (355)	1925 (366)

The preliminary analysis of picture naming accuracy revealed main effects of *Cognate Status* and *Language Context*, but not *Target Language*, and no interactions; see Table D4. In both target language subgroups, cognates were named correctly more often than noncognates, and accuracy in the dual-language context was higher than in the single-language context.

In the preliminary analysis of picture naming RTs, there were significant main effects of *Cognate Status* and *Language Context*; see Table D5. Children responded faster to cognates than to noncognates, and faster in the single-language context than in the dual-language context. In addition, there was a significant interaction between *Target Language* and *Language Context*. As illustrated in Figure D1, in the single-language context, participants in the Dutch target language subgroup responded faster than participants in the German target language subgroup, whereas this difference was much smaller in the dual-language context. The difference in the single-language context was likely caused by the Dutch target language subgroup's higher target language proficiency scores (Table D2) although Dutch proficiency covariates did not significantly improve the model in this case.

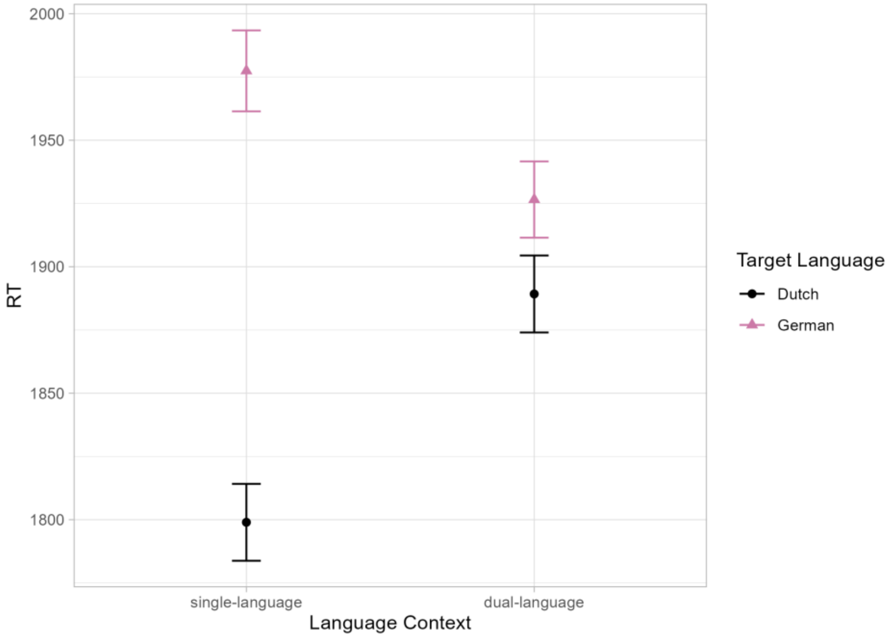
Table D4. Parameter estimates of the preliminary model of accuracy in the picture naming task.

Predictor	*B*	*SE*	*z*	*p*
(Intercept)	-2.504	1.018	-2.460	.014
Cognate Status	1.735	0.292	5.940	< .001
Target Language	-0.326	0.321	-1.015	.310
Language Context	0.651	0.275	2.369	.018
Cognate Status x Target Language	0.093	0.552	0.169	.866
Cognate Status x Language Context	-0.524	0.550	-0.954	.340
Target Language x Language Context	0.094	0.576	0.164	.870
Cognate Status x Target Language x Language Context	-0.569	1.151	-0.495	.621
Dutch Vocabulary	1.988	0.748	2.657	.008
German Vocabulary	4.381	0.851	5.146	< .001

Table D5. Parameter estimates and results from significance tests of the preliminary model of RTs in the picture naming task.

	Parameter estimates		Significance tests		
Predictor	*B*	*SE*	*F*	*df*	*p*
(Intercept)	7.759	0.108			
Cognate Status	-0.047	0.010	20.966	1,123.8	< .001
Target Language	0.061	0.032	3.620	1,54.9	.062
Language Context	0.016	0.010	4.284	1,220.7	.040
Cognate Status x Target Language	-0.008	0.019	0.182	1,182.8	.670
Cognate Status x Language Context	0.010	0.019	0.282	1,180.4	.596
Target Language x Language Context	-0.094	0.021	20.772	1,128.5	< .001
Cognate Status x Target Language x Language Context	0.015	0.041	0.130	1,123.0	.720
German Vocabulary	-0.281	0.129	4.752	1,53.9	.034

Figure D1. Interaction between *Language Context* and *Target Language*.



Preliminary Results Lexical Decision

Descriptive lexical decision results per condition per session per target language subgroup are presented in Table D6.

The preliminary analysis of lexical decision accuracy revealed a main effect of *Target Language*; see Table D7. Children in the Dutch target language subgroup responded correctly more often than children in the German target language subgroup. As discussed for picture naming RTs, this difference was likely caused by the Dutch target language subgroup's higher target language proficiency scores – again, Dutch proficiency covariates did not significantly improve this model. There were no effects of *Cognate Status* or *Language Context*.

The preliminary analysis of lexical decision RTs revealed main effects of *Cognate Status* and *Language Context*; see Table D8. Participants in both target language subgroups responded faster to cognates than to noncognates, and faster in the dual-language session than in the single-language session. There was no effect of *Target Language* and no significant interactions.

Table D6. Mean lexical decision accuracy and reaction times (standard deviations between parentheses) per condition per target language subgroup.

	German target language subgroup		Dutch target language subgroup	
	Single-language session	Dual-language session	Single-language session	Dual-language session
	Accuracy			
Cognates	0.93 (0.25)	0.92 (0.27)	0.96 (0.19)	0.96 (0.19)
Noncognates	0.94 (0.25)	0.89 (0.31)	0.96 (0.19)	0.97 (0.18)
	Reaction Times			
Cognates	1274 (268)	1247 (283)	1233 (294)	1224 (314)
Noncognates	1312 (265)	1289 (269)	1287 (305)	1245 (309)

Table D7. Parameter estimates of the preliminary model of accuracy in the lexical decision task.

Predictor	*B*	*SE*	*z*	*p*
(Intercept)	1.351	0.576	2.345	.019
Cognate Status	0.093	0.278	0.333	.739
Target Language	-0.907	0.267	-3.402	.001
Language Context	-0.348	0.230	-1.514	.130
Cognate Status x Target Language	-0.091	0.458	-0.199	.843
Cognate Status x Language Context	0.042	0.457	0.093	.926
Target Language x Language Context	-0.591	0.559	-1.058	.290
Cognate Status x Target Language x Language Context	0.547	1.113	0.492	.623
German Vocabulary	2.698	0.695	3.883	< .001

Table D8. Parameter estimates and results from significance tests of the preliminary model of RTs of the lexical decision task.

	Parameter estimates		Significance tests		
Predictor	*B*	*SE*	*F*	*df*	*p*
(Intercept)	7.125	0.015			
Cognate Status	-0.029	0.013	5.057	1,111.4	.026
Target Language	0.026	0.028	0.722	1,66.9	.399
Language Context	-0.029	0.010	9.463	1,488.7	.002
Cognate Status x Target Language	-0.012	0.020	0.344	1,203.3	.558
Cognate Status x Language Context	0.003	0.020	0.019	1,203.5	.891
Target Language x Language Context	0.012	0.025	0.248	1,112.8	.620
Cognate Status x Target Language x Language Context	-0.017	0.050	0.110	1,111.4	.741

Data availability statement

The data and analysis script used can be found on this project's entry on the Open Science Framework (link: https://osf.io/9agup/) under a CC-By Attribution 4.0 International license.

Chapter 5: The Role of Cognates and Language Distance in Simultaneous Bilingual Children's Productive Vocabulary Acquisition

Abstract

This study examined the influence of cognate status and language distance on simultaneous bilingual children's vocabulary acquisition. It aimed to tease apart the effects of word-level similarities and language-level similarities, while also exploring the role of individual-level variation in age, exposure, and proficiency. Children simultaneously acquiring two closely related languages (n = 203) or two more distant languages (n = 109) performed the LITMUS Cross-linguistic Lexical Task (CLT; Haman et al., 2015), a productive vocabulary test containing words that varied in their phonological similarity to their translation equivalents. Children speaking closely related languages obtained higher vocabulary scores than children speaking more distant languages, who showed a stronger positive effect of phonological similarity. The effect of language distance on vocabulary scores was not driven by the presence of cognates in the vocabulary test. These findings show that similarities beyond the phonological level play a role in vocabulary acquisition.

5.1. Introduction

Bilingual children can vary considerably when it comes to their vocabulary acquisition; for example, they may have a larger vocabulary in one language than in the other, and their vocabulary size may or may not differ from their (monolingual) peers. In accounting for such variation, previous research has mostly focused on individual-level factors, such as the amount of exposure children receive in each language (see e.g., Thordardottir, 2011). There are however other factors that also influence bilingual children's vocabulary acquisition, such as word- and language-level factors (e.g., Blom et al., 2020; Bosma et al., 2019). On the word level, meaning and/or form similarities can influence vocabulary acquisition. For example, concepts may be the same across languages: A child who has learned what the word *tree* refers to in English does not need to relearn this concept when acquiring the Dutch translation equivalent *boom*. However, the child still needs to learn the new word form. This is typically easier when translation equivalents sound similar across languages, that is, when they are cognates, such as Dutch *boom* and German *Baum*, both meaning 'tree' (e.g., Bosma et al., 2019; Goriot et al., 2021; Tonzar et al., 2009).

On a more general language level, recent studies have shown that vocabulary acquisition is affected by language distance (e.g., Blom et al., 2020; Floccia et al., 2018), which can be operationalized in multiple ways. For example, the degree of phono-lexical similarity, that is, the number of cognates two languages share, can influence vocabulary acquisition: As cognates are more easily acquired than noncognates, children acquiring two languages that share many cognates may have larger vocabularies in each of their two languages than children acquiring less similar languages (e.g., Blom et al., 2020). An alternative way of operationalizing language distance is through shared morpho-syntactic features. For example, language pairs may share their basic word order (e.g., SVO) or have similar morphological complexity (e.g., the number of morphemes per word), and, for young bilinguals at least, this has also been found to be related to larger vocabularies (Floccia et al., 2018).

The present study relates effects of general language distance (i.e., phono-lexical and/or morpho-syntactic similarity) on vocabulary acquisition to psycholinguistic research on the bilingual lexicon and cognate processing, by considering individual-level, word-level, and language-level variation.

Specifically, we investigate the influence of word-level phonological similarity (i.e., cognate status) on the productive vocabulary of a large group of bilingual children, who are simultaneously acquiring two more closely related or two more distant languages, and who vary in age, language exposure, and proficiency.

In the remainder of this introduction, we first briefly discuss the structure of the bilingual lexicon and bilingual word processing from a psycholinguistic perspective, including the role of individual- and word-level variation. Next, we discuss the role of word- and language-level variation in bilingual children's vocabulary acquisition in more detail, also in relation to individual-level variation.

5.1.1. Bilingual Children's Lexicon

Psycholinguistic studies have shown that bilingual children have one integrated lexicon, containing meaning representations and word form representations from both languages (e.g., Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Koutamanis et al., Chapter 2; Singh, 2014; Von Holzen & Mani, 2012), in much the same way as bilingual adults (see e.g., Dijkstra & van Heuven, 2018, for a review). In such a lexicon, meaning representations are largely shared for translation equivalents (Dijkstra et al., 2019; Dijkstra & van Heuven, 2002; Shook & Marian, 2013). In addition, words which overlap in form also share certain representations, for example, grapheme and/or phoneme representations (e.g., Dijkstra & van Heuven, 2002). For cognates, then, meaning representations as well as multiple grapheme and/or phoneme representations are shared (e.g., /b/ and /m/ for *boom* and *Baum*), which leads to cognate word forms becoming strongly co-activated during processing. As a result, they are processed more quickly and accurately than words without phonological overlap with their translation equivalents. This cognate facilitation effect has been found in multiple types of tasks in studies with bilingual adults (e.g., Costa et al., 2000; Dijkstra et al., 2010; Kroll et al., 2006; Lemhöfer et al., 2004) as well as with bilingual children (e.g., Duñabeitia et al., 2016; Koutamanis et al., Chapter 3, Chapter 4; Poarch & van Hell, 2012; Schröter & Schroeder, 2016).

The strength of the cognate facilitation effect is influenced by multiple individual- and word-level factors. At the individual level, the more proficient a bilingual is in a language, the more active the word forms from that language are assumed to be in the lexicon and the more influence they exert during processing (Dijkstra et al., 2019; Dijkstra & van Heuven, 2002). As a consequence, any cognate effects should be stronger in bilinguals' less proficient language than in their more proficient language. Indeed, many studies with adult second-language learners have found that cognate effects are stronger in the second than in the first language (see van Hell & Tanner, 2012, for a review), with highly proficient second-language learners showing bidirectional effects (e.g., Hoshino & Kroll, 2008; van Hell & Dijkstra, 2002). Similarly, in bilingual children, the more dominant language (often expressed in terms of relative proficiency or exposure) has been found to influence over the processing of the less dominant language more than vice versa (Bosma et al., 2019; Bosma & Nota, 2020; Poarch & van Hell, 2012; Singh, 2014).

At the word level, not all cognates share the same degree of phonological and/or orthographic similarity: Word forms may be identical (e.g., *hotel* is written and pronounced the same in multiple languages), or non-identical but highly similar (e.g., Dutch *boom* and German *Baum*). More similar word forms are assumed to share more grapheme and/or phoneme representations (e.g., Dijkstra & van Heuven, 2002), resulting in stronger co-activation during processing. Indeed, several studies have found stronger cognate facilitation effects for cognates with more similar word forms than for less form-similar cognates (e.g., Bosma et al., 2019; Dijkstra et al., 2010; Von Holzen et al., 2019).

5.1.2. Bilingual Children's Vocabulary Acquisition

5.1.2.1. Phonological Similarity

Cognate facilitation effects are not only found in psycholinguistic experiments, but also in second-language word learning, where cognates are typically more easily acquired than noncognates (e.g., de Groot & Keijzer, 2000; Tonzar et al., 2009). Similarly, cognate status has been shown to influence simultaneous bilingual children's and early second-language learners' vocabulary acquisition. For example, Lindgren and Bohnacker (2020) examined the productive German and Swedish vocabulary of four-to-six-year-old German-Swedish bilingual children. The items in the vocabulary tests were classified as cognates or noncognates based on subjective ratings. Children were found to know more cognates than noncognates in both languages. Goriot et al. (2021) found similar cognate effects, influenced by the degree of word-level phonological similarity (in line with e.g., Dijkstra et al., 2010). They examined the receptive English vocabulary of school-aged Dutch second-language learners of English, and used a continuous measure of phonological similarity rather than a categorical distinction between cognates and noncognates. The more phonologically similar test items were to their Dutch translations, the more accurately children responded.

The role of word-level phonological similarity has also been examined in interaction with individual-level variation. In a longitudinal study, Bosma et al. (2019) examined the receptive Frisian vocabulary of Frisian-Dutch bilingual children with differing degrees of Frisian exposure, at the ages of five to six, six to seven, or seven to eight years. The vocabulary test contained identical cognates (e.g., *poes*, meaning 'cat' in both Frisian and Dutch), non-identical cognates with a phonological regularity involving maximally three phonemes (e.g., Frisian *kâld* and Dutch *koud*, both meaning 'cold', and Frisian *wâld* and Dutch *woud*, both meaning 'forest'), non-identical cognates without (strong) regularity (e.g., Frisian *skriuwe* and Dutch *schrijven*, meaning 'to write'), and noncognates (e.g., Frisian *bern* and Dutch *kind*, meaning 'child'). Cognate facilitation effects were found for children with low and middle degrees of Frisian exposure, but not for children with high Frisian exposure. For the children with low Frisian exposure, the effect was gradual: They performed better on more regular or identical cognates. These findings are in line with the effects of dominance and phonological similarity found in other studies (e.g., Dijkstra et al., 2010; Poarch & van Hell, 2012).

Bosma et al. (2019) not only observed an interaction between phonological similarity and dominance, they also found that phonological similarity interacted with age: Children performed better as they got older, and this was especially the case for cognates with phonological regularities (e.g., *kâld – koud, wâld – woud*). Their explanation for this age effect was "developing metalinguistic skills", which are defined as the ability to reflect on and manipulate structural features of language (e.g., Nagy, 2007). A similar age effect was found by Goriot et al. (2021), where the phonological similarity effect was stronger for older children (eight-to-nine-year-olds and eleven-to-twelve-year-olds) than for younger children (four-to-five-year-olds). They offered a similar explanation for this effect as Bosma et al. (2019), namely that "older pupils may be more able than younger pupils to make use of phonological similarities between item-translation pairs".

Although not explored in these studies, age effects may also be related to the proficiency effects that are often observed in cognate processing studies. Specifically, the older children in Goriot et al. (2021) and Bosma et al. (2019) were likely more proficient in Dutch than the younger children, leading to Dutch words being more active in the lexicon and exerting a larger influence on the processing of other words during testing. On a related note, the older children likely had better literacy skills in one or both languages. As cognates often overlap both phonologically and orthographically, increased literacy skills may also lead to increased co-activation of cognate word forms in the lexicon.

In sum, multiple studies have shown that phonological similarities between words in two languages influence bilingual children's vocabulary acquisition, likely as the result of co-activation in the bilingual lexicon. In both vocabulary testing and in cognate processing studies, similar patterns have been found with regard to individual-level and word-level factors. Specifically, there seem to be stronger effects for more similar word forms, and there is evidence for individual differences in proficiency, exposure, and/or age-related changes in metalinguistic skills influencing the strength of such effects.

5.1.2.2. Language Distance

In addition to phonological similarities between specific words, similarities between languages on a more general level have also been found to influence bilingual children's vocabulary. For example, in a large-scale study with two-year-old bilingual children, Floccia and colleagues (2018) examined the vocabulary (based on parental reports) of toddlers from diverse language backgrounds: All children were simultaneously acquiring English and one of thirteen additional languages. Similarities in morphological complexity and in word order typology positively affected children's receptive vocabulary, whereas phono-lexical similarity (i.e., the average phonological similarity of translation equivalents on a word list) positively affected productive vocabulary.

In a study with older children, Blom et al. (2020) considered language distance in terms of both phono-lexical and morpho-syntactic similarities (pro-drop, morphological richness, and basic word order) and found an influence of language distance on vocabulary acquisition. The children, aged between six and seven years old, were simultaneously acquiring Dutch and either a closely related language (Frisian or Limburgish) or a more distant language (Polish, Turkish, or Moroccan). Children acquiring closely related languages were found to have comparable receptive Dutch vocabulary sizes to a monolingual Dutch control group, whereas children acquiring distant languages obtained lower vocabulary scores. Importantly, this language distance effect remained even when the groups were matched on various individual-level background characteristics, such as parents' Dutch proficiency, and even though the children acquiring distant languages received more Dutch exposure than the children acquiring closely related languages.

The role of individual-level variation and general language distance in vocabulary acquisition was also explored by Bohnacker et al. (2016). They studied the productive German and Turkish vocabulary of bilingual German-Swedish and Turkish-Swedish children between four and seven years old, who were growing up in Sweden. Even though the bilingual Turkish-Swedish children received more exposure to their home language than the bilingual German-Swedish children, there were no differences in vocabulary scores between the two language groups. The authors suggested that this null effect may have resulted from an interaction between exposure and language distance, whereby the German-Swedish children benefitted more from word-level similarities than the Turkish-Swedish children, thus compensating for lower amounts of exposure.

In sum, several studies have shown that general language distance affects bilingual children's vocabulary size, possibly in interaction with individual differences in language exposure. It remains unclear, however, what drives these language distance effects. More specifically, it is not known to what extent such effects result from phonological similarities between specific vocabulary items in the tests employed, leading to co-activation in the lexicon. In addition, it is not clear whether language-level variation plays a role in the extent to which children benefit from word-level phonological similarity as found in studies like Goriot et al. (2021). The present study aims to fill this gap.

Examining the relationship between general language distance effects and well-researched word-level and individual-level factors, such as phonological similarity or proficiency, can contribute to a better theoretical understanding of the mechanisms underlying variation in bilingual children's language processing and acquisition. It also has practical implications, for example with respect to comparing children from multiple language groups using the same vocabulary test. On the basis of their study with Dutch-speaking children acquiring English as a second language, Goriot et al. (2021) argued that variation in phonological similarity should be taken into account in such a comparison. Whether this is indeed appropriate may depend on the research question (see also Blom et al., 2020), but also on how this phonological similarity exactly influences the performance of different groups of bilingual children, that is, children simultaneously acquiring different language combinations.

5.1.3. Present Study

The aim of the present study was to tease apart effects of similarities between languages on a general level (i.e., language distance effects) and phonological similarities between specific items (i.e., cognate effects) in simultaneous bilingual children's vocabulary, while also exploring the role of individual differences in age, exposure, and proficiency. By investigating interactions between individual-level, word-level, and language-level variation, we shed more light on what drives effects of language distance on vocabulary acquisition and to what extent phonological similarity has the same effect in children with different language backgrounds.

Bilingual children simultaneously acquiring Dutch and one additional language performed a picture-naming vocabulary test in Dutch. The children's other language was either closely related to Dutch (German or English) or more distant (Spanish, Greek, or Turkish). The items in the vocabulary test varied in how phonologically similar they were to their translation equivalent in the children's other language. We followed Goriot et al. (2021) in adopting a continuous measure of phonological similarity (see also Schepens, Dijkstra, et al., 2013), and we followed Blom et al. (2020) in using a binary categorization of language distance, which allowed us to examine the effects of phonological similarity in detail across more generally defined language distance groups. The children in our sample varied in age (between 3.4 and 11 years old) and furthermore differed in terms of language exposure and proficiency. This allowed us to explore the role of individual-level variation and to examine the generalizability of language distance and phonological similarity effects over children of different ages and with different exposure and proficiency levels.

