Bilingualism and cognition
The acquisition of Frisian and Dutch
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This dissertation investigates the interplay between bilingualism and cognition. This is done by examining the linguistic and cognitive development of 5- to 8-year-old children who grow up in Fryslân, a bilingual province in the north of the Netherlands where both Frisian and Dutch are spoken. The Frisian and Dutch language that are spoken nowadays share a large part of their vocabularies and morphosyntactic structures. This extensive overlap between the two linguistic systems offers a rich opportunity to investigate how cross-language similarity interacts with variables such as exposure, age of onset and cognitive functioning, and to investigate whether growing up with two closely related languages has an effect on children’s cognitive capacities. By following 120 Frisian-Dutch bilingual children over the course of three years, this dissertation seeks to deepen our understanding of the ways in which language and cognition interact.

Bilingualism and cognition:
the acquisition of Frisian and Dutch

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Bilingualism and cognition:  
the acquisition of Frisian and Dutch

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Dankwoord

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Mijn project in Friesland liep parallel aan een project in Utrecht, waar Tessel Boerma en Mona Timmermeister onderzoek deden naar tweetaligheid bij immigrantenkinderen. Ik vond het erg fijn om in het begin zo nauw met jullie samen te kunnen werken en ervaringen te tillen en wees je me de weg naar internationale publicaties. Zonder jou had ik me niet kunnen ontwikkelen tot de wetenschapper die ik nu ben.

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In ûndersyk nei twataligen by bern kin net sûnder in twatalige mienskip dy’t meidwaan wol as stûdzje-objekt. Dêrom wol ik myn grunt tank útsprekke nei de learkrêften, âlders en bern fan de 14 skoallen dy’t meidien hawwe oan myn ûndersyk. Dat binne de Hasperschool yn Akkrum, de Stjelp yn Baard, Dübelspan yn Boazum, Twaspan yn Deinum, de Fôlefinne yn Easterwierrum, de Romte yn Itens, de Krunenstrobbe yn Jorwert, de Gielgundeme yn Mantgum, de Jasker yn Nij Beets, de Bonifatiusschool yn Wâldsein, it Pertoer yn Weidum, it Bynt yn Winsum, de Pikeloer yn Wiuwert en de Opslach yn Wommels. De Otto Clant Skoalle yn Boksum en Op ‘e Trije yn Ferwert wol ik betankje foar it meidwaan oan myn pilotstûdzje.

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Publications
The following chapters of this dissertation are slightly adapted versions of papers that have been or are to be published in peer-reviewed journals:

**Chapter 2:**

Blom was the principal investigator for this article. She posed the research questions, performed the statistical analyses and wrote the article, except for the Method section and the section on noun plurals and past participles in Dutch and Frisian, which were written by Bosma. Bosma designed the Frisian morphology task and recruited the participants. Together with test assistants Paula van Zwol and Anke Wagenaar she administered the tests and together with test assistant Paula van Zwol and intern student Rixt Weiland she interviewed the parents. Furthermore, Bosma made the test scores ready for the statistical analyses and gave feedback on earlier versions of the article. Blom submitted the article.

**Chapter 3:**

Bosma was the principal investigator for this article. She posed the research questions, designed the Frisian vocabulary task and recruited the participants. Together with test assistants Paula van Zwol and Anke Wagenaar she administered the tests and together with test assistant Paula van Zwol and intern student Rixt Weiland she interviewed the parents. Bosma performed the statistical analyses and wrote the article. Blom, Hoekstra and Versloot acted as supervisors and gave feedback on the instruments and earlier versions of the article, with Blom acting as the main supervisor. Based on the valuable comments from her supervisors, Bosma rewrote and revised the article until it was ready for submission.
Chapter 4:

The procedure followed writing this article and the responsibilities of the authors are for a large part identical to the procedure and task descriptions of the authors for chapter 3, with the exception of the statistical analyses. These were performed by Heeringa.

Chapter 5:

The procedure followed writing this article and the responsibilities of the authors are identical to the procedure and task descriptions of the authors for chapter 3.

Chapter 6:

The procedure followed writing this article and the responsibilities of the authors are identical to the procedure and task descriptions of the authors for chapter 3.
Chapter 1

General introduction
Chapter 1

The aim of this dissertation is to investigate the interplay between bilingualism and cognition. This is done by examining the linguistic and cognitive development of 5- to 8-year-old children who grow up in Fryslân, a bilingual province in the north of the Netherlands where both Frisian and Dutch are spoken. By following 120 Frisian-Dutch bilingual children over the course of three years, this dissertation seeks to contribute to our understanding of the factors that support bilingual language acquisition and the ways in which bilingual language acquisition influences cognitive development.

The Frisian-Dutch bilingual context

Fryslân is a bilingual province in the north of the Netherlands with approximately 650,000 inhabitants (Centraal Bureau voor de Statistiek, 2017) where both the national majority language Dutch and the regional minority language Frisian are spoken. Outside of the Netherlands, Frisian is known as West Frisian to avoid confusion with the Frisian languages that are spoken in Germany (North and East Frisian). In this dissertation, whenever the term Frisian is used, it refers to the West Frisian language.

In 1998, the European Charter for Regional and Minority Language (ECRML) went into force, which recognizes the Frisian language under part III. This obliges the Dutch government to take concrete actions to promote Frisian in domains like education, administration, and the media. For example, primary schools in the province of Fryslân are required to teach Frisian as a subject for at least one hour per week and in many schools Frisian is used as one of the languages of instruction. In 2005, the Dutch government recognized the Frisians as the only national minority group under the Framework Convention on the Protection of National Minorities (FCNM). Finally, in 2014, Frisian was recognized as official language of the province of Fryslân, next to Dutch, when the Wet Gebruik Friese Taal (‘Law on the use of the Frisian language’) went into force in the Netherlands.

Although Frisian is more spoken in rural than in urban areas (Breuker, 2001), it has quite a strong position in the province of Fryslân as a whole. In a recent survey of the province, a little more than half of the population reported to speak Frisian as a mother tongue (55.3%) and a little less than half of the population reported to speak Frisian with their partner (45.6%) and children (47.5%). The survey also showed that Frisian is used more as an oral than as a written language: the majority of the population reported to speak Frisian well (66.6%), whereas only a small minority reported to write it well (14.5%) (Provisje Fryslân, 2015).
General introduction

Frisian and Dutch are both West Germanic languages. Traditionally, three Frisian dialects are distinguished: Klaaifrysk (clay Frisian) in the west of the province, Wâldfrysk (forest Frisian) in the east and Súdwesthoeks (southwest quarter) in the southwest (Hof, 1933; Tiersma, 1999). These dialects differ slightly on the lexical and phonological level, but are mutually intelligible. Historically, Frisian is most closely related to English, but over time English and Frisian have diverged, while Dutch and Frisian have converged (Gooskens & Heeringa, 2004). As a result, the Frisian and Dutch language that are spoken nowadays share a large part of their vocabularies and morphosyntactic structures.