First, we predicted that children would perform more accurately on more phonologically similar (i.e., more cognate-like) words, in line with the growing literature on the simultaneous bilingual child's lexicon. Specifically, this prediction follows from the assumption that the bilingual lexicon is shared, so when words overlap in form and meaning, they become co-activated during processing. Second, we predicted that children speaking more closely related languages would score higher on the vocabulary task than children speaking more distant languages, in line with studies such as Blom et al. (2020) and Floccia et al. (2018). If general language distance effects are (mostly) driven by the phonological similarity of the specific items in a vocabulary test, we would expect no interaction between language distance and phonological similarity on children's accuracy. Alternatively, general language distance may modulate effects of phonological similarity: When two languages are closely related and share many cognates, children speaking these languages may become better trained in detecting regularities and similarities, and better able to use these in a vocabulary task. This is in line with the explanations given by Goriot et al. (2021) and Bosma et al. (2019) for the observed age effects in their studies. Our third prediction therefore was that children speaking more closely related languages would show a stronger positive effect of phonological similarity than children speaking distant languages, even after controlling for factors like age and proficiency, both of which we expected to modulate effects of phonological similarity as well (in line with e.g., Poarch & van Hell, 2012).

5.2. Method

5.2.1. Participants

The participants in this study were 312 bilingual children (169 girls, 143 boys) aged between 3.4 and 11 years (M = 7.6, SD = 1.7), who were growing up with Dutch and one additional language: German, English, Spanish, Greek, or Turkish. Most children lived in the Netherlands (n = 280), five were residents of Greece and 27 of Germany. All children had received substantial exposure to both Dutch and the other language, defined as minimally half a day per week, since before age four, and for the majority (n = 249) since birth. No children had received substantial exposure to any other languages for at least 3.5 years prior to testing, and in most cases, none at all.

Following Blom et al. (2020), we grouped children into two language distance groups: a Close group which included the bilingual Dutch-German and Dutch-English children and a Distant group which included the bilingual Dutch-Spanish, Dutch-Greek, and Dutch-Turkish children. This distinction was based on several features of the languages in question, which were independent from the specific test items, namely measures of phono-lexical similarity, language typology, and morpho-syntactic properties of the languages. With regard to phono-lexical similarity, we used Schepens, Dijkstra, et al. (2013) and Schepens, van der Slik, et al., (2013) to distinguish Dutch-German and Dutch-English on the one hand from Dutch-Spanish and Dutch-Greek on the other hand. With regard to typology and morpho-syntax, the Close languages were all Germanic languages which do not allow pro-drop, whereas the Distant languages were more varied: Spanish is a Romance language, Greek is a Hellenic language, and Turkish is a Turkic language, and all three are pro-drop languages (Dryer & Haspelmath, 2013).

Table 5.1 summarizes the children's background characteristics. Socio-economic status (SES) was based on parental education, and more specifically, the average education level of both parents on a three-point scale (primary, secondary, higher). The children in the Close group were older ($t(198) = 2.92$, $p = .004$) and came from a higher SES background ($\chi^2(2) = 20.14$, $p < .001$) than the children in the Distant group. Any non-verbal differences between the groups were assessed using the Alloway Working Memory Assessment – Forward and Backward Digit Span Tests (Alloway, 2012) in Dutch. There were no significant differences between the Close and Distant groups on either the Forward Digit Span ($t(149) = 1.56$, $p = .121$) or Backward Digit Span, although the difference between the groups was approaching significance ($t(154) = 1.95$, $p = .053$).

Table 5.1. Overview of participant characteristics.

	n	Age *M* (*SD*)	Girls / Boys	SES (parental education): *n* primary / *n* secondary / *n* higher	Working memory: Digit Span Forward / Backward
Close	203	7.8 (1.6)	109 / 94	1 / 3 / 199	98.5 (14.1) / 103.9 (13.1)
- Dutch-German	99	8.7 (1.2)	50 / 49	1 / 2 / 96	96.2 (14.7) / 99.8 (12.9)
- Dutch-English	104	6.9 (1.6)	59 / 45	0 / 1 / 103	101.5 (12.8) / 109.2 (11.6)
Distant	109	7.1 (1.9)	60 / 49	0 / 15 / 94	95.2 (14.5) / 100.2 (12.7)
- Dutch-Spanish	54	6.3 (1.5)	28 / 26	0 / 4 / 50	104.4 (15.1) / 107.5 (11.9)
- Dutch-Greek	39	7.5 (1.9)	23 / 16	0 / 3 / 36	93.4 (13.8) / 97.9 (12.7)
- Dutch-Turkish	16	9.0 (1.2)	9 / 7	0 / 8 / 8	89.4 (11.0) / 98.1 (10.9)

Note. For 85 children in the Close group and 36 children in the Distant group, Digit Span scores were not available. Digit Span scores are standard scores, with possible scores ranging from 47 to 153.

Table 5.2 summarizes the children's language exposure and literacy skills in both languages, which were both assessed through an extensive parental questionnaire (Bilingual Language Exposure Calculator, BiLEC; Unsworth, 2013). Language exposure was operationalized as *cumulative* exposure, meaning that not only the length of exposure (i.e., the age of first exposure subtracted from the child's age) was taken into account, but also the proportion of language exposure that was provided to the child in each language for each year of their life (see Unsworth, 2013, for more details). Following Thordardottir (2011), cumulative Dutch exposure was expressed as a percentage of the children's age. For example, a seven-year-old with in total four years of Dutch exposure (as calculated using the BiLEC) had 57% cumulative Dutch exposure. There were no differences between the Close and Distant groups on cumulative Dutch exposure ($t(220.83) = -0.66$, $p = .513$). Literacy was assessed for the children's two languages separately on a four-point scale: 1) not (really) literate, 2) literate, but not as well as peers, 3) literate, as well as peers, or 4) literate, better than peers. There were no differences between the Close and Distant groups on Dutch literacy ($\chi^2(3) = 5.68$, $p = .128$), but the children in the Close group had better literacy skills in their other language than the children in the Distant group ($\chi^2(3) = 8.74$, $p = .033$).

Table 5.2. Overview of participants' language exposure and literacy skills.

	Cumulative Dutch exposure *M* (*SD*)	Literacy in Dutch *n* per level			
		Not (really) literate	Less than peers	As well as peers	Better than peers
Close	53% (19%)	23	21	90	61
- Dutch-German	56% (20%)	1	18	43	34
- Dutch-English	51% (18%)	22	3	47	27
Distant	55% (19%)	13	10	22	16
- Dutch-Spanish	55% (17%)	4	1	9	4
- Dutch-Greek	52% (23%)	9	8	11	11
- Dutch-Turkish	62% (13%)	0	1	2	1
		Literacy in other language *n* per level			
		Not (really) literate	Less than peers	As well as peers	Better than peers
Close		43	56	50	44
- Dutch-German		8	33	25	29
- Dutch-English		35	23	25	29
Distant		21	21	13	5
- Dutch-Spanish		7	2	5	3
- Dutch-Greek		14	16	7	2
- Dutch-Turkish		0	3	1	0

Note. For 10 (out of 203) children in the Close group and 49 (out of 109) in the Distant group, literacy information was not available for one or both languages.

Participant information, stimulus lists, data, and analysis scripts for this study can be retrieved from http://tinyurl.com/EKChapter5OSF.

5.2.2. Materials

The vocabulary test used in this study was the LITMUS Cross-linguistic Lexical Task (CLT; Haman et al., 2015). This test is designed for multilingual children and allows for cross-linguistic comparison. Children's scores on the Dutch version (CLT-NL; van Wonderen & Unsworth, 2021) were used as the dependent variable in this study; see Scoring and Analysis. Other versions of the CLT were used to assess children's proficiency in their other language, namely in German (Rinker & Gagarina, 2017), English (Haman et al., 2013), Spanish (van Wonderen & Unsworth, 2021), and Turkish (Ünal-Logacev et al., 2012). Importantly, these different CLTs are not translations of each other, but have been developed separately according to the same criteria (see Haman et al., 2015, for more information). For Greek, we used the Child Object and Action Test (COAT; Kambanaros et al., 2013), as no CLT was available.

The original CLT, which was aimed at younger children, consisted of 30 nouns and 30 verbs. Because we tested older children, 20 extra items (10 nouns, 10 verbs) were added following the same criteria as used to design the original task. The adaptations of the CLTs used for this study thus consisted of 80 color drawings, 40 depicting objects and 40 depicting actions, corresponding to 40 target nouns and 40 target verbs. The COAT consisted of 75 color photographs, 36 depicting objects and 39 depicting actions.

The images were shown one by one on a laptop – or, for children who were tested remotely (see Procedure), via an online testing platform. The child's task was to name the object or action using a single noun or verb, respectively. For nouns, the experimenter prompted the child by asking "What is this?", and for verbs, by asking "What is he/is she/are they doing?". If a child did not understand what was depicted or provided an incorrect answer, pre-specified elicitation questions were asked. For example, if a child called a lemon an orange, the experimenter would ask the child "And if it is yellow, do you know what it is called?" The experimenter could also ask the child if they knew another word for the object or action in question.

Following Goriot et al. (2021), a continuous phonological similarity measure (*PhonSim*) was calculated for each CLT-NL target word and its translation in each of the five other languages. *PhonSim* ranged from 0 (no phonological overlap) to 1 (full phonological overlap) and was based on the

Levenshtein Distance between the phonological transcriptions of the translation pairs. For example, the Dutch word *slang* /slɑŋ/ 'snake' and its German translation *Schlange* /ʃlaŋə/ have a Levenshtein Distance of 3, as they differ in three phonemes: the first (/s/ vs. /ʃ/), third (/ɑ/ vs. /a/), and final (/ə/ only in German). Levenshtein Distance was normalized for word length (in this example: five phonemes in the longest word) and reversed to obtain the *PhonSim* measure (in this example: 1 - 3/5 = 0.4). We followed the same translation and transcription procedures as Goriot et al. (2021); see Appendix E for more details. For Dutch-German and Dutch-English, we also obtained subjective judgments on phonological overlap, which correlated strongly with *PhonSim* (0.82 and 0.83, respectively; see Appendix E).

The average *PhonSim* for all CLT-NL-items differed between languages ($F(4,395) = 23.23$, $p < .001$). A post-hoc Tukey test showed that *PhonSim* did not differ between the languages within the Close group (Dutch-German vs. Dutch-English: $p = .088$), nor within the Distant group (Dutch-Spanish vs. Dutch-Greek: $p = .907$; Dutch-Spanish vs. Dutch-Turkish: $p = .897$; Dutch-Greek vs. Dutch-Turkish: $p = .391$), but there were significant differences for each language combination across language distance groups, that is, between Dutch-German and Dutch-Spanish ($p < .001$), Dutch-Greek ($p < .001$), and Dutch-Turkish ($p < .001$), respectively; and between Dutch-English and Dutch-Spanish ($p = .002$), Dutch-Greek ($p < .001$), and Dutch-Turkish ($p < .001$), respectively.

5.2.3. Procedure

The CLTs and the COAT were administered as part of a larger test battery in eight separate studies within one project (see Koutamanis et al., Chapter 2, Chapter 3, Chapter 4; Unsworth, 2023; van Dijk, 2021; van Wonderen & Unsworth, 2021). All children were tested individually at home. In most cases, an experimenter was physically present with the child, but in some cases ($n = 64$), testing took place remotely via a video call because of COVID-19-related restrictions.

The nouns and verbs in the tests were administered using the same procedure in separate blocks. Each block was preceded by two practice items. The order between the noun block and the verb block was counterbalanced across participants within each individual study except for 64 children who participated in Koutamanis et al. (Chapter 3, Chapter 4), as the set-up of these particular studies meant that the verb block was always administered before the noun block. For these children, there was also a break between the two blocks during which another task was administered. There were no time limits, but typically each test took between 10 and 20 minutes to complete.

Children's parents or caregivers gave informed consent before the testing session. The children received a book as thanks for their participation.

5.2.4. Scoring and Analysis

The CLTs in German, English, Spanish, and Turkish and the Greek COAT were scored according to the guidelines given in Bohnacker et al. (2016). In addition to exact target responses, these guidelines also allow certain alternatives, such as (comprehensible) mispronunciations, synonyms, or more specific responses, if they are adult-like and correspond to the picture. For the CLT-NL, only trials in which a child gave the exact target response were scored as correct, as *PhonSim* was only available for target words. When the child was unable to provide an answer, the trial was scored as incorrect. Trials where no answer was given because of technical (e.g., software) issues or where the experimenter or someone else (e.g., a sibling who entered the room) said the target word before the child answered were excluded. This was the case for 80 of the total 24,960 CLT-NL trials (i.e., 0.3%).

Children's accuracy on the CLT-NL items was analyzed using generalized linear mixed effects models with the glmer function from the lme4 package version 1.1-27.1 (Bates et al., 2015). The model contained the following predictors: *PhonSim*, *Language Distance* (Close vs. Distant), *Other-Language Vocabulary* (i.e., children's scores on the CLT or COAT in their other language), and *Age*, as well as interactions between *PhonSim* and each of the other predictors. The model also contained *SES* and *Cumulative Dutch Exposure* (as a percentage of age) as covariates, to control for differences between the groups and variation within the groups that may influence children's Dutch vocabulary.[17] Finally, the model contained random intercepts for participant and item.

The continuous predictors *PhonSim*, *Cumulative Dutch Exposure*, and *Other-Language Vocabulary* were mean-centered. Orthogonal sum-to-zero contrast coding was applied to the categorical predictor *Language Distance*, with Distant coded as -0.5 and Close as 0.5. Helmert coding was applied to the covariate *SES*, where primary education (coded as -0.67) was first compared to secondary and higher education (both coded as 0.33), and next secondary education (coded as -0.5) was compared to higher education (coded as 0.5).

5.3. Results

Table 5.3 shows children's vocabulary scores in their other (i.e., non-Dutch) language. These were significantly higher for children in the Close group than for children in the Distant group ($t(190.47) = 8.02$, $p < .001$).

Table 5.3. Children's average scores (standard deviations between parentheses) on the CLT or COAT in their other language, per language group and per language distance group.

	Other-Language CLT/COAT scores
Close	72% (18%)
- Dutch-German	79% (15%)
- Dutch-English	65% (19%)
Distant	52% (22%)
- Dutch-Spanish	51% (19%)
- Dutch-Greek	50% (25%)
- Dutch-Turkish	61% (21%)

[17] The groups also differed on other-language literacy, but because this information was not available for all children and because it was a relatively crude measure compared to the other variables, it was not included in the main analysis, but in additional analyses (see Additional Analyses and Appendix G).

Table 5.4 shows the correlations between children's other-language vocabulary scores and other variables. *Other-Language Vocabulary* correlated moderately and positively with *Age* and *Other-Language Literacy*, and negatively with *Cumulative Dutch Exposure*.

Table 5.4. Correlations between the participant variables included in the analysis.

	1	2	3	4
1. Other-Language Vocabulary	–			
2. Other-Language Literacy	0.54***	–		
3. Cumulative Dutch Exposure	-0.40***	-0.26***	–	
4. Age	0.46***	0.40***	0.01	–

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

Note. Literacy is treated on a continuous scale here, but it was in fact measured and analyzed on a categorical scale. Boxplots illustrating the relation between literacy on a categorical scale and the other variables are given in Appendix F.

Descriptive results of the CLT-NL for both language distance groups are presented in Table 5.5. For illustrative purposes, the data are presented separately for children with higher and lower percentages of other-language vocabulary, and for words with higher and lower *PhonSim* (both based on a median split).

Table 5.6 shows the results of the analysis. It revealed a main effect of *PhonSim*, where children responded more accurately to items that were more phonologically similar to their translation equivalent. There was also a main effect of *Language Distance*, where children speaking closely related languages responded more accurately than children speaking more distant languages, and an interaction between *PhonSim* and *Language Distance*. As illustrated in Figure 5.1, the effect of phonological similarity was stronger for the Distant group than for the Close group. In addition, there were positive main effects of *Cumulative Dutch Exposure* and *Age* on accuracy, but no interaction between *Age* and *PhonSim*. Finally, there was an interaction effect between *PhonSim* and *Other-Language Vocabulary*. As illustrated in Figure 5.2, the effect of phonological similarity was stronger for children with higher proficiency in their other language.

Table 5.5. Mean accuracy (standard deviations between parentheses) per language distance group, for children with higher and lower other-language vocabulary, on words with higher or lower phonological similarity (based on a median split for other language proficiency and *PhonSim*).

	Close group	Distant group	Both groups
All children	0.75 (0.43)	0.65 (0.48)	0.71 (0.45)
- Higher PhonSim	0.77 (0.42)	0.69 (0.46)	0.76 (0.43)
- Lower PhonSim	0.71 (0.46)	0.63 (0.48)	0.67 (0.47)
Higher other-language vocabulary	0.77 (0.42)	0.64 (0.48)	0.74 (0.44)
- Higher PhonSim	0.80 (0.40)	0.69 (0.46)	0.79 (0.41)
- Lower PhonSim	0.72 (0.45)	0.62 (0.49)	0.69 (0.46)
Lower other-language vocabulary	0.72 (0.45)	0.65 (0.48)	0.68 (0.47)
- Higher PhonSim	0.73 (0.44)	0.69 (0.46)	0.72 (0.45)
- Lower PhonSim	0.69 (0.46)	0.64 (0.48)	0.65 (0.48)

Table 5.6. Parameter estimates from the accuracy model of the full dataset.

Predictor	*B*	*SE*	*z*	*p*
(Intercept)	-1.398	0.445	-3.143	.002
PhonSim	1.675	0.571	2.931	.003
Language Distance	0.399	0.119	3.366	.001
Other-Language Vocabulary	0.002	0.003	0.693	.489
Age	0.437	0.033	13.281	< .001
Cumulative Dutch Exposure	0.024	0.003	8.191	< .001
SES: primary vs. other levels	-1.165	0.888	-1.311	.190
SES: secondary vs. university level	0.202	0.215	0.940	.347
PhonSim x Language Distance	-0.639	0.321	-1.993	.046
PhonSim x Other-Language Vocabulary	0.031	0.006	5.155	< .001
PhonSim x Age	-0.077	0.076	-1.013	.311

Figure 5.1. Interaction between *Language Distance* and *PhonSim*.

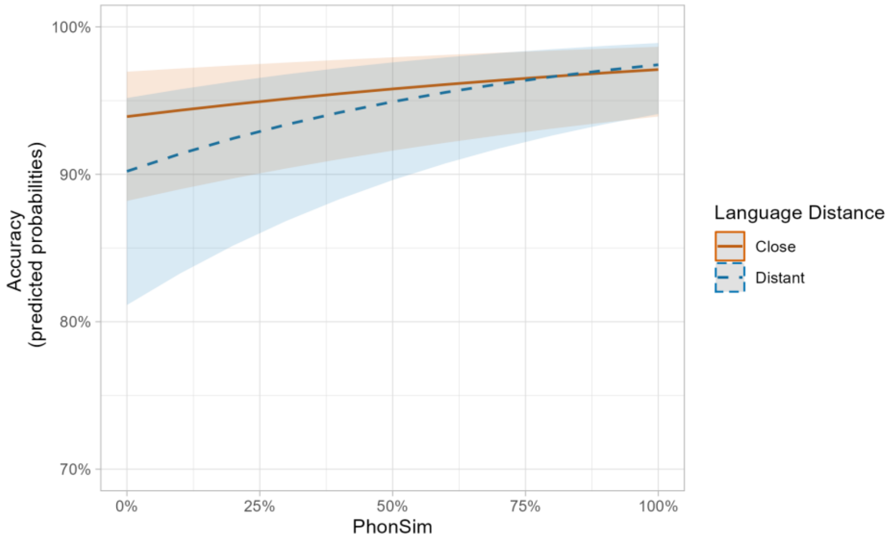
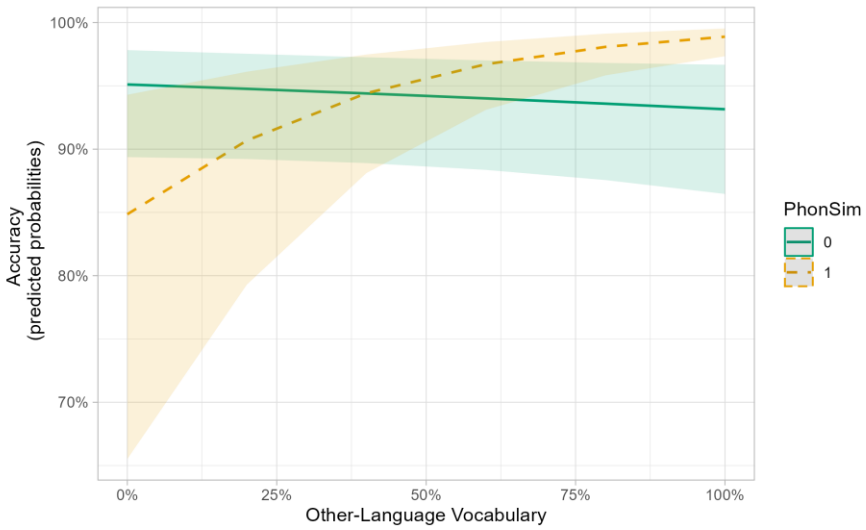


Figure 5.2. Interaction between *Other-Language Vocabulary* and *PhonSim*. For *PhonSim*, the lowest and highest values are plotted.



5.3.1. Additional Analyses

Because average *PhonSim* differed between the language groups, with more highly phonologically similar words in the Close languages than in the Distant languages (see Materials), we performed an additional analysis to gain more insight into the role of cognates in phonological similarity and language distance effects. Specifically, we excluded all (near-)identical cognates, defined here as having a Levenshtein Distance of no more than 3. We removed 53 items, leaving 347 of the total 400 items.

The results for this cognate-reduced subset are presented in Table 5.7. As for the full dataset, this analysis revealed main effects of *Language Distance*, *Age*, and *Cumulative Dutch Exposure*, but there was no main effect of *PhonSim* and no interaction between *PhonSim* and *Language Distance*. The interaction between *PhonSim* and *Other-Language Vocabulary* revealed a similar pattern to the full dataset, as illustrated in Figure 5.3.

Figure 5.3. Interaction between *Other-Language Vocabulary* and *PhonSim* in the cognate-reduced analysis. For *PhonSim*, the lowest and highest values are plotted.

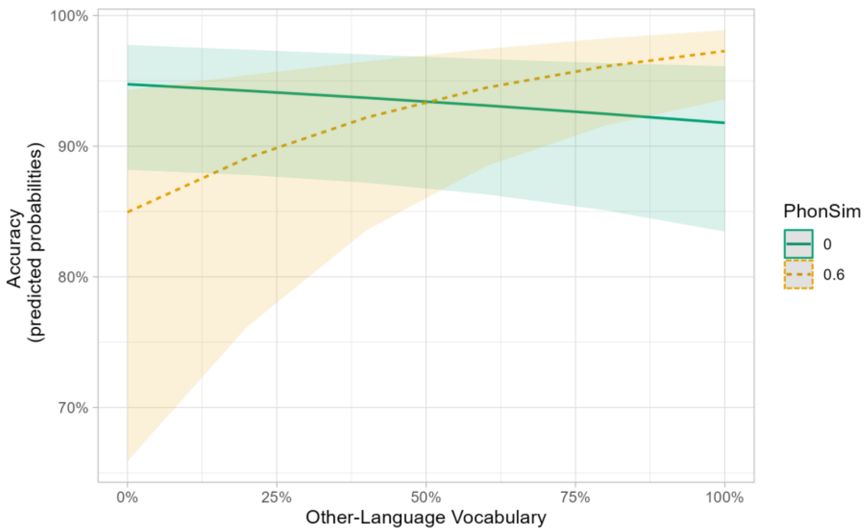


Table 5.7. Parameter estimates from the accuracy model of the cognate-reduced subset.

Predictor	*B*	*SE*	*z*	*p*
(Intercept)	-1.617	0.462	-3.503	< .001
PhonSim	-0.272	0.903	-0.301	.763
Language Distance	0.542	0.122	4.452	< .001
Other-Language Vocabulary	-0.0005	0.003	-0.144	.886
Age	0.447	0.034	13.020	< .001
Cumulative Dutch Exposure	0.025	0.003	8.324	< .001
SES: primary vs. other levels	-0.960	0.929	-1.034	.301
SES: secondary vs. university level	0.185	0.222	0.831	.406
PhonSim x Language Distance	-0.103	0.470	-0.220	.826
PhonSim x Other-Language Vocabulary	0.039	0.010	4.036	< .001
PhonSim x Age	0.112	0.117	0.954	.340

Two additional subsets were analyzed. First, because the children in the Close and Distant group differed in *Age*, *SES*, and *Other-Language Literacy* (see Participants), we re-ran the analysis on a subset where the two language distance groups were matched on these variables, to further ensure that any effects of interest did not stem from these sample differences. Second, as Turkish is arguably more distant from Dutch than Spanish and Greek, we re-ran the analysis on a subset without the bilingual Dutch-Turkish children, to ensure that any language distance effects were not driven by this language combination. Both these subset analyses revealed the same patterns as the main analysis (see Appendix G for details).

Finally, all analyses, including the subset analyses, were repeated with the addition of *Other-Language Literacy* and its interaction with *PhonSim*. Helmert coding was applied to *Other-Language Literacy*: The lowest literacy level (not literate; coded as -0.75) was compared to the three higher literacy levels (all coded as 0.25), next the second lowest level (literate, but not as well as peers; coded as -0.67) was compared to the two higher literacy levels (both coded as 0.33), and finally the second highest level (literate, as well as peers; coded as -0.5) was compared to the highest level (literate, better than peers; coded as 0.5). Adding *Other-Language Literacy* did not change any outcome patterns and there were no significant effects of *Other-Language Literacy*, but in the cognate-reduced subset, there was a trend towards an interaction between *Other-Language Literacy* and *PhonSim*. Details can be found in Appendix G.

5.4. Discussion

The present study investigated how individual-level, word-level, and language-level variation affect bilingual children's vocabulary acquisition. By teasing apart general language distance and word-level phonological similarity, we aimed to gain a better understanding of what drives language distance effects and to what extent effects of phonological similarity between specific words and their translations are generalizable across children with different language backgrounds. To this end, we examined the productive Dutch vocabulary of bilingual children simultaneously acquiring Dutch alongside either a closely related or more distant language, using a vocabulary test containing items which varied in phonologically similarity to their translation equivalent in the children's other language. We first discuss the effects of phonological similarity and language distance, before considering the role of individual differences on phonological similarity effects.

5.4.1. Phonological Similarity and Language Distance

In line with our first prediction, there was an effect of phonological similarity: Children performed more accurately on words that were more phonologically similar to their translation equivalent. This prediction was based on the widely accepted view of the bilingual lexicon that the two languages are represented in an integrated lexicon and can become co-activated during processing (Dijkstra et al., 2019; Dijkstra & van Heuven, 2002; Kroll et al., 2006; Shook & Marian, 2013). The resulting cognate facilitation effects have been found in many word processing studies (see Dijkstra & van Heuven, 2018) as well as in second-language word learning studies (e.g., de Groot & Keijzer, 2000; Tonzar et al., 2009) and in studies examining bilingual children's vocabulary (Bosma et al., 2019; Goriot et al., 2021; Lindgren & Bohnacker, 2020). The results of the present study add more evidence for cognate effects in simultaneous bilingual children's vocabulary, in more language combinations and age ranges.

In the cognate-reduced analysis, where we excluded (near-)identical cognates, children's accuracy on the vocabulary test was no longer predicted by phonological similarity. This shows that the phonological similarity effect in the full dataset was indeed a cognate effect, that is, it was driven by the words in the vocabulary test which were phonologically the most similar to their translation equivalents (in line with e.g., Dijkstra et al., 2010). A limitation of our study with respect to this issue is that phonological similarity was not manipulated to be evenly distributed across items and languages, because the CLT is a test designed to assess vocabulary acquisition and not cognate effects. Future studies with bilingual children could further examine the role of phonological similarity in cognates versus noncognates by conducting controlled experiments, manipulating the degree of overlap in a balanced manner.

In addition to phonological similarities between specific test items, we tested for effects of general language distance. This was defined based on both phono-lexical overlap and shared morpho-syntactic features, independently of the items in the test. In line with our second prediction and with Blom et al. (2020) and Floccia et al. (2018), children speaking closely related languages obtained higher Dutch vocabulary scores than children speaking more distant languages. The language combinations in our study were different from those in previous studies, suggesting that language distance effects on vocabulary acquisition are generalizable over languages. For example, in Blom et al. (2020), the Close language combinations were Dutch-Frisian and Dutch-Limburgish, which are all national or regional languages of the Netherlands, whereas in our study all Close languages originated from different countries. Despite the languages in our study being less closely related than those in Blom et al. (2020), we still found similar results for language distance.

A limitation of the present study concerning language distance was that the Distant languages were more of a mixed bag than the Close languages: Greek, Spanish, and Turkish come from different language families. Additional analyses excluding the most distant language Turkish (see Appendix G) suggested that any differences between these three languages in terms of their distance to Dutch did not affect our findings. However, further research with more language combinations is needed to confirm whether this is indeed the case, perhaps operationalizing language distance using a continuous rather than a categorical variable.

A key question in the present study was whether effects of language distance on bilingual children's accuracy in vocabulary tests are purely driven by the presence of cognates. Two findings indicate that this is not the case. First, in the main analysis language distance significantly interacted with phonological similarity, and second, and crucially, in the cognate-reduced analysis language distance still influenced children's vocabulary. Taken together, our results show that language distance effects are not purely driven by the presence of cognates, but that language distance influences children's knowledge of noncognates as well as the strength of the cognate facilitation effect.

At the same time, the direction of the interaction differed from our predictions. Specifically, our third prediction was that phonological similarity would have a stronger effect for children acquiring closely related languages, as a result of more experience with cognates. Our results, in contrast, showed that phonological similarity had a stronger effect for children acquiring more distant languages. A possible explanation for this finding is that experience with phonologically similar words influences children's sensitivity to and/or awareness of cognates, but in a different way than we expected: For children speaking combinations of languages that are more distant, cognates may stand out more compared to other words, whereas for children speaking closely related languages, the difference between words with and without (strong) phonological similarity may be less striking (see also Broersma, 2009). As such, children speaking distant languages may develop more awareness of cognates, leading to stronger cognate effects. The lack of a significant interaction between language distance and phonological similarity in the cognate-reduced subset supports our interpretation in terms of cognate processing, again showing that effects were driven by highly phonologically similar items.

The apparent difference between words with and without (strong) phonological similarity may be influenced by similarities on other levels, such as the phonetic or morphological level. For example, English *saw* and its Dutch translation *zaag* have a low phonological similarity, but share phonetic features, as do Dutch *duiken* and German *tauchen* 'to dive', which also share morphological elements. As such, children may perceive these words to be as comparable to each other in form as cognates with a higher phonological similarity (e.g., Dutch *lamp* and English *lamp* or German *Lampe*), causing the latter to stand out less. As similarities of this kind are likely more common between words from closely related languages than between words from distant languages, children speaking closely related languages may become less aware of cognates. Note that cognate awareness has also been related to metalinguistic skills (see e.g., Bosma et al., 2023; Chen et al., 2012), a topic we discuss in the next section.

A practical implication of the finding that word-level and language-level variation interact concerns the comparison of multiple language groups using a single vocabulary test, as discussed in Goriot et al. (2021). As some language pairs share more cognates than others, the distribution of phonological similarity in a test should be representative of these languages. If cognates are over- or underrepresented in a test, children's vocabulary size may be over- or underestimated. The stronger phonological similarity effect for children speaking distant languages implies that a close examination of test items and consideration of possible effects of cognates is especially important when comparing multiple distant language groups to each other or to close language groups, but possibly less so when comparing children speaking multiple closely related languages. Put differently, the risk of over- or underestimating vocabulary size because of cognate test items seems to be smaller for children speaking closely related languages.

In sum, our findings show that both general language distance effects and cognate effects are generalizable across language combinations. Moreover, they suggest that general language distance effects on vocabulary size are not purely driven by phonological similarity of specific test items, but that there is something more to language distance, possibly related to similarities on other linguistic levels and/or differences in bilingual children's cognate awareness. Future studies are needed to further explore the factors that may contribute to general language distance effects, for example by testing for effects of children's cognate awareness in word processing experiments in which similarities on multiple linguistic levels are manipulated.

5.4.2. Individual Differences

In addition to examining the relationship between phonological similarity and language distance, our study also provided insights into several individual-level factors influencing vocabulary size and phonological similarity effects. As expected, children's vocabulary scores were positively influenced by their age and the amount of exposure they had received in Dutch (expressed as a percentage of age). Our study also revealed interaction effects between phonological similarity and children's proficiency in their other language, but no interaction effects between phonological similarity and age.

The interaction between phonological similarity and other-language vocabulary, where the effect of phonological similarity was stronger for more proficient children, is in line with the literature on cognate processing: Many studies with adults (see van Hell & Tanner, 2012) and children (Bosma & Nota, 2020; Poarch & van Hell, 2012) have found stronger cognate effects in participants' weaker language. This may be explained in terms of both representation and activation: The more words children know in their other language and the more active these words are in the lexicon, the more they influence the processing of other words (Dijkstra et al., 2019; Dijkstra & van Heuven, 2002). For children with low other-language proficiency, no cognate effects may emerge because the cognate word forms are not (well-)represented and/or not sufficiently active in their lexicon.

Similar to our findings with regard to language distance, the role of other-language proficiency has implications for using vocabulary tests with different groups of children. Not only the number of cognates in the test should be examined, especially – as discussed above – for children acquiring more distant languages, but preferably some measure of children's proficiency in their other language should also be included. This was not the case in previous studies (e.g., in Bosma et al., 2019; Goriot et al., 2021). Ideally, in future studies both overall other-language vocabulary size and children's knowledge of the translations of the specific test items should be assessed, as both the levels of activation and the extent to which specific words forms are represented in the lexicon may influence bilingual word processing.

Unlike in the studies by Goriot et al. (2021) and Bosma et al. (2019), we did not find the strength of the phonological similarity effect to be sensitive to age. It is possible that the age effects in previous studies were in fact other-language proficiency effects in disguise. Especially in Goriot et al. (2021), where effects were examined in English and the 'other language' was the children's native language Dutch, age and Dutch proficiency were likely highly correlated. In our study, where effects were examined in Dutch and most children grew up in the Netherlands, their proficiency in their other language was only moderately correlated with age. For future research, we recommend including not only age but also other-language proficiency, as well as factors such as exposure and literacy skills, to better account for variation between children as well as the different role that each of these factors may play.

The different individual-level factors discussed in this study are not only related to each other, but also to metalinguistic skills. For example, older children typically have larger vocabularies than younger children, as well as more developed metalinguistic skills (as referred to in Bosma et al., 2019 and Goriot et al., 2021; see also e.g., Bialystok et al., 2014), and metalinguistic skills have been found to play a role in both vocabulary acquisition and literacy skills (Nagy, 2007). In addition, as discussed above, cognate awareness, which has also been related to metalinguistic skills (Bosma et al., 2023; Chen et al., 2012), may be influenced by language distance. Metalinguistic skills were not assessed directly in the present study, but future studies could include these to arrive at a more comprehensive understanding of bilingual children's cognate processing.

5.4.3. Conclusion

By testing productive vocabulary in a diverse group of over 300 simultaneous bilingual children, this study has shown that language distance influences bilingual children's vocabulary acquisition as well as the strength of phonological similarity effects. Specifically, children speaking more closely related languages obtained higher vocabulary scores, while children speaking more distant languages showed a stronger positive effect of phonological similarity. Importantly, the effect of language distance on vocabulary scores was not purely driven by the presence of cognates in the vocabulary test. Furthermore, by repeating our analysis with and without cognates and by examining the role of individual differences between children, we have shown that phonological similarity effects in vocabulary tests are cognate facilitation effects, driven by co-activation within the integrated bilingual lexicon and influenced by children's proficiency.

To our knowledge, this study is the first to include both item-specific phonological similarity and general language distance, as well as individual differences in age, exposure, proficiency, and literacy. By considering these different sources of variation in a large and diverse sample, we not only shed more light on the relationship between these factors and the mechanisms underlying their effects on cognate and noncognate acquisition and processing, but we also demonstrated the robustness and generalizability of both cognate facilitation and language distance effects on bilingual children's vocabulary acquisition.

Appendix E

We followed the procedure described in Goriot et al. (2021) to obtain phonological similarity (*PhonSim*) for the CLT items. For each language combination included in this study, (near-)native speakers of the two languages provided possible translations of the CLT items based on available dictionary translations, complemented by their intuitions. One translation was chosen, maximizing the match with the image and the Dutch target word and, in case there were multiple suitable candidates, minimizing differences in frequency between the two translation equivalents. Frequency was taken from the SUBTLEX-corpus in available languages (Dutch: Keuleers et al., 2010; German: Brysbaert et al., 2011; English: van Heuven et al., 2014; Spanish: Cuetos et al., 2011; Greek: Dimitropoulou et al., 2010); for Turkish, we used Acar et al. (2016). The items and their translations were transcribed into X-SAMPA based on available dictionary transcriptions.

PhonSim was then calculated as follows. First, the phonological Levenshtein Distance was calculated, which is the number of insertions, deletions, and substitutions required to get from one transcription to the other. For example, the phonological Levenshtein Distance between the Dutch word *slang* 'snake', transcribed as [slAN], and its German translation *Schlange* [SlaN@] is 3. The Levenshtein Distance was then normalized, that is, divided by the length of the longest transcription of the two (in this case five, as [SlaN@] consists of five phonemes). *PhonSim* was the normalized Levenshtein Distance subtracted from 1. For [slAN] and [SlaN@], this was 1 - 3/5 = 0.4.

For English and German, we calculated the correlation between *PhonSim* and subjective ratings of phonological similarity. The raters were 20 highly proficient speakers of Dutch and German (17 women, 3 men), aged between 19 and 43 ($M = 25$, $SD = 5$), and 21 highly proficient speakers of Dutch and English (19 women, 2 men), aged between 18 and 43 ($M = 25$, $SD = 6$) who were naïve to the purposes of the study. They rated the phonological similarities between pre-recorded CLT-items and their translations on a scale of 1 (completely different) to 7 (completely the same). The correlations between these subjective ratings and *PhonSim* were 0.82 and 0.83 for Dutch-German and Dutch-English, respectively. This suggests that *PhonSim* is an ecologically valid measure of form-similarity (see also Goriot et al., 2021, for similar findings).

Appendix F

Figure F1. Relation between *Other-Language Literacy* and *Other-Language Vocabulary*.

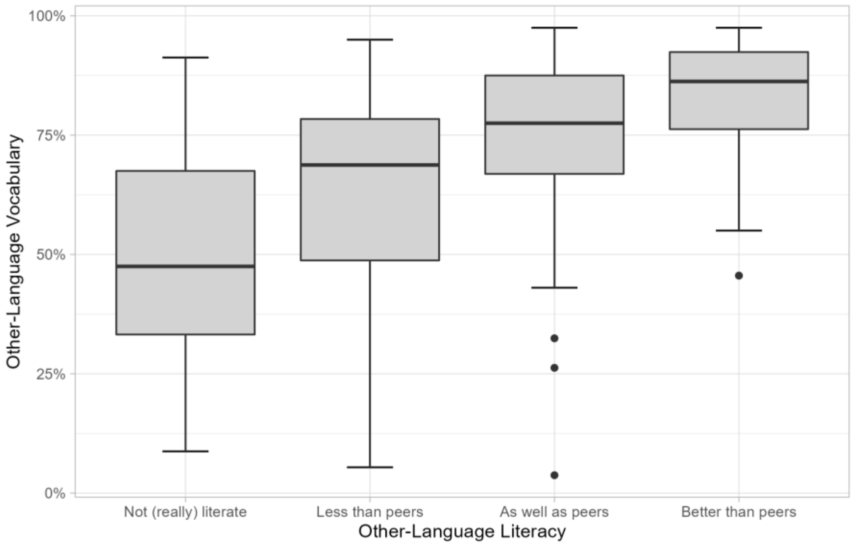


Figure F2. Relation between *Other-Language Literacy* and *Cumulative Dutch Exposure*.

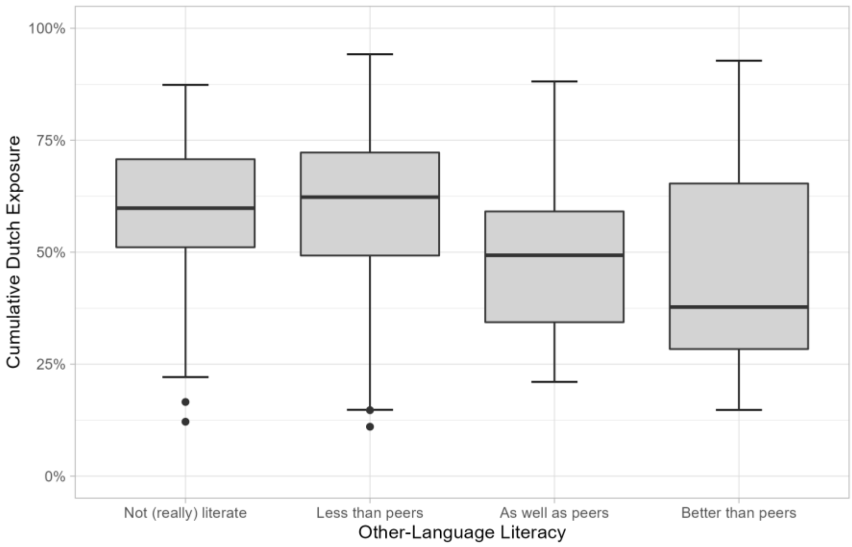
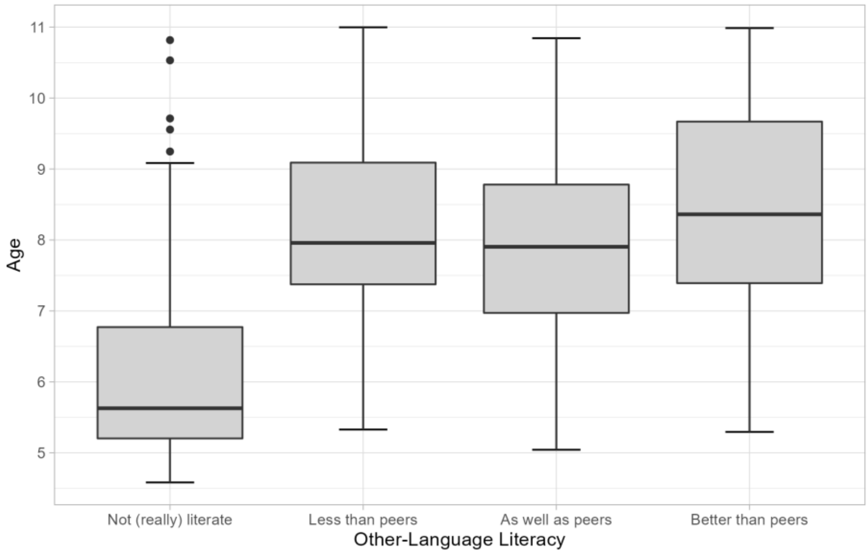


Figure F3. Relation between *Other-Language Literacy* and *Age.*



Appendix G

Subset Analyses

As the children in the Close group were older, came from higher SES backgrounds, and were more literate in their other (i.e., non-Dutch) language, we repeated the analysis with a subset in which the groups were matched on these factors. We only included children aged 5 and older, with parents who had obtained a university degree, leaving 277 (out of 312) participants. They did not differ on age (t(147.8) = 1.34, p = .182), SES (university level for all children), Forward Digit Span score (t(103.27) = 0.20, p = .843), Backward Digit Span score (t(107.85) = 0.928, p = .355), cumulative Dutch exposure (t(146.8) = -1.22, p = .223), Dutch literacy ($\chi^2(3)$ = 3.54, p = .315), or other-language literacy ($\chi^2(3)$ = 6.46, p = .091). We also performed an analysis in which bilingual Dutch-Turkish children were excluded, as Turkish is arguably more distant from Dutch than the other languages in the Distant group.