This extensive overlap between the Frisian and Dutch linguistic system offers a rich opportunity to investigate how cross-language similarity interacts with variables such as exposure, age of onset and cognitive functioning, and to investigate whether growing up with two closely related languages has an effect on children’s cognitive capacities. By investigating the linguistic and cognitive development of Frisian-Dutch bilingual children, together with environmental factors such as exposure and socioeconomic status (SES), this dissertation sought to deepen our understanding of the ways in which language and cognition interact. In what follows we will introduce the five articles that together form this dissertation.

Bilingual language acquisition and cognitive development

As Grosjean (1989) already concluded, a large number of studies have shown that a bilingual is not just two monolinguals in one person. Although bilingual children seem to go through the same developmental stages as monolingual children (Gathercole, 2007), there are several ways in which bilingual language acquisition can differ from monolingual language acquisition. As a result of a lower amount of exposure (Hoff et al., 2012; Paradis, 2010) and a later age of onset of the second language (L2) (Golberg, Paradis, & Crago, 2008; Snedeker, Geren, & Shafto, 2007; 2012), the timing of bilingual children’s language acquisition is often different from that of monolingual children. Bilingual children usually acquire each of their two languages more slowly than their monolingual peers, because they have less exposure to each individual language. The rate of development of each language varies as a function of the relative amount of exposure, with more exposure resulting in faster development (Hoff et al., 2012). For L2 vocabulary learning, an older age of onset usually also leads to a faster rate of development (Golberg et al., 2008; Snedeker et al., 2007; 2012), probably because older children have more cognitive, linguistic and social skills available (Blom & Paradis, 2015; Cummins, 1991, 2000; Snedeker et al., 2012). For L2 grammar learning, in contrast, an older age of onset does not necessarily lead to a faster rate of development. Whereas some studies
report a positive effect of age of onset on grammar learning (Blom & Paradis, 2015), others report a negative effect (Unsworth, 2013; Unsworth et al., 2014) or no effect (Snedeker et al., 2007).

These inconsistent results may stem from differences in cross-linguistic transfer, which is another reason why bilingual language acquisition is not the same as monolingual language acquisition. Cross-linguistic transfer can either slow down (negative transfer) or accelerate L2 acquisition (positive transfer). Negative transfer is more prominent when the structures of the two languages are different (McDonald, 2000; Sabourin, Stowe, & De Haan, 2006; Zevin & Seidenberg, 2002, 2004). Positive transfer, on the other hand, can happen when the structures of the two languages overlap. At the lexical level, for example, bilingual children can benefit from cognates, which are words that overlap in form and meaning across the two languages (Kelley & Kohnert, 2012; Malabonga, Kenyon, Carlo, August, & Louguitt, 2008). At the level of bound morphology, positive transfer can occur when the two languages are lexically and morphologically related (Jarvis & Pavlenko, 2008: 96). Thus, more entrenchment of first language (L1) characteristics can hinder the acquisition of L2 characteristics that are different from the L1, but support the acquisition of L2 characteristics that are similar to the L1 (Ellis, 2006; Kuhl, 2000; Kuhl, Williams, Lacerda, Stevens, & Lindblom, 1992; McDonald, 2000; Unsworth et al., 2014). In chapter 2 of this dissertation, we investigated the influence of age of onset and its relation with transfer and exposure on the acquisition of Dutch vocabulary and grammar in Frisian-Dutch bilingual children. The children who participated in this study were 5 or 6 years old at time of testing (measurement 1). For Frisian, their age of onset was 0 and for Dutch, their age of onset ranged between the ages of 0 and 4.

In chapter 3, we explored the mechanism of lexical transfer in greater depth. Several studies have shown that children with a low intensity of exposure to one of their languages can use their knowledge of the other language to understand the meaning of cognates (Schelletter, 2002; Malabonga et al., 2008; Kelley & Kohnert, 2012). Furthermore, reaction time (RT) studies have shown that both bilingual children (e.g. Breiners, Van Hell, & Dijkstra, 2011; Poarch & Van Hell, 2012a) and bilingual adults (e.g. De Groot, Dannenburg, & Van Hell, 1994; Dijkstra et al., 1999; Lotto & De Groot, 1998; Rosselli, Ardila, Jurado, & Salvatierra, 2014) respond faster and more accurately to cognates in comparison to non-cognates. Some studies with adults have shown that this effect is gradual: RTs for identical cognates are faster than RTs for non-identical cognates, and RTs for non-identical cognates are faster than RTs for non-cognates (Dijkstra, Miwa, Brummelhuis, Sappelli, & Baayen, 2007).
This gradual cognate facilitation effect shows that in the bilingual lexicon, the speed at which cognates get activated in comparison to non-cognates depends on the degree of cross-language phonological similarity. As previous research on the graduality of the cognate facilitation effect only focused on adults, it is unknown whether degree of cross-language similarity also affects bilingual children’s vocabulary acquisition. As children’s sensitivity to cognates may still be developing, it is not a priori obvious that this mechanism works the same in children as in adults. Therefore, in chapter 3 of this dissertation, we investigated to what extent Frisian-Dutch bilingual children’s receptive acquisition of cognates depends on the degree of cross-language similarity. The children were administered a Frisian receptive vocabulary task in which cross-language similarity was systematically manipulated. The items of the task were classified into four cognate categories, which differed in their degree of overlap between Frisian and Dutch: (1) identical cognates, (2) non-identical cognates that either do or (3) do not exhibit a simple phonological regularity between Frisian and Dutch, and (4) non-cognates. We were particularly interested in the performance of children with a low intensity of exposure to Frisian, as these children were expected to rely on their knowledge of Dutch. By following the children for three consecutive years, we also examined whether children’s sensitivity to different types of cognates changed over time.

In chapter 4 of this dissertation, we zoomed further in on the acquisition of non-identical cognates with a simple cross-linguistic phonological regularity, one of the cognate categories that we introduced in chapter 3. An example of a cross-linguistic phonological regularity is Frisian -ân [ɔːn] and Dutch -and [ɑnt], as in the cognate pairs hân [ɔːn] - hand [hɑnt] ‘hand’ and lân [ɔːn] - land [lɑnt] ‘country’. Although it has been suggested that bilingual speakers use these regularities to relate the vocabulary of one language to the other in their bilingual lexicon (e.g. Taeldeman, 2013), psycholinguistic evidence for this claim is lacking. To explain the representation of cross-linguistic phonological regularities, we used Bybee’s (1995, 2001, 2008, 2010) usage-based network model. As words in the input co-activate semantically and phonologically similar words, both within (Gonnerman, Seidenberg, & Andersen, 2007) and across (Dijkstra et al., 2010) languages, this model proposes that related words are stored close to each other. As a result, so-called schemas arise that capture phonological and semantic generalizations. Within this model, phonological regularities across languages are similar to grammatical rules within a language, as they are both generalizations that arise from schemas of phonologically and semantically related words. Previous research has shown that the acquisition of grammar, but not vocabulary is related to
verbal working memory (e.g. Engel de Abreu & Gathercole, 2012; Verhagen & Leseman, 2016). This suggests that verbal working memory plays a role in the acquisition of linguistic regularities. In chapter 4 of this dissertation, we tested this hypothesis by investigating whether verbal working memory is also related to the acquisition of cross-linguistic phonological regularities. In order to answer this question, we used the Frisian receptive vocabulary scores from chapter 3 and examined associations with verbal working memory, thereby controlling for verbal short-term memory (Engel de Abreu & Gathercole, 2012;), SES (Rice & Hoffman, 2015), exposure (Pearson, Fernández, Lewedeg, & Oller, 1997), non-verbal IQ (Rice & Hoffman, 2015) and age, which have previously been shown to be related to vocabulary learning.

In chapter 4 we investigated how a domain-general cognitive capacity, namely verbal working memory, supports bilingual language acquisition. The relationship between bilingualism and cognition is, however, argued to work both ways. Traditionally, speaking two languages was viewed as having a negative impact on cognitive functioning (Darcy, 1963). However, in the past 50 years, this attitude has changed, starting with a study by Peal and Lambert (1962), who showed that bilingual children outperformed monolingual children on a number of verbal and non-verbal tests. In contrast to previous studies (e.g. Pintner, 1932; Saer, 1923), Peal and Lambert (1962) controlled for potentially confounding factors such as age and socioeconomic status (SES). Since then, many studies have been carried out, with an intensification in the last decade. More and more studies showed that bilingualism enhances executive functioning (EF), (for a review, see Adesope, Lavin, Thompson, & Ungerleider, 2010), that is, cognitive processes that are used to control and regulate actions and thought (Miyake et al., 2000). As this included EF components that are not language specific, it was claimed that bilingualism could lead to a domain-general EF advantage. The most accepted explanation as to why bilingualism improves EF is that bilinguals have a continuous training in monitoring two co-activated languages (e.g. Bialystok, Craik, Klein, & Viswanathan, 2004; Costa, Hernández, Costa-Faidella, & Sebastián-Gallés, 2009; Green, 1998).

Still, the cognitive effects of bilingualism proved difficult to pin down. In recent years, more and more studies have been published that did not find any difference in EF between bilinguals and monolinguals (e.g. Duñabeitia et al., 2014; Paap & Greenberg, 2013). Furthermore, a comparison of the publication rates of conference abstracts that either support or challenge the bilingual cognitive advantage clearly showed a publication bias: studies that found a cognitive advantage for bilinguals got published more often than studies that did not (De Bruin, Treccani, & Della Sala, 2015). From these confusing results, some researchers
concluded that the cognitive effects of bilingualism either do not exist or are restricted to very specific circumstances that have yet to be determined (Paap, Johnson, & Sawi, 2015). One of the factors that is argued to moderate cognitive enhancement in bilinguals is degree of bilingualism (e.g. Bialystok & Barac, 2012; Blom, Küntay, Messer, Verhagen, & Leseman, 2014; Crivello et al., 2016; Tse & Altarriba, 2014; Videsott, Della Rosa, Wiater, Franceschini, & Abutalebi, 2012). In chapter 5 of this dissertation, we investigated the influence of degree of bilingualism on the cognitive effects of bilingualism by comparing two groups of 5- and 6-year-old bilingual children (measurement 1) that were matched on potential confounding factors such as age, non-verbal IQ, SES and Dutch language skills. One group consisted of children with more or less equal proficiency in Frisian and Dutch, while the other group consisted of children who were clearly more proficient in Dutch than in Frisian. The central question in this chapter was whether the balanced bilingual children performed better than the Dutch-dominant bilingual children on tasks that measured attention and working memory.

Although the highly constrained study described in chapter 5 may shed more light on the specific circumstances under which bilingualism enhances EF, it cannot tell how the cognitive effects of bilingualism develop over time. In order to investigate whether bilingualism has an enduring effect on EF, longitudinal research is needed. Therefore, in chapter 6 of this dissertation, we investigated the cognitive effects of bilingualism in a longitudinal design with three measurements. In contrast to most previous studies, we did not compare groups of children, but treated degree of bilingualism as a continuous variable, defined as language balance in terms of vocabulary and grammar. Next to examining whether degree of bilingualism has an effect on EF, we investigated the circumstances that support the development of a high degree of bilingualism and that might thus, indirectly, lead to cognitive enhancement. As previous research has shown that children with Frisian as their home language usually become proficient bilinguals, whereas most children with Dutch as their home language do not (Dijkstra, 2013; Van Ruijven, 2006; Ytsma, 1995, 1999), we examined whether minority language exposure predicted degree of bilingualism and whether there was a relationship between minority language exposure and EF, mediated by degree of bilingualism.

**Brief outline of the dissertation**

To summarize this introduction, various aspects of the linguistic and cognitive development of Frisian-Dutch bilingual school children are investigated in this dissertation. The central aim is to get a better understanding of the factors that support bilingual language acquisition and the ways in which bilingual language acquisition influences children’s cognitive
development. Individual topics that are examined concern the influence of age of onset and its relation with transfer and exposure on the acquisition of Dutch vocabulary and grammar (chapter 2), the role of cognates in receptive vocabulary acquisition (chapter 3), the role of verbal working memory in the acquisition of cross-linguistic phonological regularities (chapter 4), and, finally, the effect of language balance (chapter 5 and 6) and minority language exposure (chapter 6) on cognitive functioning. Because the chapters 2 to 6 are based on articles that were submitted to peer-reviewed journals, a number of sections show some overlap across the different chapters. This specifically concerns the methodology and the background information about the Frisian-Dutch bilingual context.
Chapter 2

The sooner the better? The influence of age of onset, degree of exposure and transfer in Frisian-Dutch bilingual children

This chapter has been published as:

Abstract
In this study, age of onset (AoO) was investigated in 5- and 6-year-old bilingual Frisian–Dutch children. AoO to Dutch ranged between 0 and 4 and had a positive effect on Dutch receptive vocabulary size, but hardly influenced the children’s accurate use of Dutch inflection. The influence of AoO on vocabulary was more prominent than the influence of exposure. Regarding inflection, the reverse was found. Accuracy at using Frisian inflection emerged as a significant predictor; this transfer effect was modulated by lexical overlap between the two languages. This study shows that ‘the sooner the better’ does not necessarily hold for language development. In fact, for the correct use of inflection, it does not matter whether children start at age 0 or 4. For rapidly learning words in a new language it may be helpful to first build a substantial vocabulary in the first language before learning a new language.
Introduction

It is often said that for successful language development, it is important to start early and that it is optimal to start as early as possible. However, most studies on age of onset (AoO) focus on differences between child and adult second language (L2) learners (cf. Hernandez & Li, 2007; Hyltenstam & Abrahamsson, 2003), and little is known about early AoO effects. In this study, we investigate children who started to learn a new language between the ages of 0 and 4 in order to determine whether “the sooner the better” holds for early child bilinguals.