Table G1 presents the model of the subset in which language distance groups were matched on *Age*, *SES*, and *Other-Language Literacy*. Table G2 presents the model of the subset without bilingual Dutch-Turkish children. Both subsets revealed the same patterns as in the main analysis.

Table G1. Parameter estimates from the accuracy model of the subset in which language distance groups were matched on age, SES, and other-language literacy.

Predictor	*B*	*SE*	*z*	*p*
(Intercept)	-1.433	0.360	-3.981	< .001
PhonSim	1.476	0.641	2.304	.021
Language Distance	0.313	0.128	2.442	.015
Other-Language Vocabulary	0.003	0.003	1.017	.309
Age	0.410	0.036	11.265	< .001
Cumulative Dutch Exposure	0.027	0.003	8.572	< .001
PhonSim x Language Distance	-0.746	0.361	-2.070	.038
PhonSim x Other-Language Vocabulary	0.030	0.006	4.768	< .001
PhonSim x Age	-0.040	0.082	-0.482	.630

Table G2. Parameter estimates from the accuracy model of the subset without bilingual Dutch-Turkish children.

Predictor	*B*	*SE*	*z*	*p*
(Intercept)	-1.281	0.455	-2.816	.005
PhonSim	1.669	0.581	2.873	.004
Language Distance	0.327	0.125	2.611	.009
Other-Language Vocabulary	0.004	0.003	1.361	.174
Age	0.436	0.034	12.753	< .001
Cumulative Dutch Exposure	0.026	0.003	8.568	< .001
SES: primary vs. other levels	-0.968	0.907	-1.068	.285
SES: secondary vs. university level	-0.116	0.283	-0.409	.682
PhonSim x Language Distance	-0.704	0.340	-2.073	.038
PhonSim x Other-Language Vocabulary	0.030	0.006	4.969	< .001
PhonSim x Age	-0.074	0.078	-0.947	.344

Literacy Analyses

Because the children in the Close group were more literate in their other language than the children in the Distant group and because literacy may modulate cognate effects, we repeated each analysis with *Other-Language Literacy* in interaction with *PhonSim*. Table G3 presents the model for the full dataset, Table G4 for the cognate-reduced subset, Table G5 for the subset with matched language distance groups, and Table G6 for the subset without bilingual Dutch-Turkish children. The outcomes of the models in Table G3, Table G5, and Table G6 were not different from the models without *Other-Language Literacy* as presented in the main text and above.

Table G3. Parameter estimates from the accuracy model with other-language literacy of the full dataset.

Predictor	*B*	*SE*	*z*	*p*
(Intercept)	-1.120	0.491	-2.283	.022
PhonSim	1.502	0.696	2.157	.031
Language Distance	0.398	0.148	2.691	.007
Other-Language Vocabulary	0.003	0.004	0.854	.393
Other-Language Literacy: no literacy vs. higher levels	0.106	0.156	0.681	.496
Other-Language Vocabulary: less than peers vs. higher levels	-0.154	0.140	-1.098	.272
Other-Language Vocabulary: as well as peers vs. better than peers	-0.173	0.168	-1.033	.302
Age	0.411	0.042	9.838	< .001
Cumulative Dutch Exposure	0.025	0.003	7.856	< .001
SES: primary vs. other levels	-0.715	0.920	-0.776	.437
SES: secondary vs. university level	-0.363	0.330	-1.099	.272
PhonSim x Language Distance	-1.071	0.412	-2.601	.009
PhonSim x Other-Language Vocabulary	0.035	0.007	4.822	< .001
PhonSim x Other-Language Literacy: no literacy vs. higher levels	-0.354	0.316	-1.120	.263
PhonSim x Other-Language Literacy: less than peers vs. higher levels	-0.126	0.284	-0.443	.658
PhonSim x Other-Language Literacy: as well as peers vs. better than peers	0.011	0.338	0.033	.974
PhonSim x Age	-0.028	0.090	-0.306	.760

For the cognate-reduced subset, there was a trend towards an interaction between *PhonSim* and *Other-Language Literacy*; see Table G4. Specifically, *PhonSim* tended to play a larger role for children who were more literate than their peers compared to for children who were as literate as their peers, see Figure G1.

Table G4. Parameter estimates from the accuracy model with other-language literacy of the cognate-reduced subset.

Predictor	*B*	*SE*	*z*	*p*
(Intercept)	-1.249	0.511	-2.445	.014
PhonSim	-0.468	1.111	-0.421	.674
Language Distance	0.584	0.152	3.833	< .001
Other-Language Vocabulary	0.0001	0.004	0.026	.979
Other-Language Literacy: no literacy vs. higher levels	0.163	0.164	0.993	.321
Other-Language Vocabulary: less than peers vs. higher levels	-0.148	0.148	-1.002	.316
Other-Language Vocabulary: as well as peers vs. better than peers	-0.135	0.177	-0.761	.447
Age	0.408	0.044	9.278	< .001
Cumulative Dutch Exposure	0.027	0.003	7.941	< .001
SES: primary vs. other levels	-0.506	0.963	-0.525	.599
SES: secondary vs. university level	-0.387	0.345	-1.121	.262
PhonSim x Language Distance	-0.542	0.589	-0.92	.357
PhonSim x Other-Language Vocabulary	0.031	0.012	2.631	.009
PhonSim x Other-Language Literacy: no literacy vs. higher levels	0.263	0.506	0.521	.602
PhonSim x Other-Language Literacy: less than peers vs. higher levels	0.648	0.464	1.397	.162
PhonSim x Other-Language Literacy: as well as peers vs. better than peers	0.971	0.558	1.741	.082
PhonSim x Age	0.181	0.142	1.273	.203

Figure G1. Trend towards interaction between *Other-Language Literacy* and *PhonSim*.

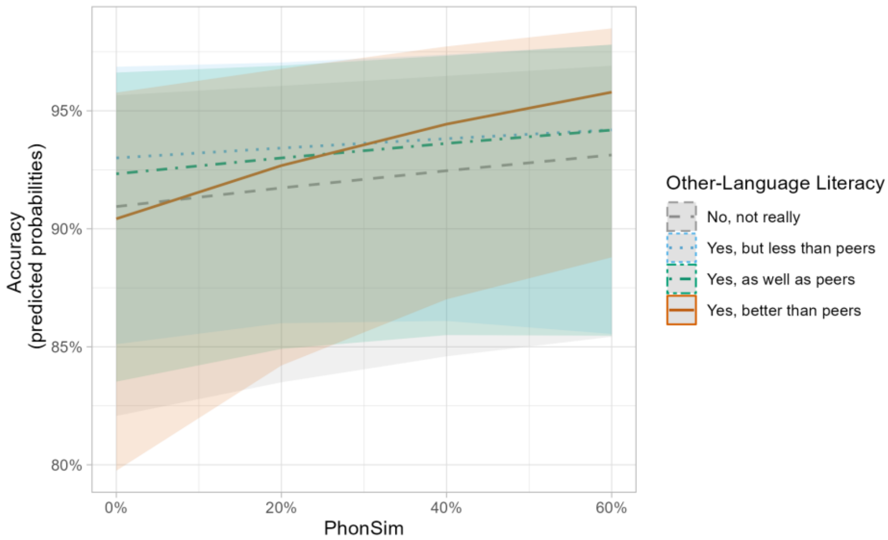


Table G5. Parameter estimates from the accuracy model with other-language literacy of the subset in which language distance groups were matched on age, SES, and other-language literacy.

Predictor	*B*	*SE*	*z*	*p*
(Intercept)	-1.402	0.401	-3.492	< .001
PhonSim	1.612	0.723	2.228	.026
Language Distance	0.318	0.157	2.021	.043
Other-Language Vocabulary	0.003	0.004	0.773	.439
Other-Language Literacy: no literacy vs. higher levels	0.077	0.161	0.477	.633
Other-Language Vocabulary: less than peers vs. higher levels	-0.125	0.144	-0.869	.385
Other-Language Vocabulary: as well as peers vs. better than peers	-0.154	0.174	-0.885	.376
Age	0.401	0.043	9.346	< .001
Cumulative Dutch Exposure	0.027	0.003	7.863	< .001
PhonSim x Language Distance	-1.284	0.441	-2.911	.004
PhonSim x Other-Language Vocabulary	0.036	0.008	4.722	< .001
PhonSim x Other-Language Literacy: no literacy vs. higher levels	-0.344	0.326	-1.058	.290
PhonSim x Other-Language Literacy: less than peers vs. higher levels	-0.121	0.291	-0.416	.677
PhonSim x Other-Language Literacy: as well as peers vs. better than peers	0.036	0.346	0.104	.917
PhonSim x Age	-0.029	0.092	-0.317	.752

Table G6. Parameter estimates from the accuracy model with other-language literacy of the subset without bilingual Dutch-Turkish children.

Predictor	*B*	*SE*	*z*	*p*
(Intercept)	-1.075	0.492	-2.186	.029
PhonSim	1.512	0.696	2.171	.030
Language Distance	0.363	0.152	2.387	.017
Other-Language Vocabulary	0.004	0.004	0.966	.334
Other-Language Literacy: no literacy vs. higher levels	0.107	0.157	0.681	.496
Other-Language Vocabulary: less than peers vs. higher levels	-0.171	0.142	-1.204	.229
Other-Language Vocabulary: as well as peers vs. better than peers	-0.183	0.169	-1.086	.278
Age	0.412	0.042	9.830	< .001
Cumulative Dutch exposure	0.026	0.003	7.996	< .001
SES: primary vs. other levels	-0.625	0.919	-0.679	.497
SES: secondary vs. university level	-0.508	0.351	-1.446	.148
PhonSim x Language Distance	-1.096	0.422	-2.601	.009
PhonSim x Other-Language Vocabulary	0.035	0.007	4.776	< .001
PhonSim x Other-Language Literacy: no literacy vs. higher levels	-0.352	0.317	-1.110	.267
PhonSim x Other-Language Literacy: less than peers vs. higher levels	-0.139	0.285	-0.487	.627
PhonSim x Other-Language Literacy: as well as peers vs. better than peers	0.029	0.338	0.087	.931
PhonSim x Age	-0.029	0.090	-0.323	.747

Chapter 6: General Discussion

The goal of this thesis was to examine how the lexicon of simultaneous bilingual children is organized and accessed during word retrieval. As such, it brought together research on cross-linguistic influence (CLI) in the lexicons of bilingual adults and bilingual children. Psycholinguistic research on the bilingual lexicon in adults, usually second language (L2) learners, has focused on two related questions: whether the two languages are represented in separate lexicons or in an integrated lexicon, and whether access to the lexicon(s) is language-selective or language-nonselective (see e.g., Dijkstra & van Heuven, 2018). Studies with adult L2 learners, as well as more recent studies with bilingual children, provide evidence that the bilingual lexicon is integrated and accessed language-nonselectively. These properties result in CLI at the lexical level, such as between-language priming effects and cognate effects (see e.g., Dijkstra & van Heuven, 2018). In child research, CLI has been mostly examined at the level of morpho-syntax (e.g., Serratrice, 2013; van Dijk, 2021), with attention for differences between individual children and other factors that predict when CLI does and does not emerge.

The studies in this thesis tested for different forms of lexical CLI in school-aged simultaneous bilingual children, in particular for between-language priming effects and cognate effects. The studies applied techniques commonly used with adults, such as lexical decision, or used with both adults and children, such as picture naming or picture selection. They manipulated various factors that may modulate the strength of lexical CLI, thereby examining the role of a) individual-level variation, which has received much attention in the field of child bilingualism, b) task- and context-level variation, which has received more attention in adult word processing studies, and c) language-level variation, which is relatively understudied in both fields. The different studies included groups of children speaking different language combinations and used different techniques and measurements, both in controlled psycholinguistic experiments and in more naturalistic tasks and settings.

Through these varied studies, we aimed to answer multiple questions. In Chapter 2, we examined the extent to which semantic and sub-lexical phonological representations are shared in the simultaneous bilingual child's lexicon, leading to co-activation of lexical phonological representations. In all chapters, we tested whether effects of lexical CLI, resulting from this co-activation, are influenced by differences in individual children's language proficiency and/or exposure. In Chapters 3 and 4, we further examined the influence of task-level variation between production and comprehension tasks on lexical CLI, and in Chapter 4 we also focused on context-level variation. Specifically, we tested whether lexical CLI effects are stronger in dual-language contexts than in single-language contexts. Finally, in Chapter 5, we zoomed in on language-level variation, testing whether lexical CLI effects are stronger for children speaking more closely related languages than for children speaking more distant languages, and how this interacted with word-level similarities.

In the next sections, the findings of the different studies are discussed in light of our theoretical understanding of the bilingual lexicon. Because all chapters address the emergence of lexical CLI as well as the influence of at least one modulating factor, the structure of this discussion mirrors that of Chapter 1: First, we discuss our findings for lexical CLI and what these show for how the bilingual child's lexicon is organized and accessed. Next, we move to our findings for the modulating factors and the mechanisms underlying their effects, starting with individual-level variation, which was examined in all chapters, followed by task- and context-level variation, which was examined in in Chapters 3 and 4, and finally language-level variation, which was examined in Chapter 5. We also discuss interactions between these various modulating factors. Following the review and interpretation of our findings, we discuss implications for research, education, and bilingual parenting. Because of the organization in terms of phenomena rather than per chapter, we summarize our main findings in Table 6.1, providing an overview that the reader can refer back to throughout this discussion.

Table 6.1. Main findings of the different studies in this thesis with regard to the emergence of lexical CLI and to the factors modulating these effects. (Continues on next page.)

	Method & Participants	Results: Lexical CLI	Results: Modulating Factors
Chapter 2	Greek-to-Dutch between-language priming by Dutch-Greek bilingual children	Priming effects: - phonological (eye-tracking and RT) - translation (eye-tracking and RT) - phonological through translation (eye-tracking)	Dominance: No effects of relative language exposure on between-language priming effects.
Chapter 3	Greek cognate processing by Dutch-Greek bilingual children: - lexical decision task - picture naming task	Cognate facilitation effects: - lexical decision (accuracy) - picture naming (RT)	Dominance and task: - Cognate effect in lexical decision stronger for children with more Dutch exposure. - No effects of relative language exposure on cognate effect in picture naming.

Table 6.1 (continued). Main findings of the different studies in this thesis with regard to the emergence of lexical CLI and to the factors modulating these effects.

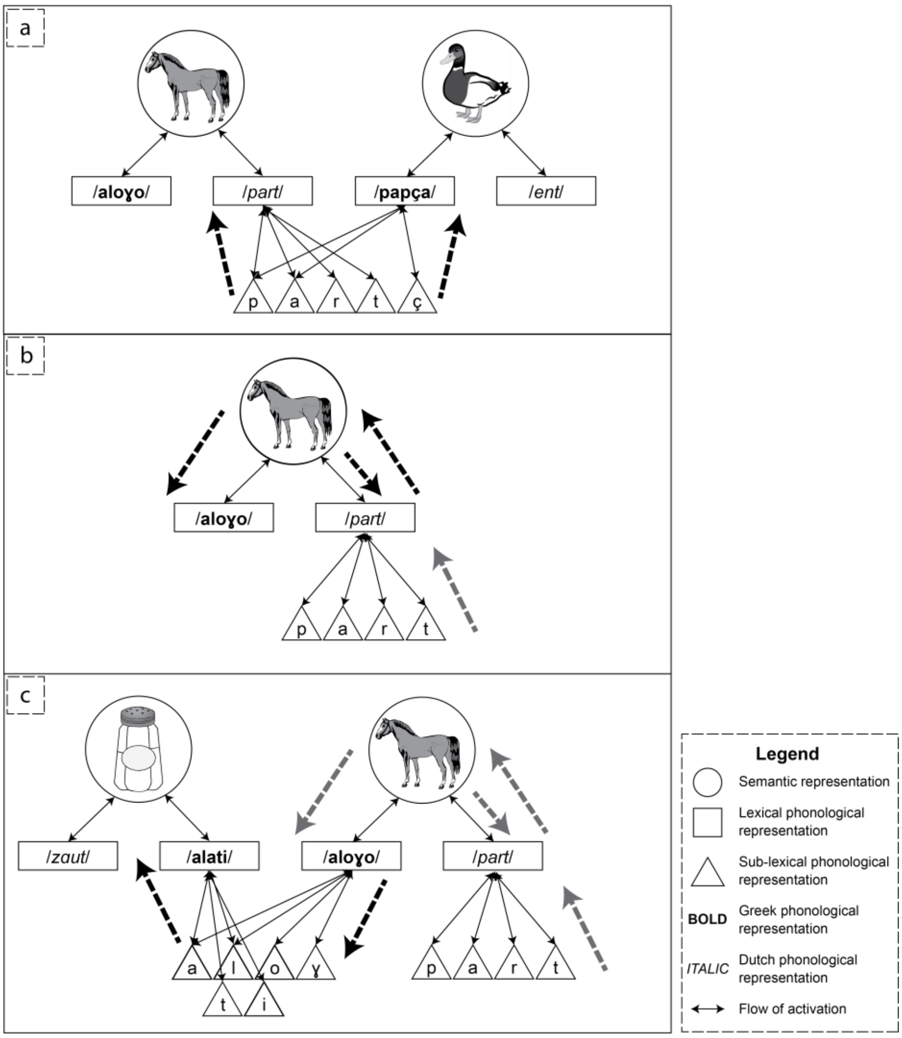
	Method & Participants	Results: Lexical CLI	Results: Modulating Factors
Chapter 4	Dutch and German cognate processing by Dutch-German bilingual children: - lexical decision task in single-language and dual-language context - picture naming task in single-language and dual-language context	Cognate facilitation effects: - lexical decision (RT) - picture naming (accuracy and RT)	Dominance, task, and context: - No effects of relative language exposure on cognate effect in lexical decision. - Cognate effect in single-language context picture naming stronger for children with more other-language exposure. - Cognate effect in dual-language context picture naming weaker for children with more other-language exposure.
Chapter 5	Dutch cognate processing in a productive vocabulary test by Dutch-German, Dutch-English, Dutch-Spanish, Dutch-Greek, and Dutch-Turkish bilingual children.	Cognate facilitation effects (accuracy)	Dominance and language distance: - Cognate effects stronger for children with higher other-language lexical proficiency. - Cognate effects stronger for children acquiring more distantly related languages.

6.1. The Bilingual Lexicon

Throughout this thesis, it was predicted that representations of both languages would be shared in the simultaneous bilingual child's lexicon and interacting during processing. In this section, we first discuss the main outcomes of Chapter 2 regarding this prediction. We specifically hypothesized that semantic representations and sub-lexical representations are shared, both leading to co-activation of lexical representations, as is assumed for adults in models such as BIA+ (Dijkstra & van Heuven, 2002). To test these hypotheses, we examined forms of between-language priming which could capture the different flows of activation between connected representations from both languages using a primed picture selection task with Dutch-Greek simultaneous bilingual children. After discussing our findings with regard to priming, we briefly discuss how our findings with regard to cognate processing in the other chapters confirm our conclusions from Chapter 2.

In line with previous priming studies with bilingual toddlers (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Singh, 2014; Von Holzen & Mani, 2012), the findings of Chapter 2 provided evidence for lexical CLI at different types of representation and at different stages of word processing. First, hearing a word in one language (in this case Greek) led to co-activation of (partially) corresponding word representations from both languages, similar to what was found by Von Holzen and Mani (2012). Following the BIA+ model, this co-activation of lexical representations can be explained through shared phoneme representations; see Figure 6.1a. The co-activated word forms competed for selection (in line with e.g., Weber & Cutler, 2004; see also Dufour, 2008), as evidenced by children's eye movements. More specifically, when one of the co-activated words (in this case a phonologically related Dutch word) was presented next, early on children looked towards the corresponding picture less than in a control condition. By the time this competition was resolved, however – which, on average, took place while children were still listening to the second (i.e., target) word – the co-activated Dutch word remained more active, and this resulted in the observed shorter reaction times (RTs) for selecting the corresponding picture.

Figure 6.1. Different parts of the process of how activation flows between semantic and phonological levels of representation in an integrated bilingual lexicon. The images are used here as a proxy for complex semantic representations. The dashed arrows represent the streams of activation that are most relevant in phonological priming, e.g., between Dutch *paard* 'horse' and Greek *papia* 'duck' (panel a), translation priming, e.g., between Dutch *paard* 'horse' and Greek *alogo* 'horse' (panel b), and phonological priming through translation, e.g., between Dutch *paard* 'horse' – via Greek *alogo* 'horse' – to Greek *alati* 'salt' (panel c).



The (co-)activation of lexical representations also led to the activation of semantic representations, and from there, activation resonated back to the lexical level. As translation equivalents are assumed to share a semantic representation, it follows that activation not only resonates back to one lexical representation, but also to its translation equivalent; see Figure 6.1b. As a result, hearing a word in one language led to its translation also becoming more active. When this translation was presented next, it was processed more quickly, as evidenced by both increased looks to the corresponding picture and faster selection of that picture. Similar translation priming effects had been found in toddlers (Floccia et al., 2020), and this thesis extends this finding to school-aged children.

Next, from the lexical representation of the translation equivalent, activation spread to other word forms that overlapped with it in form. Following the BIA+ model, we assume that this again happened via shared phoneme representations; see Figure 6.1c. These co-activated word forms competed for selection, as evidenced by decreased target image looks, similar to what was found by Von Holzen and Mani (2012) and similar to our findings for phonological priming. Unlike in phonological priming, however, this phonological priming through translation did not lead to any significant differences in RTs compared to the control condition. A possible explanation for this finding is that co-activation is weaker when words are only indirectly related to the input (in line with e.g., Amrhein & Knupsky, 2007).

All in all, the different types of priming effects found in Chapter 2 reveal that both semantic and (sub-lexical) phonological representations are shared or connected between languages in the lexicon of school-aged simultaneous bilingual children. As a result, words from both languages can become (co-)activated during processing if they overlap with the input in form or meaning, even when this overlap is indirect. To our knowledge, this was the first study systematically examining multiple forms of between-language priming in bilingual children in this age group. Previous studies (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Singh, 2014; Von Holzen & Mani, 2012) involved much younger children, typically focusing only on either the phonological or the semantic level. Our study suggests that the bilingual lexicon of older children is organized in much the same way as that of bilingual toddlers as well as bilingual adults, as the combination of eye-tracking and RTs revealed comparable patterns of between-language priming effects to both toddler studies and adult studies.

The conclusion that simultaneous bilingual children have a fully integrated lexicon with language-nonselective access was further supported by the cognate effects that were found in the other chapters in this thesis. In the lexical decision tasks in Chapters 3 and 4, hearing a cognate word in one language activated the corresponding sub-lexical representations, which led to co-activation of multiple lexical representations, including the two cognate words. Both cognate lexical representations activated the same semantic representation, and activation resonated back and forth between the semantic representation and the lexical and sub-lexical representations. As a result of this increased activation of cognate words, bilingual Dutch-Greek (Chapter 3) and Dutch-German children (Chapter 4) were found to respond more accurately and more quickly to cognates than to noncognate control words. The picture naming tasks in Chapters 3, 4, and 5 furthermore revealed that similar flows of activation took place in word production (differences between the tasks are discussed in following sections). In cognate production, seeing a picture led to activation of a semantic representation, from where both corresponding word forms were activated and further activated the same sub-lexical representations, with resonating activation leading to similar cognate effects as in comprehension.

Together, the different studies in this thesis clearly indicate that simultaneous bilingual children have an integrated lexicon, fully shared at the levels of semantic and sub-lexical phonological representations, with a high degree of connectivity between these representations. This lexicon is accessed in a language-nonselective manner, with activation spreading and resonating between connected representations irrespective of language.

In the introduction of this thesis, we speculated that children and adults may have differently organized lexicons because of differences in their chronological age and their age of onset. As neither of simultaneous bilingual children's languages is fully developed before the other is acquired, it is possible that this might lead to differences in the degree of separation of the languages compared to L2 learners. Although this thesis did not compare groups of different ages and/or with different ages of onset, the between-language priming effects and cognate facilitation effects found in this thesis are in line with what has been found for both simultaneous bilingual toddlers (Floccia et al., 2020; Jardak & Byers-Heinlein, 2019; Singh, 2014; Von Holzen et al., 2019; Von Holzen & Mani, 2012), older bilingual children (Bosma et al., 2019; Bosma & Nota, 2020; Duñabeitia et al., 2016; Poarch & van Hell, 2012; Schröter & Schroeder, 2016), and adult L2 speakers (see e.g., Dijkstra & van Heuven, 2018). In other words, the organization of the bilingual lexicon does not seem to qualitatively differ at different ages or with different ages of onset.

6.2. Modulating Factors

The between-language priming effects found in Chapter 2 provide important insights into the organization of the lexicon and the flows of activation taking place during processing, the consequences of which include lexical CLI. Based on combined insights from research on children and on adults, we also tested to what extent the strength of such lexical CLI was influenced by lexicon-internal mechanisms that affect the strength of activation of representations and by lexicon-external mechanisms that affect further processing of these activated representations. In this section, we discuss our main findings for individual-level, task- and context-level, and language-level variation and how these influence lexical CLI through lexicon-internal and lexicon-external mechanisms.

6.2.1. Individual-Level Variation

No two people are the same, and no two simultaneous bilingual children's language development is the same either. The participants in the studies in this thesis were selected according to the same criteria, but there was still considerable variation within groups and differences between groups on factors like age, socio-economic status (SES), and working memory, as well as language proficiency and language exposure. Where we directly compared groups, as in Chapter 4 (the preliminary analyses) and Chapter 5, we statistically controlled for such between-group differences. Variation within groups, however, provided insights into the role of language dominance in bilingual word processing and specifically the strength of lexical CLI.

Language dominance, often operationalized in terms of proficiency or exposure, is probably the most well-studied source of variation modulating CLI in children, both at the lexical level (e.g., Floccia et al., 2020; Jardak & Byers-

Heinlein, 2019; Singh, 2014) and the morpho-syntactic level (see e.g., van Dijk et al., 2021). Whilst the term 'dominance' is not as widely used in adult research, differences between participants' first language (L1) and their second language (L2) as well as L2 proficiency have been subject to extensive investigation (see e.g., van Hell & Tanner, 2012, for a review). Generally, influence from the more dominant language (or the L1) on the non-dominant language (or the L2) has been shown to be stronger than influence from the non-dominant language on the dominant language (van Dijk et al., 2021; van Hell & Tanner, 2012).

The influence of dominance-related factors on lexical CLI was included throughout this thesis. In Chapters 2, 3 and 4, we tested to what extent children's relative exposure to the non-target language affected the strength of lexical CLI in the target language. Using a continuous exposure variable allowed us to test the predictions following from the BIA+ and Multilink models (Dijkstra et al., 2019; Dijkstra & van Heuven, 2002). Specifically, these models predict that more exposure to the words from one language leads to a stronger influence of those words on the processing of words from the other language, due to increased resting-level activation and consequently quicker activation of word form representations that a bilingual has been frequently exposed to. In Chapter 5, which focused more on vocabulary acquisition and less on lexical processing, we tested for effects of non-target-language lexical proficiency instead of exposure. Given the moderate to strong correlations between proficiency and exposure in all samples included in this thesis, however, any effects of proficiency and exposure could – to a certain degree – be interpreted as similar dominance effects.

Effects of exposure or proficiency did not emerge in every experiment in this thesis, but where they did, they influenced bilingual word processing in the manner expected. In Chapter 3, more Dutch-dominant children showed a stronger cognate facilitate effect in Greek lexical decision, and in Chapter 4, similar effects were found in Dutch-German children in picture naming (in a single-language context; see next section for a discussion of context effects). Similarly, in Chapter 5, children with higher other-language proficiency scores showed a stronger effect of phonological similarity (i.e., a continuous cognate effect) in a Dutch productive vocabulary test, in line with cognate processing studies (e.g., Poarch & van Hell, 2012).

In contrast to cognate processing effects, we found no influence of dominance on the strength of priming effects (Chapter 2). An important difference between these two sets of findings, however, is directionality: We found dominance modulating effects of Dutch on Greek (Chapter 3), but not of Greek on Dutch (Chapter 2). On average, the Dutch-Greek bilingual children in both studies were Dutch-dominant: Most of them were residents of the Netherlands and as a consequence were exposed to more Dutch than Greek. As discussed in Chapter 2, it seems that any differences between children in the resting-level activation of Greek words in the lexicon were smaller than – and therefore masked by – differences between the resting-level activation of Dutch words compared to Greek words. As a result, CLI from Greek to Dutch was less influenced by individual differences in children's exposure to Greek, compared to how CLI from Dutch to Greek was influenced by children's amount of exposure to Dutch.

Another explanation for the null effects of dominance on Greek-to-Dutch priming may come from the degree of overlap, where the high degree of overlap in cognates may leave more room for dominance effects than in noncognates. Specifically, as cognates overlap strongly in both form and meaning, activation resonates between mostly the same representations, namely a shared semantic representation connected to two lexical representations, which are connected to multiple shared sub-lexical (phoneme and/or grapheme) representations. If one lexical representation has a high resting-level activation, its strong activation keeps on resonating towards the other lexical representation. In noncognate processing, in contrast, activation spreads more between different representations that overlap in either form or meaning. As such, co-activation may be influenced less by individual differences in resting-level activation but more by other factors, for example how directly related words are (see our findings of weaker co-activation in indirect priming), and consequently it may be less likely to find dominance effects in (primed) noncognate processing than in cognate processing. This would also explain why several child (noncognate) priming studies found no effects of dominance (e.g., Singh, 2014, found dominance effects, but in similar studies Floccia et al., 2020, and Jardak & Byers-Heinlein, 2019, did not).

In Chapter 2 we put forward a number of other explanations for the null effect of dominance, including the relatively small sample size and general noisiness of child data. These explanations seem unlikely once we consider the results of Chapter 3, as sample sizes were similar between the two studies (24 and 27, respectively) and the data collected in the web-based study in Chapter 3 were arguably noisier than the data collected in person in Chapter 2. Since these circumstances did not lead to null effects of dominance in Chapter 3, it seems unlikely that they explain the null effect of dominance in Chapter 2.

There are, however, also differences between Chapters 3 and 4 regarding the influence of dominance, which neither directionality nor stimulus type can explain. In these chapters, different tasks tested for cognate processing in the same direction within the same children. Despite these similarities, dominance effects did not emerge in the same way in the same tasks between the two studies. This suggests that individual differences in dominance can also interact with task differences. Effects of task-level variation are discussed in the next section, as well as effects of context-level variation.

6.2.2. Task- and Context-Level Variation

The findings discussed so far show that lexical CLI can occur in simultaneous bilingual children in different directions, in different modalities, and in different tasks. This does not mean, however, that the same child will always show such effects in the same manner and to the same degree. Chapters 3 and 4 examined to what extent lexical CLI differed between different tasks and between different language contexts. In this section, we first discuss our main findings for task-level variation and for context-level variation, followed by interactions between them. We also discuss how these factors interact with individual-level variation.

In Chapters 3 and 4, task coincided with modality: Children performed one comprehension task and one production task. The particular tasks we chose may accentuate certain properties of the two modalities. Specifically, "good enough" processing is more likely to lead to successful comprehension than production (e.g., Ferreira et al., 2002; Ferreira & Patson, 2007), and this seems to hold even more in lexical decision tasks: Since there are only two response options ('yes' or 'no'), when a participant is not certain about a word form, they may still guess correctly. In addition, word meanings do not necessarily come into play when providing a response. In picture naming, in contrast, the (correct) semantic representation must be accessed and, at the form level, the word must be correctly pronounced in the target language.

As expected, in these cognate processing studies, differences in modality and/or specific task demands appeared to influence how lexical CLI manifests itself, in line with e.g., de Groot et al. (2002). Specifically, in both studies, dominance influenced cognate processing in one task only: in the lexical decision task for the Dutch-Greek children in Chapter 3, and in the picture naming task for the Dutch-German children in Chapter 4. These differences between the tasks in both studies show that the specific ways in which task-level factors influence CLI depends on other factors as well, which we return to later in this section.

In addition to task effects, in Chapter 4 we also tested for context effects. Language context specifically referred to which languages were used in a task and during any interactions before or after a task. Our manipulation followed and expanded upon studies by Elston-Güttler and colleagues (Elston-Güttler et al., 2005; Paulmann et al., 2006): In dual-language contexts, the target language of the main tasks differed from the context language (which was used in communication with the experimenter, in instructional videos, and in background (proficiency) tasks), whereas in single-language context the target language and context language were the same.

Importantly, cognate effects emerged both in a dual-language context and in a single-language context. This confirms that bilingual lexical processing is fundamentally language-nonselective: Even when the other language is not explicitly being used, it can influence word processing, both in comprehension and in production. In contrast to what we expected based on studies like Elston-Güttler et al. (2005) and Gross and Kaushanskaya (2020), cognate effects were not necessarily stronger in a dual-language context than in a single-language context. Instead, the role of language context seemed to depend on individual children's dominance as well as on task demands. Specifically, language context only influenced cognate effects in picture naming, and in this instance, the effects of language dominance on cognate facilitation were reversed between the single-language and dual-language context. We discuss the ways different factors were found to interact in the remainder of this section.

We first discuss the interaction between context and dominance. A key mechanism underlying this interaction is inhibition, which may take place in the Task/Decision subsystem (e.g., Elston-Güttler et al., 2005) and is required for cued or involuntary switching between languages (e.g., Green & Abutalebi, 2013; Gross & Kaushanskaya, 2015). Inhibition of a dominant language has been found to be more effortful and therefore stronger (i.e., more difficult to overcome) than inhibition of a non-dominant language (e.g., Misra et al., 2012). Thus, when children had just used their more dominant language (e.g., in a background task), switching to their other language (e.g., in the main tasks) required strong inhibition of the dominant language.

As also mentioned in the introduction of this thesis, the exact mechanisms behind task and context effects remain a topic of discussion (e.g., Bobb & Wodniecka, 2013; Gross & Kaushanskaya, 2015; see also Gade et al., 2021). For example, the language switching literature distinguishes local and global inhibition, also known as reactive and proactive, where reactive inhibition is a bottom-up reaction to a stimulus and proactive inhibition refers to top-down inhibition of all words from a language (see e.g., Gross & Kaushanskaya, 2015). Reactive inhibition fits in with how the Task/Decision subsystem of the BIA+ model is described (see also Elston-Güttler et al., 2005), but it is not clear to what extent proactive inhibition does. The studies in this thesis did not aim to distinguish between or explain such inhibition mechanisms, but they suggest that there is certainly more to explore on this topic. For example, the type of switching in our studies may have had effects on both the local and the global level: Children were reacting to changes in the language used by the characters in the cover story of the experiment, while at the same time also receiving explicit instructions before starting a certain task to use a specific language. To provide more insights into the mechanisms underlying context effects, future studies may manipulate both local and global language context, where local language context may be operationalized as stimulus list composition, that is, the languages that are used as stimuli.

We now turn to the role of task-level factors in interaction with context and dominance. Specifically, in Chapter 4, the strength of context-related inhibition differed per task. In the lexical decision task, inhibition of the dominant language in the dual-language context led to overall slower processing for children who were more dominant in the non-target language and who were now performing the task in their non-dominant language. In the picture naming task, inhibition of the dominant language was even stronger, likely because of the demands of this task. Specifically, the target word needed to be pronounced correctly in the target language. As a result, for the most non-target-language-dominant children, all influence from the dominant language was inhibited, leading to smaller or even no cognate facilitation effects.

Interactions between task, context, and dominance may also explain differences between Chapter 3 and 4 with regard to dominance, which were briefly discussed in the previous section. Specifically, in Chapter 3, dominance was not found to influence cognate processing in picture naming, whereas it did in Chapter 4. In Chapter 3, children were actually tested in both single- and dual-language contexts, but because of high data loss, the data were collapsed over the contexts. Considering the findings from Chapter 4, we cannot rule out the possibility that, also in Chapter 3, there were similar contrasting influences of dominance between the two contexts, but that these cancelled each other out when the data was grouped together, resulting in null effects. In contrast to the findings for picture naming, in the lexical decision task, dominance influenced cognate processing in Chapter 3 but not in Chapter 4. Because of their high proficiency in both languages, children in Chapter 4 were at ceiling for lexical decision accuracy (see also Schröter & Schroeder, 2016). It is possible that as a result, their reaction times for this task were also approaching ceiling, leaving less room for individual differences compared to the more Dutch-dominant children in Chapter 3.

Taken together, the findings from the different studies in this thesis show that lexical CLI in bilingual children is robust, as is the case for bilingual adults, and that it emerges in both comprehension and production tasks, in both single-language and dual-language contexts. Through these studies, we have shown that, as in adults (e.g., de Groot et al., 2002; Dijkstra et al., 2010; Dijkstra & van Heuven, 2002; Poort & Rodd, 2017; van Hell & Dijkstra, 2002), task and context effects can influence the strength or manifestation of lexical CLI effects in children. In addition, we found that task and context effects interact with individual-level factors. Whereas adult studies have mostly compared effects in L1 and L2 or examined the role of L2 proficiency (see van Hell & Tanner, 2012), our findings provide more detailed insights into the role of dominance in bilingual word processing in different tasks and different language contexts.

6.2.3. Language-Level Variation

One of the aims of this thesis was to test simultaneous bilingual children growing up with different language combinations. The studies in Chapters 2 and 3 focused on Dutch-Greek bilinguals, which is not a commonly studied language combination, thereby contributing to linguistic diversity in bilingualism research. In Chapter 4, we moved to a different population, namely Dutch-German bilingual children. These language combinations differ in language distance: Dutch and German are closely related to each other and share many morpho-syntactic and phono-lexical similarities, whereas Dutch and Greek are more distant from each other and share fewer cognates (e.g., Schepens, Dijkstra, et al., 2013; Schepens, van der Slik, et al., 2013).

By conducting similar cognate processing studies with different language groups in Chapters 3 and 4, we obtained insights into the generalizability of cognate effects and task effects. As discussed in the previous sections, the result patterns were quite similar, with differences that seem to stem from individual- and context-level variation. In addition, however, there was a difference that suggested that language distance may affect lexical CLI. Specifically, in Chapter 3 we argued that Dutch-Greek children may sometimes inhibit knowledge of their dominant language when processing their non-dominant language, resulting in inhibitory rather than facilitatory cognate effects. This inhibition may occur for these children because their languages are relatively distant, and they therefore do not expect to be able to benefit from their knowledge of their other language. Similar inhibitory patterns of CLI have been found in sentence processing studies with bilingual Dutch-Turkish children (van Dijk et al., 2022), whose languages are also not closely related (see also Muntendam et al., 2022).

Language distance was investigated more systematically in Chapter 5, where bilingual Dutch-German, Dutch-English, Dutch-Spanish, Dutch-Greek, and Dutch-Turkish children all performed the same Dutch vocabulary test including more and less phonologically similar (i.e., cognate-like) items. Overall, children scored more accurately on items that were more similar in form to their translation in the other language, that is, cognate effects emerged even in this offline, less experimental setting (see also e.g., Bosma et al., 2019; Goriot et al., 2021; Lindgren & Bohnacker, 2020). Interestingly, we found a stronger (positive) cognate effect for children speaking more distant languages than for children speaking closely related languages. This was unexpected: As language pairs like Dutch and German share many cognates, we had predicted that e.g., Dutch-German bilingual children would be more sensitive to and/or aware of cognates and better able to make use of their knowledge of their other language than e.g., Dutch-Greek bilingual children. Our findings, however, suggest the opposite: For children acquiring distant languages, cognates may stand out more than for children acquiring closely related languages, possibly due to the degree of similarities on other linguistic levels, such as phonetic or morphological similarities.

Our findings in Chapters 3 and 5 suggest that language distance interacts with both individual-level factors and task-level factors. Specifically, whether any heightened sensitivity to and/or awareness of cognates for children speaking distant languages leads to inhibitory cognate effects, as discussed above for the Dutch-Greek children in Chapter 3, or facilitatory effects, as for the Dutch-Spanish, Dutch-Greek, and Dutch-Turkish children in Chapter 5, appears to depend on both these levels of variation. Chapter 3 showed how a dominant language may be inhibited more than a non-dominant language, leading to inhibitory cognate effects when performing a task in a non-dominant language. In addition, a comparison between Chapters 3 and 5 suggests that task-level variation also plays a role, as inhibition was only found in lexical decision (Chapter 3) but not in picture naming (Chapter 3 and 5). This difference may be specifically driven by the binary response option in lexical decision: As only target-language words required a 'yes'-response, logically non-target-language words required a 'no'-response. Especially for children who were inhibiting words from their dominant language, if a cognate was recognized as belonging to that language (instead of or in addition to the target language), this may have led to more 'no'- responses (similar to findings by Brenders et al., 2011; Poort & Rodd, 2017).