The few studies that have investigated early effects of AoO looked at different aspects of language. While the studies on vocabulary development report positive effects of a later AoO, showing that children with a later AoO perform better (Golberg et al., 2008; Snedeker et al., 2007, 2012), studies on children’s accuracy at using grammatical morphemes report no effect (Snedeker et al., 2007), negative effects (Unsworth, 2013; Unsworth, Argyri, Cornips, Hulk, Sorace, & Tsimili, 2014) and positive effects (Blom & Paradis, 2015) of a later AoO. For the present study, we investigate Dutch vocabulary size and the correct use of Dutch grammatical morphemes (inflection) in Frisian-Dutch bilingual children. The children who participated in the study were 5 or 6 at time of testing and had an AoO for Frisian from birth and for Dutch between ages 0 and 4. Analyses on vocabulary tested whether we could replicate previous findings with a new population. With regard to grammatical morphemes, our goal was to examine the presence and direction of AoO effects and relationships between AoO, transfer and exposure.

Participants were recruited from the Dutch province of Fryslân. Fryslân is a bilingual province where both the national majority language, Dutch, and the regional minority language, Frisian, have official status. Outside of the Netherlands, the regional language is known as West Frisian to avoid confusion with the Frisian languages spoken in Germany. Whenever the term Frisian is used in this article, it refers to the West Frisian language. Historically, Frisian is most closely related to English, but over time English and Frisian have diverged, while Dutch and Frisian have converged due to language contact (Gooskens & Heeringa, 2004). Structural similarities and differences between Dutch and Frisian allowed us to investigate interactions between AoO and transfer. Besides transfer, the intensity of exposure to Dutch was examined, because it is likely that children who differ in AoO also differ in the amount of exposure to the target language and contexts in which exposure takes place (Unsworth et al., 2014).

Investigating early AoO effects is relevant for several reasons. First, it can shed light on the relationship between linguistic development and other developing skills that support
learning language. For instance, older children have more cognitive, linguistic, social and literacy-related resources available that could predict a faster rate of language development (Blom & Paradis, 2015; Cummins, 1991, 2000; Snedeker et al., 2012). These are all reasons to suspect that within childhood the idea of “the sooner the better” may not necessarily hold. Second, it may provide information on the effects of transfer. Namely, further entrenchment of first language (L1) characteristics and perceptual fine-tuning to language-specific properties could hinder learning the unfamiliar L2 characteristics (Ellis, 2006; Kuhl et al., 1992; Kuhl, 2000; McDonald, 2000; Unsworth et al., 2014). Thus, sooner may be better if a child’s L1 differs from the L2. Third, from a practical viewpoint, early AoO effects could be important for determining the optimal age for starting bilingual or immersion programmes at (pre-)school (Cummins, 1980; Genesee, 1978).

A later age of onset: a positive or negative effect?

Studies on AoO focus on different aspects of children’s language development. Interestingly, the outcomes seem to differ depending on whether vocabulary or grammar is studied. Studies on vocabulary development quite consistently show a positive relationship between a later AoO and vocabulary size and vocabulary growth, which goes against the idea of “the sooner the better”. Snedeker et al. (2007) analyzed the data of a sample of internationally adopted children whose AoO ranges between 2;7 and 5;6. The data in this study were based on parental report (Communicative Developmental Inventory 2). The older adoptees had larger vocabularies than the younger adoptees, in particular in the first few months after arrival into the new family. When compared to younger infants who were not adopted, it turned out that the internationally adopted children acquired vocabulary about four times as rapidly. In parallel with these findings, Golberg et al. (2008) found that immigrant children learning English L2 who were exposed to English after age 5 (60 months) had a larger receptive vocabulary than English L2 learners who were exposed to English earlier. Snedeker et al. (2012) report that adopted children learn abstract words that refer to past tense, certain behaviors, or internal states earlier than infants, which suggests that cognitive development constrains vocabulary development in specific ways.

The results of research on grammar are less consistent. In the study by Snedeker et al. (2007) AoO did not predict the proportion of grammatical morphemes used or grammatical complexity. With respect to grammar measures, there was also no difference between the non-adopted infants and the internationally adopted older children, suggesting that cognitive development does not influence grammatical development during early childhood. In a study
The influence of age of onset, degree of exposure and transfer

comparing bilingual children with and without Specific Language Impairment (SLI) who were English second language learners, Blom and Paradis (2015) found that a later AoO was associated with fewer omissions of regular tense inflection. This positive effect of a later AoO was carried by the SLI group. Blom and Paradis argue that having more resources (associated with older age) may be particularly relevant to children with SLI who often have less verbal short-term memory capacity and a shorter attention span than their peers with Typical Development (TD). Also, children with SLI may rely on declarative memory for regular inflection (Pierpont & Ullman, 2005). Declarative memory consists of associations that are strengthened based on environmental information, which, in turn, is accumulated over time. For children with TD such accumulated information may be less relevant because they rely on procedural memory for using regular inflection (Pierpont & Ullman, 2005).

Other areas of research report negative effects of a later AoO on grammar acquisition. Unsworth et al. (2014) investigated effects of AoO in bilingual children learning Dutch or Greek with English as their L1, and found that children with a later AoO performed less accurately in the grammar tests they used than children with an earlier AoO. In this study, a factorial design was used with three learner groups for each language: simultaneous bilinguals (2L1), early successive bilinguals whose AoO lies between 1;0 and 4;0 (mean: 2;4/2;2), and successive bilinguals with an AoO between 4;0 and 10;0 (mean: 6;4/6;5). In both languages, morphemes expressing grammatical gender were investigated. For Dutch, AoO effects emerged when (cumulative) exposure was not controlled; when the early and late successive bilinguals were matched on exposure, their accuracy was the same. For Greek, the 2L1 group outperformed both other groups. The early successive children were less accurate on feminine/masculine gender than the 2L1 group, but they performed better than the late successive group. For neuter nouns, both the 2L1 group and early successive learners outperformed the successive learners.

Unsworth et al. suggest that English L1 children with an older AoO performed less accurately on Greek grammatical gender than English L1 children with a younger AoO because the older children have had more experience with a language without grammatical gender (English), and may display stronger effects of negative transfer. At the onset of exposure to Greek the early successive children started from the English system, which was already, to some degree, in place, and which does not classify nouns based on gender. The authors furthermore do not rule out the possibility that the AoO effects in Greek could be input effects in disguise, because matching was only possible for a small subset of the data. Note furthermore that the effects of AoO only emerged in the ANOVA based on group
comparisons, but AoO did not emerge as a significant predictor in the regression analysis, limiting the predictive value that can be assigned to AoO based on this study.

The mixed findings on early AoO effects in the domain of grammar as well as the explanations given for the findings resemble outcomes and explanations in studies that compare learners who have started to learn the L2 during childhood with post-puberty learners. Some of these studies find that AoO is not an important predictor for morphological attainment (Jia & Fuse, 2007) or report a positive effect of AoO on learning grammar as an effect of more cognitive resources and better abilities to use declarative memory at older ages (Muñoz, 2006; Pfenninger, 2011). Others conclude that a later AoO influences learning grammatical morphology negatively (Johnson & Newport, 1989; McDonald, 2000). Such negative effects of a later AoO have been attributed to maturational constraints and motivational factors, but also to stronger effects of (negative) L1 transfer at later ages and differences in exposure between early and later learners (Birdsong, 1999, 2006).