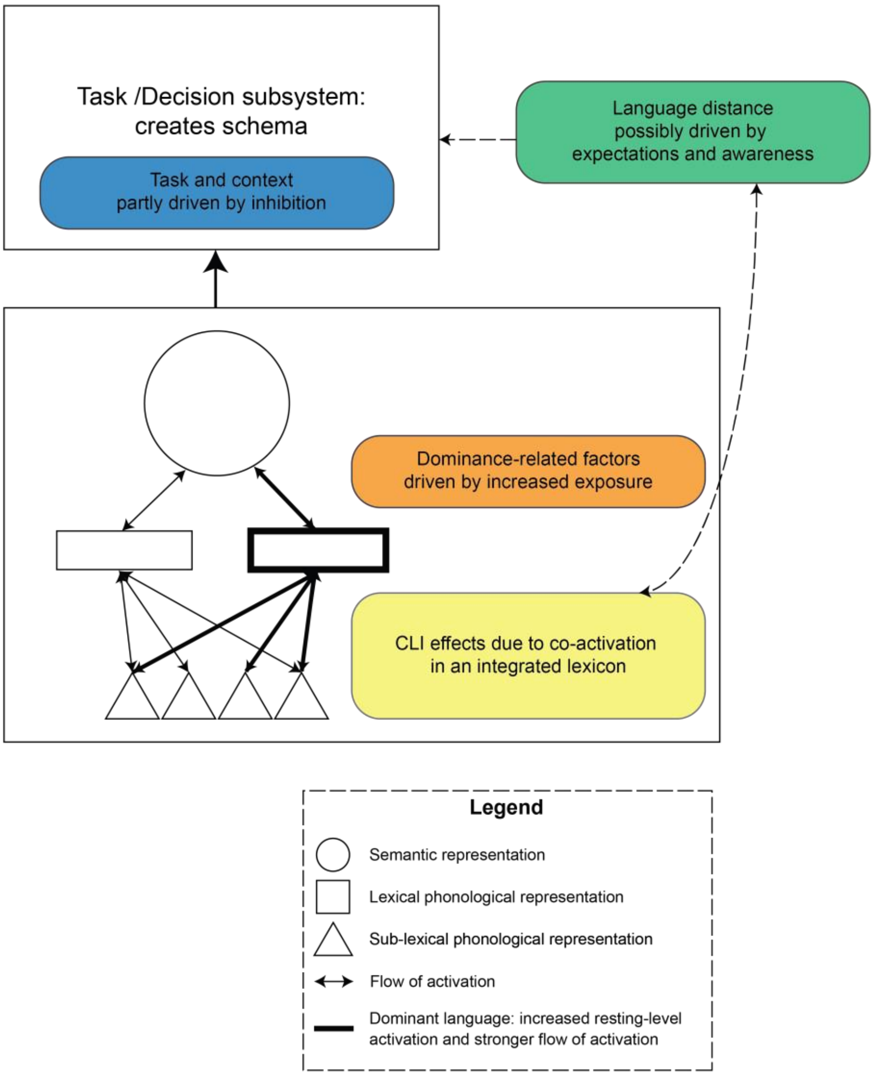
In addition to language distance effects on cognate processing, Chapter 5 also provided more insights into language distance effects on vocabulary acquisition in general. Previous studies had found that language distance influenced children's vocabulary acquisition (Blom et al., 2020; Floccia et al., 2018), although the exact mechanisms behind these language distance effects remained unclear. We similarly found that children speaking more closely related languages scored more accurately overall. Crucially, this was the case even when only noncognates were considered. Our findings thus show that cognate facilitation is not the (only) driving force behind language distance effects. Similarities on other linguistic levels may play a role: For example, Floccia et al. (2018) found morpho-syntactic similarities such as word order to be related to a larger receptive vocabulary in young children. It seems that similar word orders between two languages facilitate the comprehension of (new) words in young bilinguals, possibly also leading to a larger vocabulary at later stages of development.

In sum, the studies in this thesis have shown that lexical CLI can take place in children simultaneously acquiring closely related languages as well as children acquiring languages that are more distant from each other. Language distance may play a role in how strongly words become co-activated during processing, as the degree of overlap may differ, but also in how words are further processed, for instance by the Task/Decision subsystem. Specifically, bilinguals' sensitivity to and/or awareness of cognates may play a role in cognate processing, as well as their general expectations concerning the extent to which they can make use of their other language, in interaction with task effects. Finally, we showed that effects of language distance on vocabulary are not purely driven by cognate facilitation, but that children speaking closely related languages have larger vocabularies overall.

6.3. Tying the Results Together

Through the different studies in this thesis, we have shed light on the representation and processing of words from different languages in the simultaneous bilingual child's lexicon, as well as how processing within the lexicon and at later stages (e.g., decision level) is modulated by a) individual differences in language dominance, b) modality, task demands, and language context, and c) word-level similarities as well as more general language similarities. The general findings with regard to the lexicon itself and the modulating factors are summarized in Figure 6.2, which combines elements of Figure 1.7 in Chapter 1 and of figures depicting the bilingual child's lexicon (e.g., Figure 6.1).

Figure 6.2. How individual-level factors, task- and context-level factors, and language-level factors influence word processing in general and lexical CLI in particular, based on the findings from this thesis.



Within the lexicon, words from different languages may share semantic representations and/or sub-lexical phonological (and/or orthographic) representations, if they overlap in form and/or meaning, and activation spreads between connected representations in a language-nonselective manner. Language exposure or other dominance-related factors modulate how quickly a certain representation can become activated, as increased exposure leads to increased resting-level activation (in line with Dijkstra et al., 2019; Dijkstra & van Heuven, 2002). In principle, the same representations are assumed to be activated in similar ways in different tasks in both comprehension and production, with the main difference being which representation is activated first (sub-lexical representations in comprehension and semantic representations in production) (see e.g., Menenti et al., 2011; Pickering & Garrod, 2013; Zwitserlood, 1994). However, task demands (including modality) and context-related factors influence how (co-)activated representations are further processed to come to a task-appropriate response. To be able to efficiently process language in a certain task and context, certain (co-)activated words may be inhibited, and, according to e.g., Gollan and Ferreira (2009) and Gross and Kaushanskaya (2015), even all words from one language may be slightly inhibited if required. Dominance plays a role here too: The more dominant a language is, the more effort is required to inhibit it and subsequently to overcome this inhibition. It seems that language distance may also play a role in task demands, with the degree of similarity between two languages on the word level or other levels modulating bilinguals' expectations for how they can make use of their other language to come to a task-appropriate response.

6.4. Limitations and Suggestions for Future Research

The findings from this thesis suggest that there are no qualitative differences in the way the lexicon is organized and accessed in bilinguals with different chronological ages or different ages of onset. However, it is still possible that there may be quantitative differences in processing. Although in Chapter 5 we did not find any influence of age on cognate processing, this study did not include toddlers, adolescents, or adults, and all children were early or simultaneous bilinguals. Future studies may more systematically examine chronological age, for example in longitudinal studies, to shed more light on similarities and differences in processing and representation at different ages. Furthermore, future studies may compare (adult) simultaneous bilinguals and (adult) L2 speakers, to shed more light on the effect of age of onset on the organization of and/or processing in the bilingual lexicon. In addition, although we took insights from the literature on morpho-syntactic CLI, especially concerning individual differences, the studies in this thesis were focused on lexical processing. Future studies may combine lexical processing and syntactic processing to expand our understanding of the bilingual lexicon and how it relates to the representation and processing of syntax.

There are also limitations in terms of individual-level factors other than chronological age or age of onset. For example, the children in these studies generally came from high SES backgrounds, which is known to play an important role in language acquisition (e.g., Hoff, 2003). To further test the generalizability of our conclusions and increase the diversity of samples in child language research, future studies should aim to test more diverse samples or specifically focus on children from lower SES backgrounds. In addition, children's literacy skills were only included in additional analyses in Chapter 5, using relatively coarse measures. Future studies may examine literacy in more detail, similar to how we considered verbal proficiency.

Regarding task demands, the different tasks employed in this thesis provide insights into the generalizability of cognate effects and have shown that task demands influence bilingual word processing, specifically cognate processing. Future studies may look further into the exact mechanisms underlying these task effects. For example, a systematic comparison between multiple comprehension or production tasks with different demands would be an interesting avenue for future research. Multiple variations of a task may be compared, such as language-specific and language-general lexical decision tasks, or more different tasks within the same modality, such as lexical decision and picture selection. Direct comparisons between such pairs of tasks would provide a better understanding into exactly which task-level factors modulate bilingual word processing in which way.

Regarding language distance, this thesis has shown that this affects bilingual word processing and lexical CLI, although the number of language combinations included in this thesis remains relatively limited. In addition, there were differences between the language combinations that were grouped together in Chapter 5. For example, insofar as there is a consensus on how to measure language distance, Dutch and German are more closely related than

Dutch and English (e.g., Schepens, van der Slik, et al., 2013), and Dutch and Turkish are more distant from each other than Dutch and Spanish. Future studies should therefore include more language pairs, with more participants per language group, so that the effect of language distance on lexical CLI can be investigated in a more detailed and possibly continuous way. In addition, future studies would benefit from including children's meta-linguistic skills, such as cognate awareness: While we argued in Chapter 5 that this may play a role in how children with different language backgrounds process cognates, we did not include tests specifically measuring these kinds of skills.

All in all, it is clear that there are many factors that may influence bilingual word processing, and although this thesis provides evidence for effects of different types of factors, examining all of them in depth was beyond the scope of this thesis. As we have seen that different types of factors also interact with each other in complex ways, arriving at a complete understanding of all the mechanisms that play a role in lexical CLI will be a challenge for future research. This is especially the case for research on simultaneous bilingual children, who are still developing and may differ in many ways even beyond all the possible variation in language proficiency, exposure, and use. We therefore recommend child bilingualism researchers to collaborate in large-scale projects, similar to the ManyBabies project (Visser et al., 2022), and to collaborate with researchers from related fields, including adult bilingualism, in order to exchange ideas, possibilities, and insights, and bridge the gap between these fields of study.

6.5. Strengths and Innovations

The studies in this thesis on the one hand provide an in-depth analysis of the flows of activation between different representations in the lexicon of simultaneous bilingual children, and on the other hand cover a broad range of factors that may modulate bilingual word processing. Our studies are among the first to examine interactions at multiple levels of lexical representation in simultaneous bilingual children, to test for CLI in different production and comprehension tests in different language contexts, and to assess both word-level similarities as well as more global language distance. Covering this range of topics, many of which had not been thoroughly investigated in children, brought different fields closer together, most notably combining insights from literature on CLI in children and on the bilingual lexicon in adults.

This thesis used several methods, some more commonly used in adults (e.g., lexical decision) and others in (younger) children (e.g., picture selection). Throughout the chapters, we moved from more controlled experiments in lab-like settings (e.g., eye-tracking) to less controlled, more practically relevant tasks (e.g., vocabulary tests), showing that lexical CLI is not limited to the lab. In addition, we were among the first to find evidence for CLI from children in web-based experiments, by using innovative (combinations of) techniques that allowed us to collect accuracy and RTs in word comprehension as well as word production remotely. We put effort into making the tests attractive and interesting for children of several ages by incorporating them into animated stories – something that we started in Chapter 2 and utilized even more in the web-based studies in Chapters 3 and 4, where the stories included background tasks as well and even contributed to our experimental manipulations (language context). Whilst we had to rely on parents' help in setting up the experiment and making audio recordings, and an experimenter being present in a video call during testing, we have nevertheless shown that psycholinguistic data can be collected from bilingual children fully online and likely even independently from experimenters, something which increases the likelihood of large-scale data collections and collaborations being successful.

Each study in this thesis combined several conditions, measures, tasks, or analyses. The study in Chapter 2 looked into the flows of activation between different types of representations in the bilingual lexicon by including three forms of direct and indirect between-language priming. In addition, it expanded upon previous toddler studies using eye-tracking by adding a picture selection element and measuring children's RTs, thereby bridging the gap between studies with young children and studies with adults. Importantly, we found that the different measures tapped into different stages of processing and therefore both contributed to obtaining a fuller picture of the processes in the bilingual lexicon.

The studies in Chapters 3 and 4 included accuracy and RT measures, production and comprehension tasks, and, in Chapter 4, single-language and dual-language contexts. By conducting two different cognate processing tasks in two language contexts with the same groups of children, we found richer evidence for interactions in the bilingual lexicon, while also providing insights into modality and tasks effects as well as context effects. Both task effects and language context effects on lexical CLI had rarely been included in child research. By including these sources of variation, we have shown that this is an area worth exploring further, as discussed in the previous section.

The study in Chapter 5 analyzed the data of a large number of bilingual children, namely over 300 children in total. This was obtained by combining data from different studies that employed the same task as part of their test battery. Although only accuracy data were available for this task, the large sample size allowed us to analyze multiple subsets of the data to gain insights into the processes underlying our effects. For example, analyzing the data without (near-)identical cognates showed that effects of phonological similarity in a vocabulary test were driven by cognates and therefore likely resulted from co-activation in the lexicon.

In addition, the studies in this thesis took into account non-linguistic individual-level factors such as age, SES, and working memory, as well as various item-level factors, namely word frequency, age of acquisition, concreteness, length, onset phonemes, other phonological overlap, and semantic relatedness. We carefully selected primes, targets, and distractors, as well as cognates, noncognates, and fillers to be as similar as possible (or dissimilar in case of distractors) on these variables. Both on the participant level and on the stimulus level there are limits to how perfectly matched and balanced they can be, and performing multiple tasks with multiple measures while taking into account variation on multiple levels considerably complicates study design and analysis. The studies in this thesis have employed various ways to deal with this, for example by building up analysis models with covariates or by analyzing subsets. We hope that we have shown the importance of triangulation in word processing studies in general and in child research in particular, and that we have made researchers more aware of the complex interactions that exist between factors on multiple levels when a bilingual child is processing a word.

6.6. Implications

The findings from this thesis illustrate the robustness of lexical CLI effects, while also showing the complexity and interactivity of individual differences and task-, context-, and language-level factors that modulate CLI. In the context of educating and parenting bilingual children, a key finding is that lexical CLI can in principle be expected to occur in all children, regardless of age or language combination. Furthermore, it can occur in different circumstances, including in a single-language context such as at school or when speaking to a parent who can only use one of the child's two languages. This is no reason for concern with respect to children's language development. For example, when a child is being raised with a minority language at home, this home language will likely influence their comprehension and use of the school language. As a result, they may interpret a word differently if it sounds similar to a word from their home language. For example, imagine a Dutch-dominant child attending a German-language school. They may be briefly surprised when they are asked to draw something on the *Tafel*, which means 'blackboard' in German but 'table' in Dutch. This does not mean that they are confused and cannot distinguish their languages, but it simply shows that both languages are represented in an interconnected and interactive system.

In many cases, however, the interconnectedness of the bilingual lexicon may not lead to any noticeable effects, as words need to overlap in both form and/or meaning to influence children's behavior, and even when there is considerable overlap between words, their influence will often not be directly visible, similar to what has been found for morpho-syntactic CLI (see van Dijk, 2021). For example, some effects in this thesis only emerged in careful and precise measurements of children's eye movements or reaction times. As such, although they provide important insights into the architecture of the bilingual lexicon, such interactions do not necessarily play an important role in children's daily life.

One area where lexical CLI can be seen outside of the lab and without special measurements is in children's performance on vocabulary tests. Because parents or teachers will not always have (sufficient) knowledge of both languages that a bilingual child speaks, however, they will often not be able to identify cognates in a vocabulary test. As such, the positive influence of one language on the other may be underestimated compared to inhibitory effects such as between the false friends *Tafel* 'blackboard' and *tafel* 'table'.

Being aware of cognates in vocabulary tests is also important for researchers. As discussed in Chapter 5, when comparing the vocabulary of different groups of bilingual children or comparing monolingual and bilingual children, test items should be carefully examined on their cognate status. Depending on (research) goals, the number of cognates in a test may influence children's performance in an unintended way. Specifically, as we found stronger cognate facilitation effects for children speaking more distant languages than for children speaking more closely related languages, it seems especially important to gauge the number of cognates when testing children with different language distances.

Not only (visible) cognate effects in vocabulary, but also the more subtle effects of lexical CLI have implications for educating and parenting bilingual children. These effects show that children cannot simply 'turn off' their other language, and, as found in studies like Misra et al. (2012), inhibiting a dominant language is cognitively demanding. As also discussed by Bosma et al. (2023), the notion that both languages are represented in an interconnected and interactive system thus underlies *translanguaging* strategies, where bilingual children's languages both have a place in the classroom. Specifically, this notion explains how strengthening connections in the lexicon between words from different languages can be beneficial for bilingual children's vocabulary development, similarly to how stronger and denser (semantic) connections have been found to aid word leaning in monolingual children (see Bosma et al., 2023). In other words, due to the interconnectedness of the bilingual lexicon, stimulating bilingual children's vocabulary in one language can contribute to their development in their other language. The studies in this thesis provide important evidence for this interconnectedness and contribute to a better understanding of cross-linguistic influence in the lexicon and in vocabulary acquisition.

6.7. Conclusion

The findings presented in this thesis revealed lexical cross-linguistic influence (CLI) in the form of cognate effects and several forms of between-language priming in different groups of primary-school-aged simultaneous bilingual children speaking Dutch and one additional language (German, English, Spanish, Greek, or Turkish). Using several tasks, including primed picture selection, lexical decision, and picture naming, children's behavior indicated that their processing in one language was influenced by form- and/or meaning-related words from their other language, resulting in lexical CLI effects in their eye movements, accuracy, and reaction times. These effects show that bilingual children are in possession of a fully integrated lexicon, that is, word forms and meanings are represented in one interconnected system, and that this lexicon is accessed language-nonselectively, that is, representations from either language may become activated during processing based on their semantic and phonological (or orthographic) properties. The view that the bilingual lexicon is integrated is generally accepted for adults, and the present findings add clear evidence that this also applies to children at multiple – and possibly all – stages of development.

Not only did the studies in this thesis provide detailed insights into co-activation processes in the lexicon, they also showed that the strength of lexical CLI is influenced by individual differences in dominance, in interaction with task- and context-level factors as well as by language distance. For example, the more dominant a language is, the more strongly it typically influences the other language, but when the context requires switching between languages, this may change: Especially in production, a more dominant language may be more strongly inhibited, resulting in reverse dominance patterns. In addition, we showed that lexical CLI happens both in children speaking closely related languages sharing many cognates and in children speaking more distant languages, but the effect appears to be stronger for the latter group. By looking into different types of modulating factors, this thesis provides important insights into the generalizability of lexical CLI effects and brings forward many interesting avenues for future research, especially concerning the mechanisms underlying task effects and language distance effects.

The studies in this thesis were methodologically innovative and carefully designed, tapping into multiple aspects and stages of word processing by bilingual children. They form a bridge between studies on lexical processing by bilingual adults on the one hand and simultaneous bilingual language acquisition in children on the other. Our findings have various implications for research, as they highlight many factors that influence bilingual word processing and that may be taken into account depending on research goals, and they show that the fields of adult bilingualism and child bilingualism can learn and benefit from each other's insights. There are also implications for educating and parenting bilingual children, the most important being that lexical CLI is part and parcel of being bilingual, from adult second-language learners to young simultaneous bilinguals.

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Research Data Management

I complied with the RDM requirements of my Faculty in the following way.

Ethical approval and consent

I have received approval from the ethics committee for this project. I received approval from Ethische Toetsingscommissie Geesteswetenschappen on 04-07-2017 with reference number 4804.

My research required an informed consent procedure. I have followed the informed consent procedure established by the Ethics Assessment Committee Humanities at Radboud University, as specified by the Centre for Language Studies lab.

Personal data

I collected and processed personal data. I collected audio recordings of participants during the experiments and of their parents during interviews on the children's family and language background. In these interviews I obtained personal information, including participants' name, gender, and date of birth, siblings' first name and age, parents'/caregivers' age, education, and occupation, and information about participants' and family members' language skills and language use. The names were only needed for administrative purposes and were not further included in further processing and analyses of the data. I also collected children's scores on tests of language proficiency and working memory. It was necessary to collect and process these data, because one of the goals of the project was to explore the relationship between individual factors such as age, working memory, socio-economic background, language proficiency, exposure, and use, and the outcomes of our main language processing tests. In order to achieve this goal, it was crucial to collect detailed information at the personal level. I did not collect more personal data than necessary: The level of detail in the language background and use questionnaire, which is the most personal data I collected, is based on previous research exploring the effects of similar factors on different language outcomes. This data will be stored for 10 years.

I also collected participants' addresses, as they were mostly tested at home, and parents' contact information. This data will be removed, except for parents/caregivers who have given consent for their information to be kept so that they can be approached for any future experiments.

Participants' privacy is protected by (pseudo-)anonymising some of the data. Per study, the parental interviews have been summarized in an overview file, which only contains ID numbers, genders, ages, and various outcomes (expressed as number) for language exposure and use. The key file linking ID numbers to names etc. is a password-protected database on the project's workgroup folder. The final datasets that are analysed do not contain name, date of birth, address, or parent' contact information, only ID numbers, age, gender, and outcomes (expressed as numbers) for working memory, language proficiency, exposure, and use. In the publicly available versions of these datasets (see below), the ID numbers have been changed by consecutively numbering participants per chapter, so that they cannot be linked to any key file. All information in the final datasets is analyzed and reported in the accompanying chapters, and is important to report for generalizability and reuse of the data.

The audio recordings that were made of the interviews as well as the other tasks cannot be (pseudo-)anonymised. All information (responses, accuracy, reaction times) that was needed from these recordings has been stored in the ways described above and in pseudonymised transcripts, textgrids, and answer sheets.

Storing and sharing during research

Safe storage has been used during my research. Data were stored in a Radboud University workgroup folder on the campus network while research was ongoing. The workgroup folders meet legal and ethical requirements. Safe and secure storage is guaranteed by the IT security and safety protocols. The data is automatically backed up on a daily basis.

When working off-campus, I used a secure VPN connection to access the workgroup folder. When personal data was gathered off-campus, I used the VPN connection to transfer the data to the workgroup folder on the campus network as soon as possible. Before the data could be transferred, it was saved on an encrypted laptop or USB stick.

During my research I have shared my data with researchers, interns, and student assistants affiliated with Radboud University, because interns and student assistants collected and processed part of the data, and because part of the data was re-analyzed by other members of the project group. We followed the policy of the university and used the work group folders of the University network. In addition, Surfdrive and FileSender have been used to exchange standard data between researchers during the project. Workgroup folders were used to exchange personal data, or alternatively, FileSender in encryption mode.

The structure of the Radboud University workgroup folder meets the minimum requirements as described in my institute's RDM protocol.

Long term archiving and reuse

The research data associated with my publication (including raw data, metadata and documentation) will be stored in a Radboud University work group folder for a minimum of 10 years.

The data will be made publicly available, as far as possible: After publication of each chapter, the final data sets and analysis scripts will be made public on OSF: Chapter 2: https://osf.io/q4h28/, Chapter 3: https://osf.io/k2xw6/, Chapter 4: https://osf.io/9agup/, Chapter 5: https://osf.io/kx6zp/.

Personal data, including audio recordings and detailed information concerning family background variables will not be made publicly available, since these cannot be fully anonymized and/or can be traced back to a specific participant/family.

International Max Planck Research School (IMPRS) for Language Sciences

The educational component of the doctoral training was provided by the International Max Planck Research School (IMPRS) for Language Sciences. The graduate school is a joint initiative between the Max Planck Institute for Psycholinguistics and two partner institutes at Radboud University – the Centre for Language Studies, and the Donders Institute for Brain, Cognition and Behaviour. The IMPRS curriculum, which is funded by the Max Planck Society for the Advancement of Science, ensures that each member receives interdisciplinary training in the language sciences and develops a well-rounded skill set in preparation for fulfilling careers in academia and beyond. More information can be found at www.mpi.nl/imprs.

Nederlandse samenvatting

Wereldwijd zijn er meer kinderen die opgroeien met meerdere talen dan kinderen die uitsluitend één taal leren. Toch wordt eentaligheid vaak als norm beschouwd. Het valt dan ook snel op als een tweetalig kind iets op een andere manier zegt of begrijpt dan een eentalig kind. Als een Grieks-Nederlands kind bijvoorbeeld het woord *apotheek* hoort, zou ze geneigd kunnen zijn aan een schuur te denken. Dit komt doordat het Griekse woord *αποθήκη* (uitgesproken als *apothiki*) 'schuur' betekent. Ook zou een Frans-Nederlands kind vaker iets kunnen zeggen als 'Waarom jij huilt?' in plaats van 'Waarom huil jij?' dan een eentalig Nederlands kind (Strik & Pérez-Leroux, 2011). (In het Frans is dit een prima zin, namelijk 'Pourquoi tu pleures?') Dit soort voorbeelden betekenen niet dat deze tweetalige kinderen in de war zijn of dat ze een (taal)achterstand hebben. Het laat alleen iets zien over het VERWERKEN (bij het spreken en het begrijpen) van taal. Het verwerken van de ene taal (in dit geval Nederlands) wordt beïnvloed door de kennis van de andere taal (in dit geval Grieks of Frans). Dit fenomeen wordt CROSS-LINGUISTIC INFLUENCE genoemd, wat vertaald kan worden als TUSSEN-TALIGE INVLOED.

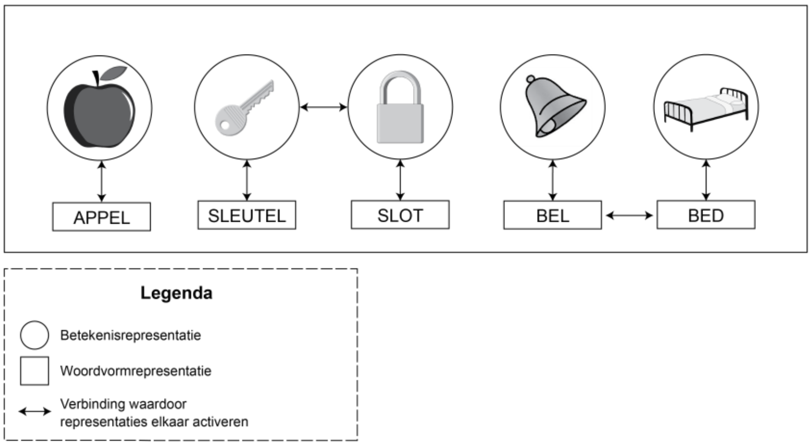
Tussen-talige invloed bij tweetalige kinderen is voornamelijk onderzocht op het gebied van zinsverwerking, zoals de volgorde waarin tweetalige kinderen de woorden in een zin plaatsen, net als in het Frans-Nederlandse voorbeeld hierboven (zie bijv. van Dijk, 2021). Dit proefschrift gaat over een vorm van tussen-talige invloed die nog niet vaak onderzocht is bij tweetalige kinderen, namelijk tussen-talige invloed op het gebied van woordenschat en woordverwerking, oftewel LEXICALE TUSSEN-TALIGE INVLOED. Deze invloed kan de verwerking van woorden wat hinderen of vertragen, zoals in het Grieks-Nederlandse voorbeeld hierboven, maar kan ook positief zijn. Zo zou hetzelfde Grieks-Nederlandse kind waarschijnlijk veel minder moeite hebben met een woord als *xylofoon* dan een eentalig Nederlands kind, aangezien het Griekse woord *ξυλόφωνο* (uitgesproken als *xylofono*) hetzelfde betekent. Bovendien komt het woord *ξύλο* (*xylo*), wat 'hout' betekent, in het dagelijks leven vaak genoeg voor.

Lexicale tussen-talige invloed is met name onderzocht bij tweetalige volwassenen, die op latere leeftijd een tweede taal hebben geleerd (zie bijv. Kroll, Bobb, & Wodniecka, 2006 en Dijkstra & van Heuven, 2018, voor een overzicht). De onderzoeken in dit proefschrift richten zich op lexicale tussen-talige invloed bij simultaan tweetalige kinderen, oftewel kinderen die gelijktijdig twee talen leren. Hierbij wordt gebruik gemaakt van gecombineerde inzichten uit het onderzoek naar tussen-talige invloed op zinsniveau bij kinderen en uit het onderzoek naar woordverwerking bij tweetalige volwassen.

Lexicale tussen-talige invloed en het mentale lexicon

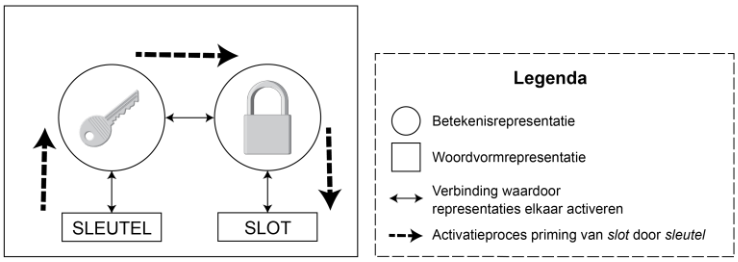
Onderzoek met tweetalige volwassenen laat zien dat lexicale tussen-talige invloed voorkomt als gevolg van hoe woorden in het hoofd zijn opgeslagen en hoe deze verwerkt worden. Het kennen van een woord omvat namelijk veel informatie, waaronder de woordvorm (dat wil zeggen, hoe het woord klinkt en uitgesproken moet worden), wat het betekent, en welke woordvormen en betekenissen bij elkaar horen. Dit soort informatie moet voor alle duizenden woorden die iemand kent op een of andere manier in het hoofd zijn opgeslagen. Mensen hebben dus een soort 'woordenboek in het hoofd', wat het MENTALE LEXICON wordt genoemd. Door de meeste onderzoekers wordt aangenomen dat dit bestaat uit verschillende REPRESENTATIES van woordvormen en woordbetekenissen, met verbindingen tussen die representaties, zodat ze een netwerk vormen. Binnen dit netwerk zijn niet alleen de representaties van een woordvorm en de bijbehorende betekenis met elkaar verbonden (bijvoorbeeld *appel* en de betekenis van 'appel'), maar ook representaties van woordvormen die op elkaar lijken (bijvoorbeeld *bel* en *bed*) en betekenisrepresentaties die iets met elkaar te maken hebben (bijvoorbeeld de betekenissen van 'sleutel' en 'slot'). Een vereenvoudigd model van zo'n netwerk is te zien in Figuur 1.

Figuur 1. Vereenvoudigd model van het mentale lexicon als een netwerk van representaties en verbindingen tussen representaties. In de onderzoeken in dit proefschrift wordt voornamelijk gebruik gemaakt van de modellen BIA+ (Dijkstra & van Heuven, 2002) en Multilink (Dijkstra et al., 2019).



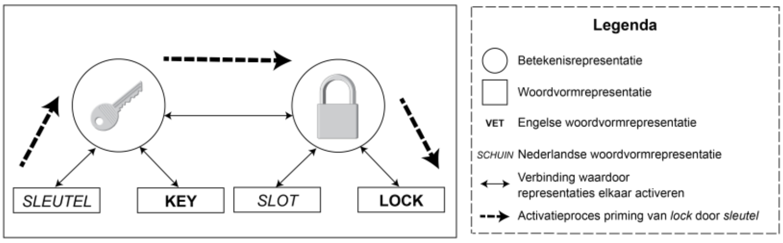
De informatie uit het mentale lexicon wordt tijdens het verwerken van woorden GEACTIVEERD. Als je bijvoorbeeld 'sleutel' hoort, wordt eerst de representatie van de woordvorm geactiveerd, gevolgd door de woordbetekenis. De aard van het netwerk zorgt ervoor dat ook andere representaties geactiveerd worden. Zo wordt via de betekenisrepresentatie van 'sleutel' ook de betekenisrepresentatie van 'slot' actief. Dit heeft gevolgen voor de woordverwerking: het is eenvoudiger om het woord *slot* te verwerken na het horen van het woord *sleutel*. Dit fenomeen, waarbij de verwerking van een woord beïnvloed wordt door een voorafgaand woord, wordt PRIMING genoemd. Het tweede woord (in dit geval *slot*) wordt dus geprimed door het voorafgaande woord (in dit geval *sleutel*). De gestreepte pijlen in Figuur 2 laten dit zien.

Figuur 2. Priming van *slot* door *sleutel* als gevolg van activatie in het mentale lexicon.



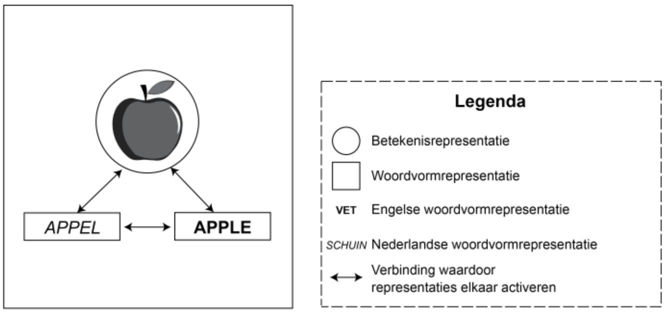
Priming speelt een belangrijke rol in het onderzoek naar het mentale lexicon van tweetaligen – om precies te zijn TUSSEN-TALIGE PRIMING, oftewel priming tussen woorden uit verschillende talen, een vorm van tussen-talige invloed. Zo is gebleken dat bij bijvoorbeeld Nederlands-Engels tweetalige volwassenen het woord *sleutel* niet alleen het woord *slot* zou primen, maar ook Engelse woorden als *lock* of *key*. Dit laat zien dat tweetalige volwassenen niet twee aparte lexicons hebben, één voor iedere taal, maar één lexicon dat woorden uit beide talen bevat. In dit lexicon zijn representaties van woordvormen en betekenissen met elkaar verbonden, ongeacht de taal waaruit ze afkomstig zijn. De betekenisrepresentatie van 'sleutel' is bijvoorbeeld verbonden aan zowel de woordvorm *sleutel* als de woordvorm *key*. Ook woordvormen uit beide talen die op elkaar lijken, zoals *dop* en het Engelse *dog*, zijn met elkaar verbonden. Een vereenvoudigd model van zo'n tweetalig lexicon is te zien in Figuur 3. De verbindingen tussen representaties uit verschillende talen kunnen dus leiden tot tussen-talige priming, zoals aangegeven door middel van de gestreepte pijlen in Figuur 3.

Figuur 3. Vereenvoudigd model van het tweetalige mentale lexicon, met woorden en betekenissen uit beide talen in hetzelfde netwerk, en met priming tussen woorden uit verschillende talen.



Een andere vorm van lexicale tussen-talige invloed is het COGNAATEFFECT. COGNATEN zijn woorden uit verschillende talen die én hetzelfde betekenen én qua woordvorm op elkaar lijken, zoals de woorden *xylofoon* en *ξυλόφωνο* (*xylofono*) die al eerder aan bod kwamen, of *appel* en *apple*, of *Apfel*, *æble*, *äpple*, *afal*... Het cognaateffect houdt in dat cognaten door tweetaligen sneller en/of correcter verwerkt worden dan andere woorden (niet-cognaten), zonder dat ze geprimed hoeven te worden. Als een Nederlands-Engels tweetalige het woord *appel* wil zeggen, wordt namelijk ook *apple* sterk geactiveerd, doordat deze woorden een betekenisrepresentatie delen én verbonden woordvormrepresentaties hebben (zie Figuur 4). Beide woordvormen blijven elkaar activeren, wat helpt bij het spreken of begrijpen.

Figuur 4. Vereenvoudigd model van de woordvorm- en betekenisrepresentaties van cognaten in een tweetalig lexicon.



Lexicale tussen-talige invloed bij kinderen

Lexicale tussen-talige invloed is voornamelijk aangetoond bij volwassenen, maar er zijn ook onderzoeken geweest naar dit soort effecten bij kinderen. Zo heeft een aantal studies tussen-talige priming-effecten gevonden bij jonge tweetalige peuters (bijv. Von Holzen & Mani, 2012), en cognaateffecten bij tweetalige kinderen in de basisschoolleeftijd (bijv. Poarch & van Hell, 2012). Het lijkt er dus op dat het lexicon van tweetalige kinderen op een soortgelijke manier georganiseerd is als het lexicon van tweetalige volwassenen, en dat de woordverwerking op soortgelijke manieren beïnvloed wordt door de kennis van de andere taal, maar dit onderzoek is vrij beperkt. In dit proefschrift is daarom zowel tussen-talige priming onderzocht (**Hoofdstuk 2**) als de productie en het begrip van cognaten (**Hoofdstuk 3 t/m 5**) bij simultaan tweetalige kinderen in de kleuter- en basisschoolleeftijd. Dit onderzoek leidt niet alleen tot meer kennis over tussen-talige invloed in het algemeen, maar ook over in hoeverre het tweetalig lexicon van deze kinderen, net als bij volwassenen, één gedeeld netwerk vormt voor beide talen.

Modulerende factoren

Naast het onderzoeken *of* lexicale tussen-talige invloed voorkomt, heeft dit proefschrift als doel om te onderzoek *hoe* deze effecten zich uiten, en of dit gelijk is voor verschillende kinderen en onder verschillende omstandigheden. Op basis van eerder onderzoek naar zowel volwassenen als kinderen worden drie soorten factoren onderzocht die lexicale tussen-talige invloed zouden kunnen beïnvloeden of MODULEREN: individuele factoren, taak- en contextgerelateerde factoren, en talige factoren.

Individuele factoren

Ieder kind is uniek, en de taalontwikkeling van ieder kind (daardoor) ook. Een belangrijke factor die de tweetalige taalontwikkeling beïnvloedt en van individu tot individu verschilt, is TAALDOMINANTIE. Taaldominantie verwijst naar de relatieve sterkte van de twee talen binnen een persoon, en kan bijvoorbeeld worden bepaald door de hoeveelheid taalaanbod en/of de taalvaardigheid in de beide talen te vergelijken. In theorie kan een tweetalig kind gebalanceerd zijn, wat betekent dat beide talen ongeveer even sterk zijn, maar doorgaans is één taal sterker, oftewel dominanter, en de andere taal zwakker.

Eerder onderzoek met zowel volwassenen als kinderen suggereert dat de sterkere taal meer invloed heeft op de zwakkere taal dan andersom (bijv. Bosma et al., 2019; van Hell & Tanner, 2012). Een Duits-Nederlands tweetalig kind dat opgroeit in Nederland en naar een Nederlandstalige school gaat, zal vaak Nederlands-dominant zijn, waardoor bijvoorbeeld het cognaateffect vaker zal optreden wanneer het kind in het Duits praat dan wanneer het Nederlands praat. Met andere woorden: het Duitse woord *Apfel* zal meer geholpen worden door het Nederlandse woord *appel* dan andersom. In onderzoek naar lexicale tussen-talige invloed bij kinderen worden dit soort dominantie-effecten echter zeker niet altijd gevonden (bijv. wel in Singh, 2014, maar niet in de soortgelijke onderzoeken van Floccia et al., 2020 en Jardak & Byers-Heinlein, 2019). In dit proefschrift wordt de rol van taaldominantie daarom nader onderzocht (**Hoofdstuk 2 t/m 5**), in combinatie met taak- en contextgerelateerde factoren en talige factoren.

Taak- en contextgerelateerde factoren

De informatie uit het mentale lexicon kan op verschillende manieren gebruikt worden, bijvoorbeeld om een woord te produceren of juist te begrijpen, in een taalkundig experiment of in een gesprek met mensen die één of meerdere talen spreken. In principe zou lexicale tussen-talige invloed in al die gevallen kunnen worden verwacht. Eerder onderzoek heeft echter laten zien dat de verwerking van woorden wordt beïnvloed door allerlei verschillen tussen WOORDPRODUCTIE EN WOORDBEGRIPSTAKEN – het verschilt immers per situatie wat je precies met een woord moet doen (zie bijv. de Groot et al. 2002; Dijkstra & van Heuven, 2002). Of deze verschillen ook van invloed zijn op lexicale tussen-talige invloed is nog niet duidelijk, en zeker niet bij kinderen. Daarom wordt in **Hoofdstuk 3 en 4** onderzocht of tussen-talige invloed op dezelfde manier voorkomt in zowel een woordproductietaak als een woordbegripstaak. Ook wordt onderzocht of de rol van taaldominantie hetzelfde is in verschillende taken.

Daarnaast worden de taken in **Hoofdstuk 4** afgenomen in verschillende TAALCONTEXTEN. Onder taalcontext wordt in dit proefschrift verstaan welke talen expliciet gebruikt worden in een bepaalde situatie (zie bijv. Green & Abutalebi, 2013; Gross & Kaushanskaya, 2020). In een eentalige context wordt slechts één taal gesproken. In een tweetalige context worden beide talen gebruikt, en moet een tweetalige telkens wisselen tussen talen. Dit is bijvoorbeeld het geval als een tweetalige met meerdere mensen in gesprek is en de gesprekspartners in verschillende talen aanspreekt. In het onderzoek in Hoofdstuk 4 wordt niet van taal gewisseld afhankelijk van de gesprekspartner, maar afhankelijk van de taak. Op deze manier wordt onderzocht of lexicale tussen-talige invloed in woordproductie en woordbegrip altijd in dezelfde mate plaatsvindt, of dat dit bijvoorbeeld minder het geval is wanneer maar één taal expliciet gebruikt wordt. Ook hierbij wordt de rol van taaldominantie meegenomen.

Talige factoren

Tot slot wordt in dit proefschrift gekeken naar de rol van TAALAFSTAND, oftewel hoe sterk talen op elkaar lijken. Eerder onderzoek heeft laten zien dat taalafstand van invloed is op de woordenschat. Kinderen die twee talen leren met een kleine taalafstand hebben een grotere woordenschat in één taal dan kinderen die twee talen leren met een grotere taalafstand (bijv. Blom et al., 2020; Floccia et al., 2018). Het is nog niet duidelijk hoe taalafstand en lexicale tussen-talige invloed met elkaar samenhangen. Zo kennen talen met een kleine afstand, zoals Duits en Nederlands, veel cognaten (bijvoorbeeld *appel* en *Apfel*, *stoel* en *Stuhl*, of *boek* en *Buch*). Mogelijk kunnen taalafstand-effecten (deels) verklaard worden als cognaateffecten. Daarnaast zou het kunnen dat kinderen die sterk gelijkende talen spreken een sterkere mate van tussen-talige invloed laten zien dan kinderen die minder gelijkende talen spreken.

In dit proefschrift wordt daarom gekeken in hoeverre lexicale tussen-talige invloed gelijk is voor kinderen die twee talen leren met een kleinere of een grotere taalafstand (**Hoofdstuk 5**). Dit maakt niet alleen duidelijker in hoeverre lexicale tussen-talige invloed bij alle tweetaligen voorkomt, maar kan ook inzichten geven over de bron van taalafstand-effecten op de woordenschat. Hierbij wordt, net als bij taak- en contextgerelateerde factoren, eveneens rekening gehouden met de taaldominantie van de kinderen.

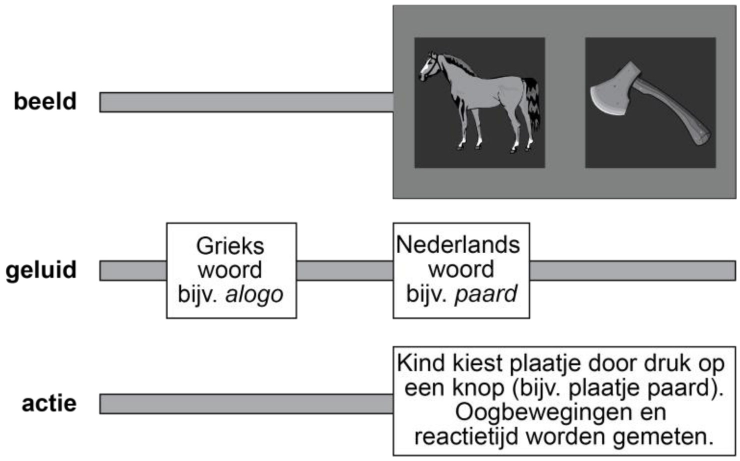
Samenvatting per hoofdstuk

Hoofdstuk 2: Tussen-talige priming in woordbegrip

Het onderzoek in **Hoofdstuk 2** was gericht op de manier waarop het mentale lexicon georganiseerd is bij tweetalige kinderen. Om precies te zijn is gekeken in hoeverre de representaties van zowel woordbetekenissen als woordvormen gedeeld zijn tussen verschillende talen. Dit werd door middel van een tussen-talige priming-taak onderzocht in een groep van 24 Grieks-Nederlandse kinderen tussen de 4 en 9 jaar oud.