In sum, whereas research on early AoO effects in vocabulary consistently shows positive effects of a later AoO, previous research on grammar is inconsistent and shows no effects, positive effects and also negative effects of a later AoO. The primary aim of this study was to replicate the positive effect of a later AoO by investigating Frisian-Dutch children’s receptive vocabularies. The second aim was to examine AoO effects on bound grammatical morphemes, more specifically noun plurals and past participles. It has been suggested that the negative effects of a later AoO on grammatical morphology are to some extent caused by effects of transfer that become stronger over time (Birdsong, 1999, 2006; Ellis, 2006; McDonald, 2000; Unsworth et al., 2014). In the next section, the relevant properties of Dutch and Frisian are explained in order to determine possible effects of transfer that could contribute to AoO effects.

**Age of onset and transfer: Noun plurals and past participles in Dutch and Frisian**

While some researchers have argued that transfer plays no role in acquiring bound inflectional morphology (Eubank, 1993), others conclude that “although the wholesale transfer of bound morphology from one language to another is a highly restricted phenomenon, it does occur quite frequently when the source and target languages are lexically and morphologically related” (Jarvis & Pavlenko, 2008: 96). For instance, when the L1 and the L2 share lexical properties (e.g. verb stem) but differ in the inflected forms, a learner might be triggered to use the L1 inflected form in the L2. However, previous research indicates that transfer effects on bound grammatical morphology are found without significant lexical and morphological
overlap, showing that transfer takes place on a more abstract level. One example comes from research on English tense inflection showing that child L2 learners of English with an isolating L1 such as Cantonese omit obligatory tense inflection in English more persistently than children with richly inflected L1s such as Spanish (Blom, Paradis, & Sorenson Duncan, 2012; Blom & Paradis, 2015). Other studies show that the negative effects of a later AoO are more pronounced when L1 and L2 have less overlap (McDonald, 2000; Monaghan & Ellis, 2002; Sabourin et al., 2006; Zevin & Seidenberg, 2002, 2004) and that with increasing age it becomes more difficult to process and learn L2 properties that are not part of the L1 (Ellis, 2006).

In this study, noun plurals and past participles were investigated. Both types of rules overlap between Frisian, the children’s L1, and Dutch, their L2. However, there are also differences between the inflectional rules in the two languages, which may be a source of negative transfer. Below, the rules of Dutch and Frisian noun plurals and past participles are explained in order to derive more specific predictions for interactions between AoO and transfer.

Nouns are pluralized in Dutch in two ways, either with the suffix –en (boek-boeken ‘book-books’) or with the suffix –s (tafel-tafels ‘table-tables’). The –s suffix is used with fewer nouns and has a lower type frequency than the –en suffix: the type frequency of –s is about 31% (Baayen, McQueen, Dijkstra, & Schreuder, 2003). Both –en and –s plurals are viewed as regular. In addition there are various subregularities that apply to a limited number of nouns (n < 50). These are, for instance, plurals formed through the combination of –en suffixation and lengthening of the stem vowel (dak-daken ‘roof-roofs’), change of the stem vowel (schip-schepen ‘ship-ships’, overheid-overheden ‘government-governments’), adding of a coda (koekoeien ‘cow-cows’), or suffixation of –eren (kind-kinderen ‘child-children’).

As in Dutch, Frisian plurals are formed by adding the –en suffix (dak-dakken ‘roof-roofs’) or –s (leppel-leppels ‘spoon-spoons’). In addition, there are nouns in which breaking occurs, a phenomenon which involves the alternation of rising and falling diphthongs. Breaking is a functionally redundant rule, since all plural forms with breaking also have the –en suffix that marks plurality (Ytsma, 1995: 39-40). A few nouns in Frisian are highly irregular. For instance, some plurals are identical to their singular form (bern-bern ‘child-children’). Others only alter the stem vowel (ko-kij ‘cow-cows’). Some forms are regular in one language, but irregular in the other, e.g. skoech-skuon ‘shoe-shoes’ in Frisian is irregular whereas schoen-schoenen in Dutch is regular. Conversely, dak-dakken is regular in Frisian while dak-daken (with lengthening of the stem vowel) in Dutch is irregular.
In Dutch, infinitival forms are uniformly formed through adding the \(-en\) suffix. Participle formation, in contrast, is dependent on whether verbs are regular or irregular. Dutch regular verbs have participles that are formed with a circumfix, \(ge_t/d\) (\(dansen\)-\(gedanst\) ‘dance-danced’, \(rennen\)-\(gerend\) ‘run-run’). This pattern applies to more than 80% of the verbs (based on Tabak, Schreuder, & Baayen, 2005). Participles of irregular verbs are formed with the circumfix \(ge_en\) and an alternation of the stem vowel that can be traced back to the Ablaut (\(zitten\)-\(gezeten\) ‘sit-sat’). In addition, subregularities exist with a low type frequency, with either the circumfix \(ge_t\) or \(ge_en\) and a significant stem change beyond the stem vowel. For instance, \(brengen\)-\(gebracht\) (‘bring-brought’) or \(verliezen\)-\(verloren\) (‘lose-lost’). If verbs already have a prefix, such as the verb ‘lose’ where the stem \(verliez\) contains the prefix \(ver\)-, no participial prefix is added.

Frisian regular verbs either have an infinitive that ends in \(-e\) or an infinitive that ends in \(-je\) (\(wenje\) ‘to live’). Participles of the first type are formed with a suffix \(-t\) (\(bakke\)-\(bakt\) ‘bake-baked’) or \(-d\) (\(draaie\)-\(draaid\) ‘turn-turned’), whereas participles of the latter are formed with a suffix \(-e\) (\(dünsje\)-\(dünse\) ‘dance-danced’). The participles of irregular verbs in Frisian can be divided into three classes. One class consists of participles that are similar to the second/third person singular present tense with \(Wechselflexion\), a pattern in which the second and third person are distinct from the rest of the present tense paradigm (Dammel, 2010) (\(meitsje\)-\(makke\) ‘make-made’; \(reitsje\)-\(rekke\) ‘hit-hit’). The second type has participles formed with the suffix \(-en\) and alternation of the stem vowel (\(swimme\)-\(swommen\) ‘swim-swum’), while the third type forms participles with a stem change beyond the stem vowel (\(sykje\)-\(socht\) ‘search-searched’).

**Research questions and predictions for the present study**

For this study we investigated, first, whether we could replicate earlier findings on effects of AoO on vocabulary size in a sample of bilingual Frisian-Dutch children. The guiding research question is formulated in (1).

(1) Does AoO of exposure to Dutch predict the size of the Dutch vocabulary in Frisian-Dutch bilingual children?

Vocabulary development relies on access to concepts and older learners will have more concepts available than younger learners. Older children will also have more associations in declarative memory that support learning new words, they have more verbal short-term
memory capacity and better attention spans than younger children. Verbal short-term memory enables children to retain phonological information which is important for vocabulary development (Edwards & Munson, 2009). Attention refers to the process of concentrating cognitive resources on one stimulus while ignoring other stimuli (Posner, 2012). To learn words, specific referents have to be selected out of multiple possible referents and mapped onto the relevant strings of sounds. To do this accurately, a good attention span is mandatory. For vocabulary, a positive effect of a later AoO was therefore expected.