De priming-taak is schematisch in een tijdlijn weergegeven in Figuur 5. De kinderen kregen woordparen te horen, bestaande uit telkens een Grieks woord gevolgd door een Nederlands woord. De twee woorden hadden op verschillende manieren met elkaar te maken. Ze konden dezelfde betekenis hebben (bijvoorbeeld *alogo*, wat 'paard' betekent, en *paard*), of ze konden met dezelfde klanken beginnen (bijvoorbeeld *papia*, wat 'eend' betekent, en *paard* – beide beginnen met 'pa'). Ook waren er woordparen die indirect aan elkaar gerelateerd waren, doordat de vertaling van het Griekse woord met dezelfde klanken begon als het Nederlandse woord (bijvoorbeeld *charti*, wat 'papier' betekent, en *paard* – in dit geval zijn de beginklanken van *papier* en *paard* dus beide 'pa'). De vraag hierbij was of het Nederlandse woord in deze gevallen geprimed werd door het Griekse woord en de verwerking dus werd beïnvloed. Om te onderzoeken hoe de woorden verwerkt werden, kregen de kinderen na ieder woordpaar twee plaatjes te zien, waarvan één overeenkwam met het tweede woord uit het woordpaar. Er werd gemeten naar welk plaatje ze op welk moment keken. Ook drukten de kinderen op een knop om het juiste plaatje te kiezen, en werd gemeten hoe snel ze dit deden.

Figuur 5. Tijdlijn van de priming-taak.



De resultaten lieten zien dat de verwerking van de Nederlandse woorden inderdaad werd beïnvloed door eigenschappen van het voorafgaande Griekse woord. Als de kinderen eerst de Griekse vertaling gehoord hadden, keken ze gemiddeld meer naar het juiste plaatje en drukten ze sneller op de knop, dan wanneer ze een ongerelateerd Grieks woord gehoord hadden. Ook als het Griekse woord qua woordvorm leek op het Nederlandse woord – direct, zoals in *papia* en *paard*, of indirect, zoals *charti* en *paard*, via het woord *papier* – beïnvloedde dit het kijkgedrag en de snelheid waarmee ze het juiste plaatje kozen.

Deze resultaten laten zien dat woordvormen en woordbetekenissen van woorden uit verschillende talen bij simultaan tweetalige kinderen in één gezamenlijk netwerk zitten (zoals in bijv. Figuur 3). Daarbij hebben woorden met dezelfde betekenis waarschijnlijk een gedeelde betekenisrepresentatie, dus als de kinderen eerst het Griekse woord horen, wordt via die gedeelde betekenisrepresentatie ook het Nederlandse woord actief. Daardoor kan dit sneller verwerkt worden. Ook woorden die qua woordvorm op elkaar lijken worden actief tijdens de verwerking, ongeacht uit welke taal ze komen. Dit leidt dus, in ieder geval in deze woordbegripstaak, tot lexicale tussen-talige invloed, hier in de vorm van tussen-talige priming.

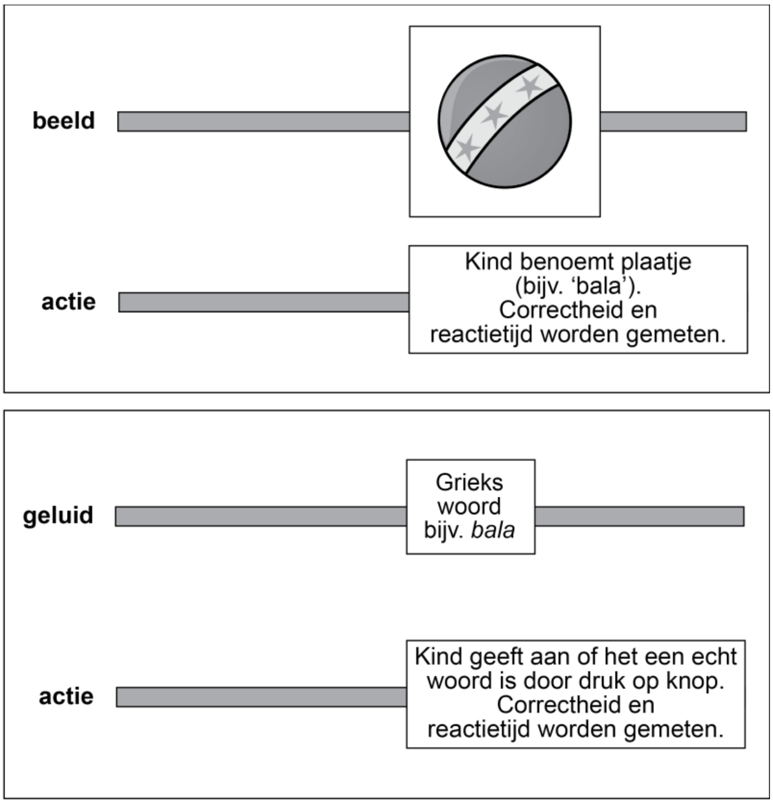
In dit onderzoek werd ook de rol van taaldominantie op tussen-talige priming onderzocht. Hoewel verwacht werd dat de priming-effecten groter zouden zijn bij kinderen die meer Grieks-dominant waren, was dit niet het geval.

Hoofdstuk 3 en 4: Cognaateffecten in woordproductie en -begrip, in eentalige en tweetalige contexten

Nadat het onderzoek in Hoofdstuk 2 had laten zien dat zowel woordbetekenissen als woordvormen uit beide talen in één gezamenlijk netwerk zitten en dat dit kan leiden tot tussen-talige invloed, werd in **Hoofdstuk 3 en 4** verder onderzocht of deze tussen-talige invloed onder verschillende omstandigheden voorkomt. De vorm van tussen-talige invloed die onderzocht werd was het cognaateffect, oftewel of cognaten sneller en/of met minder fouten verwerkt worden.

In het onderzoek in **Hoofdstuk 3** werd het cognaateffect onderzocht in zowel woordproductie als woordbegrip, met als vraag of verschillen tussen de taken de sterkte van het effect moduleren. Een groep van 27 Grieks-Nederlandse kinderen tussen de 7 en de 11 jaar oud voerde twee taken uit: in de ene taak kregen zij plaatjes te zien die ze met één Grieks woord moesten benoemen, in de andere taak kregen zij woorden te horen waarvan ze moesten aangeven of dit echte Griekse woorden waren of niet (zie Figuur 6). Beide taken bevatten een deel cognaten, zoals *bal* en *μπάλα* (uitgesproken als *bala*, betekent 'bal'). Er werd gemeten of ze op de cognaten sneller en/of vaker correct reageerden dan op de andere woorden (niet-cognaten). Ook werd onderzocht of dit verschil groter was voor kinderen die meer Nederlands-dominant waren.

Figuur 6. Tijdlijn van de plaatjesbenoemtaak (boven) en de woordbeslissingstaak (onder).



In het onderzoek in **Hoofdstuk 4** werd hier verder op voortgebouwd, door dezelfde taken (in het Duits of in het Nederlands) af te nemen bij een groep van 63 Duits-Nederlandse kinderen tussen de 7 en de 11 jaar oud. Bovendien werden de taken twee keer afgenomen bij dezelfde groep tweetalige kinderen: een keer in een eentalige context en een keer in een tweetalige context. In de eentalige context werd slechts één taal gebruikt in alle taken en in alle communicatie. In de tweetalige context voerde het kind de twee taken uit in de ene taal (bijvoorbeeld Duits), maar werd verder de andere taal gebruikt (bijvoorbeeld Nederlands), namelijk in instructievideo's, in de communicatie met de (virtueel) aanwezige onderzoeker, en in taalvaardigheidstoetsen en andere achtergrondtaken die tussen de taken door werden afgenomen.

In beide hoofdstukken werden cognaateffecten gevonden in zowel woordproductie als woordbegrip. Wel zagen deze effecten er anders uit, afhankelijk van een combinatie van taalgroep, taak, en, in Hoofdstuk 4, taalcontext. Deze resultaten worden hieronder per taak besproken.

In de plaatjesbenoemtaak benoemden zowel de Grieks-Nederlandse kinderen als de Duits-Nederlandse kinderen cognaten sneller dan niet-cognaten. De Duits-Nederlandse kinderen maakten bovendien ook minder fouten bij cognaten dan bij niet-cognaten. Bij de Grieks-Nederlandse kinderen werd het cognaateffect niet beïnvloed door taaldominantie. Bij de Duits-Nederlandse kinderen wel, afhankelijk van de context. In de eentalige context was de invloed van de ene taal groter naarmate deze dominanter was, waarmee het cognaateffect dus sterker werd, in overeenstemming met eerder onderzoek met volwassenen en kinderen (bijv. Bosma et al., 2019; van Hell & Tanner, 2006). In de tweetalige context was het effect van dominantie echter andersom: het cognaateffect werd juist kleiner naarmate de dominantie sterker was. Het lijkt erop dat de kinderen in dit geval hun dominante taal onderdrukten. Mogelijk was dit een gevolg van dat ze vaak tussen hun talen moesten wisselen in deze tweetalige context.

In de woordbeslissingstaak maakten de Grieks-Nederlandse kinderen minder fouten bij cognaten dan bij niet-cognaten. Hierbij was er ook sprake van een dominantie-effect, waarbij het cognaateffect in het Grieks sterker was voor meer Nederlands-dominante kinderen. Met andere woorden, de invloed van de ene taal was hier wederom groter als deze meer dominant was. De Duits-Nederlandse kinderen maakten over het algemeen weinig fouten, en reageerden sneller op cognaten dan op niet-cognaten. Bij hen werd dit niet beïnvloed door dominantie.

Samen laten deze twee hoofdstukken ten eerste zien dat tussen-talige invloed in zowel woordproductie als woordbegrip kan voorkomen. Ten tweede lijkt wat er precies tijdens de taak van een kind verwacht wordt invloed te hebben op de vorm van dit effect, zoals of het in het aantal fouten of in de reactietijden optreedt, en of er een invloed is van dominantie. Ook context speelt hierbij een rol: een combinatie van taak en context kan ervoor zorgen dat de invloed van dominantie een omgekeerd patroon laat zien ten opzichte van wat in het meeste onderzoek gevonden wordt. Dat de exacte resultaten ook verschilden tussen de twee hoofdstukken suggereert dat ook taalafstand een rol zou kunnen spelen. De kinderen in het ene onderzoek spraken Grieks en Nederlands– twee talen die niet sterk op elkaar lijken – en de kinderen in het andere onderzoek Duits en Nederlands – twee talen die sterk op elkaar lijken.

Hoofdstuk 5: Cognaateffecten en taalafstand

In het onderzoek in **Hoofdstuk** *5* is de rol van talige factoren, om precies te zijn taalafstand, nader onderzocht. Dit werd gedaan in een grote groep tweetalige kinderen, tussen de 3 en 11 jaar oud, die verschillende talen spraken, namelijk 99 Duits-Nederlandse kinderen, 104 Engels-Nederlandse kinderen, 54 Spaans-Nederlandse kinderen, 39 Grieks-Nederlandse kinderen, en 16 Turks-Nederlandse kinderen. Alle kinderen hadden dezelfde Nederlandse woordenschattaak uitgevoerd. De woorden in de woordenschattaak varieerden in hoe 'cognaat-achtig' ze waren, oftewel hoe sterk gelijkend op de vertaling in de andere talen die de kinderen spraken. Zo lijkt *hoed* sterker op de Duitse vertaling *Hut* dan *citroen* lijkt op de Duitse vertaling *Zitrone*, maar lijken bijvoorbeeld *geit* en het Duitse *Ziege* weer een stuk minder op elkaar dan zowel *hoed* en *Hut* als *citroen* en *Zitrone*.

Ten eerste werd onderzocht of er in deze taak, waarin er geen heel duidelijk onderscheid was gemaakt tussen cognaten en niet-cognaten, ook een cognaat-effect kon optreden. In dit geval zouden kinderen dus beter scoren op woorden naarmate deze meer 'cognaat-achtig' waren. Duits-Nederlandse kinderen zouden dus beter scoren op *hoed* dan op *citroen*, en beter op *citroen* dan op *geit*. Ten tweede werd onderzocht of dit effect even groot was voor alle kinderen, of dat kinderen die twee talen spreken met een kleine afstand (Duits of Engels naast Nederlands) bijvoorbeeld een groter cognaateffect vertonen dan kinderen die talen met een grotere afstand spreken (Spaans, Grieks, of Turks naast Nederlands). Ook werd hierbij wederom rekening gehouden met mogelijke effecten van taaldominantie. Ten derde werd onderzocht of kinderen die meer gelijkende talen spreken een grotere woordenschat hebben, zoals gevonden is in eerder onderzoek, en in hoeverre dit gedreven werd door de aanwezigheid van cognaten in de woordenschattaak.

Over het algemeen kenden de kinderen inderdaad meer woorden naarmate deze meer 'cognaat-achtig' waren, en dit effect was groter voor kinderen die meer dominant waren in hun andere taal. Deze effecten waren in lijn met de verwachtingen. Ook scoorden de kinderen die talen spraken met een kleinere afstand over het algemeen hoger, zowel op sterk gelijkende cognaten als op niet-cognaten of cognaat-achtige woorden. Dit laat zien dat er inderdaad taalafstand-effecten zijn in de woordenschat, die niet (volledig) verklaard kunnen worden als cognaateffecten.

Wat onverwacht was, was dat het cognaateffect sterker was voor kinderen die talen spraken met een grotere afstand dan voor kinderen met een kleinere taalafstand. Voor een Duits-Nederlands kind was er dus bijvoorbeeld minder verschil tussen *hoed*, *citroen*, en *geit*, dan voor een Turks-Nederlands kind tussen bijvoorbeeld *ananas* (in het Turks: *ananas*), *lamp* (in het Turks: *lamba*), en *liniaal* (in het Turks: *cetvel*). Mogelijk vallen sterk gelijkende woorden meer op voor kinderen die talen spreken met een grotere afstand, terwijl een cognaat voor een Duits-Nederlands of Engels-Nederlands kind niet zo een speciale status heeft. Ook zijn er voor deze talen mogelijk meer gelijkenissen op andere taalkundige niveaus (bijvoorbeeld morfologie of fonetiek), waardoor veel niet-cognaten op een andere manier toch ook geholpen worden door de kennis uit de andere taal.

Algemene conclusies en implicaties

In **Hoofdstuk 6** werden de uitkomsten van de verschillende onderzoeken in dit proefschrift bij elkaar gebracht. Samen geven deze onderzoeken meer inzicht in hoe woorden uit twee verschillende talen zijn opgeslagen en worden verwerkt in het lexicon van tweetalige kinderen. Daarbij laten ze ook zien hoe die verwerking wordt beïnvloed door individuele factoren, taak- en contextgerelateerde factoren, en talige factoren. De belangrijkste conclusie is dat het lexicon van tweetalige kinderen een gedeeld netwerk vormt, waarbij de representaties van woordvormen en woordbetekenissen uit beide talen met elkaar verbonden zijn en zelfs gedeeld kunnen zijn. Tijdens het verwerken van woorden worden verbonden representaties actief, ongeacht uit welke taal de woorden afkomstig zijn. Dit kan leiden tot lexicale tussen-talige invloed in de vorm van tussen-talige priming-effecten of cognaateffecten.

In principe kan lexicale tussen-talige invloed bij alle tweetalige kinderen voorkomen, in zowel woordproductie als woordbegrip, in eentalige en tweetalige contexten. Hoe lexicale tussen-talige invloed zich precies uit, hangt echter af van een combinatie van factoren. De sterkte van de activatie van representaties in het lexicon is onder andere afhankelijk van taaldominantie:

hoe dominanter een taal, hoe actiever de woorden uit die taal en hoe meer invloed ze daardoor uitoefenen op de verwerking van andere woorden. In principe leidt dit tot sterkere lexicale tussen-talige invloed, maar dit is niet altijd het geval. Taak en context spelen hierbij ook een rol. Zo kan het onder bepaalde omstandigheden gebeuren dat een dominantere taal juist onderdrukt wordt, waarschijnlijk als dit helpt om de specifieke taak in de specifieke context uit te voeren. Tot slot lijkt ook taalafstand een rol te spelen in de sterkte van lexicale tussen-talige invloed, mogelijk door de hoeveelheid overlap op verschillende taalkundige niveaus, wat ook weer van invloed kan zijn op de verwachtingen die kinderen hebben over in hoeverre ze gebruik kunnen maken van hun andere taal.

Kortom, de bevindingen uit dit proefschrift laten enerzijds zien hoe robuust lexicale tussen-talige invloed in de vorm van tussen-talige priming en cognaateffecten is, en maken anderzijds duidelijk dat verschillende factoren van invloed zijn op de manier waarop tussen-talige invloed zich uit, namelijk individuele, taak- en contextgerelateerde, en talige factoren, en dat deze bovendien ook op complexe wijze op elkaar inspelen. Samen met eerder onderzoek naar volwassenen en (jongere) kinderen wordt duidelijk dat het tweetalig lexicon op soortgelijke wijze is ingericht en op soortgelijke wijze functioneert in meerdere – en mogelijk alle – stadia van de ontwikkeling. Het onderzoek in dit proefschrift vormt daarmee een brug tussen onderzoek naar woordverwerking door tweetalige volwassenen en onderzoek naar de tweetalige taalverwerving en tussen-talige invloed bij kinderen, en laat zien dat deze twee onderzoeksvelden van elkaars bevindingen kunnen leren.

Deze bevindingen hebben niet alleen gevolgen voor het onderzoek, maar ook voor de praktijk, bijvoorbeeld voor het onderwijs of de opvoeding van tweetalige kinderen. Voor leraren en ouders of verzorgers is het met name belangrijk dat lexicale tussen-talige invloed bij alle tweetalige kinderen kan voorkomen, ongeacht leeftijd, de talen die een kind spreekt, of de situatie waarin het kind zich bevindt. Het kan dus ook plaatsvinden in een volledig eentalige context, dus in situaties waarin maar één taal wordt aangeboden, zoals op school. Dit is geen reden tot zorg: tussen-talige invloed lijkt een natuurlijk bijproduct van tweetaligheid te zijn.

Tegelijkertijd zal tussen-talige invloed in veel gevallen niet erg opvallen. Zo bleken sommige effecten in dit proefschrift alleen uit nauwkeurige metingen van oogbewegingen of reactietijden. Dat geeft weliswaar belangrijke inzichten in de verwerking, maar speelt niet per se een grote rol in het dagelijks leven.

Waar lexicale tussen-talige invloed wel relatief makkelijk zichtbaar kan worden, is bijvoorbeeld in woordenschattoetsen. Tweetalige kinderen scoren gemiddeld genomen beter op woorden die meer 'cognaat-achtig' zijn, oftewel meer gelijkenissen vertonen met woorden uit hun andere taal. Leraren, maar ook onderzoekers die dit soort toetsen afnemen, moeten zich daarom bewust zijn van de hoeveelheid cognaten in deze toetsen en of deze hoeveelheid representatief is voor de talen die het kind spreekt. Als cognaten te veel of juist te weinig voorkomen, kan een vertekend beeld van de grootte van de woordenschat ontstaan.

Ook de subtielere effecten van tussen-talige invloed zijn van belang voor het onderwijs. Het is namelijk duidelijk dat kinderen hun andere taal niet zomaar kunnen 'uitzetten': in principe zijn beide talen altijd actief. Hierdoor kan het erg effectief zijn om juist gebruik te maken van beide talen, bijvoorbeeld door middel van zogenaamde TRANSLANGUAGING-strategieën. Eerder onderzoek heeft al laten zien dat het versterken van de woordenschat in de ene taal ook de woordenschat in de andere taal vergroot (zie bijv. Bosma et al., 2023, voor een overzicht). Door kinderen uit hun kennis van beide talen te laten putten door middel van *translanguaging*-strategieën, kan de woordenschat in beide talen dus versterkt worden. Het idee dat beide talen met elkaar verbonden zijn en met elkaar in interactie gaan in het lexicon ligt ten grondslag aan deze strategieën, en dit proefschrift heeft aanzienlijk bewijs geleverd voor dit soort verbindingen en interacties. Kortom: dit proefschrift heeft aangetoond dat lexicale tussen-talige invloed er voor tweetalige kinderen, net als bij tweetalige volwassenen, nu eenmaal bij hoort.

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Curriculum vitae

Elly Koutamanis was born in 1994 in Delft, the Netherlands. She studied Linguistics at Utrecht University, where she obtained her Bachelor's degree (cum laude) in 2015 and her Master's degree (cum laude) in 2017. During her studies, she worked as a research assistant in the *Coloring Book* project, which aimed to develop a new method for testing language comprehension. During her Master's, she also visited Michigan State University as a research intern. In 2017, Elly started her PhD project at the Centre for Language Studies at Radboud University as part of the NWO-funded VIDI project *The priming mind of the bilingual child: Simultaneous acquisition, simultaneous activation* (2in1 project). During her PhD, she also worked as a researcher at Hogeschool KPZ and as a freelance data analyst. Elly is currently employed at Radboud University as part of Kletskoppen, an initiative for language science communication aimed at children and families.

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Koutamanis, E., Kootstra, G. J., Dijkstra, T., & Unsworth, S. (2023). Cognate facilitation in single-and dual-language contexts in bilingual children's word processing. *Linguistic Approaches to Bilingualism*. https://doi.org/10.1075/lab.23009.kou

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