In the present study, AoO was treated as a continuous variable. In other research AoO is often a dichotomous variable (Golberg et al., 2008; Unsworth et al., 2014). However, dichotomization leads to a loss of precision and more error (Baayen, 2004). As pointed out in Unsworth et al. (2014), AoO and exposure are easily confounded in the sense that an earlier AoO may go hand-in-hand with more consistent exposure and a greater intensity of exposure (see also, Flege, 2009, for further discussion on this issue). In order to rule out a confound between AoO of exposure to Dutch and intensity of exposure to Dutch in the home environment, we included the latter as a covariate in the analyses and, if necessary, decorrelated AoO and length of exposure.

Second, we examined the effect of AoO on children’s accuracy with Dutch noun plurals and past participles, thereby investigating the simultaneous effect of AoO, proficiency at Frisian inflection, type of inflection and intensity of exposure. The research question is in (2).

(2) Do AoO of exposure to Dutch, proficiency at Frisian inflection, type of inflection, and intensity of exposure to Dutch predict Frisian-Dutch bilingual children’s accuracy at using Dutch noun plurals and past participles?

Regarding grammar in general, an older AoO may predict better performance because an older AoO is associated with more cognitive resources (verbal short-term memory, attention span, declarative knowledge) (Gathercole, 1998; Kolling & Knopf, 2015). Effects of AoO could be negative if AoO is confounded with exposure and/or AoO is moderated by transfer. Regarding exposure, a similar method was applied in the analyses in which inflection was the dependent variable as was done in the analyses with vocabulary as the dependent variable. Proficiency at using Frisian inflection was included to assess effects of transfer more globally. A global negative effect of transfer could be expected for past participles due to the absence of a participial prefix in Frisian. Because longer learning of Frisian past participles could lead
to more persistent omission of the participial prefix in Dutch and errors in the choice of the
suffix (-d/-t, -en, -e), a later AoO may therefore show a negative effect for past participles and
no effect for noun plurals. Transfer may also cause local negative effects of AoO, because
longer exposure to and greater entrenchment of specific Frisian forms that differ from Dutch
may be associated with an extended period of errors with the Dutch equivalents. To explore
local transfer effects and the relation to AoO, research question (3) was formulated.

(3) Are there differences between inflected forms that overlap between Frisian and Dutch
and inflected forms that do not overlap between the two languages?

a. Is children’s accuracy on inflected forms that overlap higher than for inflected
forms that do not overlap?

b. Does AoO have a differential effect on inflected forms that do and do not
overlap?

We expected better performance on overlapping forms than on forms that do not overlap. A
later AoO for Dutch implies greater entrenchment of the specific Frisian forms, hence
children may be more likely to make mistakes on Dutch forms that do not overlap with
Frisian forms. This effect was not expected for the overlapping forms.

Method

Participants

For the study, data from 122 5- and 6-year-old Frisian-Dutch bilingual children were analysed
(M age at testing = 5 years and 10 months, SD = 6 months). Participants were selected by
contacting primary schools in the more rural parts of the province of Fryslân. About 55% of
the inhabitants of Fryslân speak Frisian as their L1 and about 48% speak Frisian to their
children (Provincje Fryslân, 2015). The prevalence of Frisian is strongest in the more rural
parts of the province. A total of 15 schools participated. 14 of these schools are situated in
municipalities where 60% to 80% of the population speaks Frisian as their L1 (Provincje
Fryslân, 2015).

The sample showed individual variation in the children’s AoO of exposure to Frisian
and Dutch, with clearly a larger amount of variation for Dutch than for Frisian. The majority
of the children had been exposed to Frisian from birth (91.5%). Fewer children had been
exposed to Dutch from birth (66%). For two children details about their AoO for Dutch were
not available at time of data analysis, and for a third child the AoO for Frisian was
unavailable. For the purpose of this study, we focused on Dutch, because for Dutch AoO was sufficiently varied whereas this was not the case for Frisian. Data from the children with exposure to Frisian at later ages and data from children for whom no information regarding AoO was available were excluded from the study \((n = 12)\).

**Measures**

The dependent variables in the study were receptive vocabulary as measured by the Dutch version of the *Peabody Picture Vocabulary Task* (PPVT; Schlichting, 2005) and accuracy at using Dutch morphology as measured by a subtest of the *Taaltoets Alle Kinderen* (TAK, “Language assessment for all children”; Verhoeven & Vermeer, 2002). The PPVT is a standardized multiple choice test for people between 2;3 and 90 years of age. It contains 204 items divided over 17 sets, each containing twelve items. The items are ordered by difficulty, starting with the easier, more frequent items in the first set after which the degree of complexity gradually increases. Each item is a sheet with four pictures from which the participant has to indicate the stimulus word. For the current study, participants were tested on the 144 items of the first twelve sets of the task. The dependent variable was calculated by counting the number of correct items.

The TAK word formation task tests plural formation with nouns and participle formation with verbs. In total there are 24 items, twelve elicit noun plurals and twelve elicit past participles. Items in the TAK test fall in three classes which differ according to regularity. Each class contains eight items, divided over four noun plurals and four past participles. Highly regular plurals are formed with \(-en\), somewhat less regular plurals with \(-s\), and irregular plurals are formed through the combination of \(-en\) suffixation and lengthening of the stem vowel. Highly regular past participles are formed with the circumfix, \(ge_t/d\). Less regular past participles are formed with the circumfix \(ge_en\) and alternation of the stem vowel. Irregular past participles are formed with the circumfix \(ge_t\) or \(ge_en\) – except for the item *verloren* (‘lost’) which has no participial prefix - and a significant stem change, beyond the stem vowel. The items are listed in Appendix 2-1.

Only morphological errors that were related to specific properties of the inflected form were counted as incorrect. This included omission of the plural suffix or use of an incorrect plural suffix with items testing noun pluralization. In those cases where pluralization required lengthening of the stem vowel, as in *dak-daken* (‘roof-roofs’), no lengthening of the stem vowel was also counted as incorrect. Final \(-n\) deletion was not counted as a mistake, as this is common practice in colloquial Dutch (Booij, 1995: 141). Phonological errors in the stem and
not in the target morpheme, such as *krande* instead of *kranten* ‘newspapers’, were also not considered a mistake. With items testing participles the following were counted as incorrect: omission of the prefix or suffix, the incorrect use of a prefix or a suffix, and errors with the stem (i.e. no/incorrect changes to the stem).

In order to answer the third research question, TAK items were assigned the value ‘overlap’ in cases of lexical and morphological overlap between Dutch and Frisian (*n* = 13). Morphological overlap was defined as similar suffixes and changes in the stem that are needed to form the plural or the participle. The Dutch prefix *ge-* for participles was not considered. For instance, *kocht* and *amers* (Frisian) and *gekocht* and *emmers* (Dutch) have the same suffix and stem change (no stem change in the case of *amers – emmers*). Items were assigned the value ‘no_overlap’ if the inflected form in Frisian is different from the inflected form in Dutch (*n* = 11). This could either be a difference in lexical form, as in *gespeeld* (Dutch) and *boarte* (Frisian) ‘played’, or a difference with respect to stem change, as in *daken* (Dutch) and *dakken* (Frisian) ‘roofs’. In the latter case children may be misled by Frisian since in Frisian the inflected, plural form does not have lengthening of the stem vowel (resembling regular plural forms in Dutch), while in Dutch the inflected form requires lengthening of the stem vowel. Some items that were assigned the value ‘no_overlap’ also had a difference in suffix, alongside a difference in stem change or a difference in lexical form.

The independent variables in the study were AoO of exposure to Dutch, proficiency at Frisian inflection (noun plurals, past participles) and type of inflection. Type of inflection consisted of two values: noun plurals and past participles. Further explanation is given below as to how AoO for Dutch, intensity of exposure to Dutch and proficiency at Frisian inflection were measured.

AoO for Dutch and intensity of exposure to Dutch were measured with a parental questionnaire based on the *Questionnaire for Parents of Bilingual Children* (PaBiQ) (COST Action IS0804, 2011; Tuller, 2015). For the purpose of the project, questions were added to determine a child’s AoO: “Was there a certain age at which your child received more exposure to Dutch than before. YES/NO”? “If YES, what age was this and what caused the change?” . Whether the parents’ responses were consistent with questions regarding the languages that the parents used with the child was checked. All children who had one parent speaking Dutch and the other parent speaking Frisian were assigned an AoO for Dutch of 0.

Besides information about AoO for Dutch, the PaBiQ also provided information on intensity of exposure to Dutch in the home environment. Intensity of exposure to Dutch was a
measure of current exposure and measured as the mean proportion of Dutch input that the child received from his mother, father, siblings and other adults who looked after the child regularly at time of testing. Each of these individuals was asked how often (s)he spoke Frisian and Dutch to the child: ‘never’ (0% = 0), ‘seldom’ (25% = .25), ‘sometimes’ (50% = .50), ‘usually’ (75% = .75) and ‘always’ (100% = 1.00). Siblings were cumulated in one score, as it did not occur that siblings spoke different languages to the target child. Contact with other adults ranged from once per week to five times a week. In case there was more than one other adult, the average proportion of these other adults was calculated.

For the purposes of this research a Frisian word formation task was developed. Like the Dutch task, the Frisian task comprises 12 noun plurals and 12 past participles with different degrees of regularity.

**Procedures**

The schools distributed information about the research and consent forms to the parents of the 5- and 6-year-old children. Only children with parental consent were tested. The tasks were administered in a series of language and cognitive tasks that were divided over two sessions, each lasting one hour. The Frisian language tasks were tested in the first session and the Dutch language tasks in the second. Between these two test sessions there was a minimum of 5 days to minimize influence from the Frisian test on the Dutch test. Each child was tested individually by a bilingual speaker of Frisian and Dutch. During the first session the individual who took the tests consistently spoke Frisian and during the second session she consistently spoke Dutch. The children were encouraged to speak Frisian during the first and Dutch during the second session but they were by no means forced to do so. Afterwards the participants were rewarded with a gel pen.

**Results**

**Descriptive statistics**

The children’s mean AoO of exposure to Dutch was 1 year (ranging between 0 and 4 years). Figure 2-1 shows the distribution of AoO in the sample. The children’s mean intensity of exposure to Dutch at home was .32 (SD = .25; range = 0-1). On average, proficiency in Frisian inflection was 13.65 (SD = 5; range = 2-23; maximum score = 24), and proficiency in Dutch inflection was 15 (SD = 3.15; range = 8-23; maximum score = 24). Their mean score on Dutch receptive vocabulary was 93 (SD = 7.62; range = 67-115; maximum score = 144).
Closer inspection of the children’s use of Dutch inflection revealed that on average the proportion correct on noun plurals ($M = .67; SD = .07$) was higher than on past participles ($M = .58; SD = .24$). Regarding regularity, the proportion of correct responses was lowest for items with a low degree of regularity ($M = .54; SD = .15$), followed by medium regularity ($M = .62; SD = .18$). The proportion of correct responses was highest for items with a high degree of regularity ($M = .71; SD = .16$), as expected.

**Figure 2-1. Distribution of AoO of exposure to Dutch in months**

The types of errors that the children made are summarized in Tables 2-1 (noun plurals) and 2-2 (past participles).

**Table 2-1. Types of errors with noun plurals class 1 (NP1), class 2 (NP2), class 3 (NP3)**

<table>
<thead>
<tr>
<th></th>
<th>$n$</th>
<th>Suffix</th>
<th>Stem</th>
<th>Combined</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP1</td>
<td>440</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>NP2</td>
<td>440</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>NP3</td>
<td>440</td>
<td>13</td>
<td>389</td>
<td>0</td>
<td>9</td>
<td>411</td>
</tr>
<tr>
<td>Total</td>
<td>1320</td>
<td>31</td>
<td>389</td>
<td>0</td>
<td>10</td>
<td>430</td>
</tr>
</tbody>
</table>

Table 2-1 indicates that by far most errors with noun plurals were made with the most irregular items: 95% (411/430) of the errors with noun plurals were made with items in class 3 (NP3). In those cases, children did not apply lengthening of the stem vowel. Of the errors
The influence of age of onset, degree of exposure and transfer

with a suffix, 32% (10/31) were cases of suffix omission, and 68% (21/31) were cases of a wrong suffix. ‘Other’ refers to children either responding with ‘I do not know’ or using a different word.

### Table 2-2. Types of errors past participles class 1 (PP1), class 2 (PP2), class 3 (PP3)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Prefix</th>
<th>Suffix</th>
<th>Stem</th>
<th>Combined</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP1</td>
<td>440</td>
<td>2</td>
<td>126</td>
<td>0</td>
<td>4</td>
<td>13</td>
<td>145</td>
</tr>
<tr>
<td>PP2</td>
<td>440</td>
<td>0</td>
<td>1</td>
<td>91</td>
<td>48</td>
<td>4</td>
<td>144</td>
</tr>
<tr>
<td>PP3</td>
<td>440</td>
<td>0</td>
<td>1</td>
<td>119</td>
<td>141</td>
<td>14</td>
<td>275</td>
</tr>
<tr>
<td>Total</td>
<td>1320</td>
<td>2</td>
<td>128</td>
<td>210</td>
<td>193</td>
<td>31</td>
<td>564</td>
</tr>
</tbody>
</table>

Table 2-2 demonstrates that with past participles, almost half of the errors (275/564) were made with items in class 3, that is, the most irregular forms (PP3). All errors with the suffix (only) comprise uses of an incorrect suffix. Stem changes were difficult for the children as indicated by the relative frequency of stem errors (37%), as compared to errors with the prefix (0%) or suffix (23%). Combined errors were most frequently combinations of a wrong stem and an incorrect suffix, and hardly ever contained omissions of the prefix ($n = 5$). Omission of a prefix as the sole error only occurred twice.

**Effects of AoO on vocabulary**

The first research question was addressed by analyzing the data using multiple linear regression with Dutch receptive vocabulary as the dependent variable and AoO for Dutch and intensity of exposure to Dutch as predictors. The correlation between AoO and intensity of exposure was significant but moderately strong and did not exceed the level of .70 which would lead to collinearity, $r(109) = -.53, p < .001$. Therefore, the two predictors could be included in the same regression model.

A multiple linear regression analysis revealed that neither AoO nor intensity of exposure emerged as significant predictors. However, positive effects of a later AoO could have been masked by negative effects of length of exposure; namely, children with a later AoO also had a shorter length of exposure, $r(111) = -.94, p < .001$. Length of exposure was calculated by subtracting AoO from age at time of testing. To isolate the effect of age, we predicted the variation in AoO for Dutch by length of exposure to Dutch using linear regression. The residual variation, that is, the variation in AoO that could not be explained by
length of exposure, was used to create a new *decorrelated* AoO predictor. This predictor correlated significantly with the original AoO predictor, though the correlation was not strong, $r(111) = .33$, $p < .001$. Together, AoO (decorrelated) and intensity of exposure explained a significant amount of variance, $F(2, 110) = 12.85$, $p < .001$, adjusted $R^2 = .17$, in the children’s Dutch receptive vocabulary. AoO emerged as a significant predictor, $\beta = .53$, $p < .001$, as did intensity of exposure to Dutch, $\beta = 5.99$, $p = .02$.

About 2/3 of the children were exposed to Dutch from birth and only 1/3 received exposure to Dutch at later ages. Because the sample was unbalanced, we also ran a multiple linear regression analysis with a subsample of the children. In this analysis, half of the children ($n = 40$) were exposed to Dutch from birth and the other half ($n = 40$) were exposed to Dutch at later ages. This did not alter the outcomes: AoO (decorrelated) and intensity of exposure explained a significant amount of variance, $F(2, 80) = 7.96$, $p < .001$, adjusted $R^2 = .14$, in children’s Dutch receptive vocabulary. Both AoO, $\beta = .44$, $p < .001$, and intensity of exposure to Dutch, $\beta = 5.90$, $p = .02$, predicted a significant amount of variance.

**Effects of AoO on inflectional morphology**

To address the second research question, the data were analysed using mixed logistic regression modeling. This method is suitable because the dependent variable for the grammatical morphemes is binary (correct, incorrect). Child and Item were included as random-effect variables and AoO (decorrelated), proficiency at Frisian inflection, type of inflection, and intensity of exposure to Dutch as fixed-effect predictor variables. We started with the full model that included all four predictors (model 1) and then tested reduced models by removing non-significant predictors (backward elimination). Models were compared using the Akaike Information Criterion (AIC): a lower AIC value implies a better model fit. The reduced model with significant main effects of AoO, intensity of exposure to Dutch and proficiency at Frisian inflection (model 2) had a slightly better model fit than the full model (in which type of inflection turned out to be a non-significant predictor): AIC model 1 = 1889.2, AIC model 2 = 1888.6. Again, we reran the analyses with a subsample to check the outcomes for a more balanced sample (see above). In this smaller sample, AoO was not significant, while the significant main effects for intensity of exposure to Dutch and proficiency at Frisian inflection remained unaltered (model 3). Relevant model information (coefficients, standard error, $Z$ value and associated $p$-value) can be found in Appendix 2-2.

The data was further explored using non-parametric classification procedures, which provide insight into the variable structure (Hothorn, Hornik, & Zeileis, 2006; Strobl, Malley, 38
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& Tutz, 2009; see for application to linguistic data and further explanation: Blom & Baayen, 2012; Blom & Paradis, 2015; Tagliamonte & Baayen, 2012). The goal of classification is to build a model that predicts the outcome value based on a number of prespecified variables. We started with binary recursive partitioning, a procedure in which one classification tree is built. AoO for Dutch, intensity of exposure to Dutch, proficiency at Frisian inflection and type of inflection were entered as the predictors and accuracy (correct, incorrect) was the outcome variable. Figure 2-2 shows the result. The full set of observations is at the top (node 1). The boxes at the bottom indicate the predicted probability that in the subsets (which result from splitting) a response is either correct or incorrect. For instance, the tree shows that for plurals the probability that children respond correctly is about .70 (node 2). The tree also shows that whereas accuracy at using past participles is influenced by all predictors, accuracy at using noun plurals is not.

**Figure 2-2.** Binary recursive partitioning tree for children’s accuracy at using Dutch inflection based on the pre-specified predictors intensity of exposure (Intensity_exposure_Dutch), type of inflection (Inflection_type) divided into noun plurals (plur) and past participles (part), proficiency at Frisian inflection (Proficiency_Frisian) and AoO (AoO_Dutch_resid)
The first and top-most split (node 1) is made based on type of inflection and shows that the children perform better with noun plurals than with past participles. As explained above, the children’s performance on noun plurals is unaffected by intensity of exposure or proficiency at using Frisian inflection. This is different for past participles. Node 3 shows that children whose intensity of exposure to Dutch is higher than .40 perform better with Dutch past participles than children with an intensity of exposure to Dutch of .40 or lower. Both within the group with lower and higher intensity of exposure, proficiency at using Frisian inflection is relevant (node 4, node 13): in the group with lower intensity of exposure, the optimal splitting value is at a proficiency score of 15, whereas in the group with higher intensity of exposure this is at a proficiency score of 11. In both exposure groups, the direction of the effect is positive, showing that children who are more proficient at using Frisian inflection make fewer errors at using past participles in Dutch than children who are less proficient at using Frisian inflection. AoO turned out to be relevant for accuracy in using past participles but only for a subgroup of children ($n = 22$): within the group of children who were relatively proficient at inflection in Frisian (score $> 15$) and had a relatively low intensity of exposure (score $\leq .40$), children with a higher AoO were more accurate than children with a lower AoO.

A single tree is easy to interpret. However, single trees can be unstable and their predictive accuracy can therefore be low. To remedy this, the recommendation is to also perform analyses where ensembles of trees are grown (Strobl et al., 2009). The output of this random forest procedure is plotted in the variable importance plot in Figure 2-3. Figure 2-3 demonstrates the relative importance of the four predictors based on a large number of trees. The predictors on the y-axis are ordered with the most important at the top and the least important at the bottom. Variable importance, as indicated on the x-axis, is calculated by means of a permutation test: it is the (normalized) difference between the prediction error before and after the values for a predictor have been permuted. The rationale behind this measure is that if a variable is not important, permutation will not degrade the prediction accuracy.

Figure 2-3 reveals that inflection type is the most important predictor, followed by proficiency at Frisian inflection and intensity of exposure to Dutch. Of least importance is AoO, in line with the outcomes of binary recursive partitioning where AoO did not emerge in the classification tree.

Both the binary recursive partitioning and random forest analysis were applied to the more balanced, smaller dataset. The classification tree was similar to Figure 2-2 without
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nodes 6, 7 and 10. Thus, in the smaller sample AoO did not contribute significantly. Variable importance remained unaltered.

Figure 2-3. Variable importance plot indicating the relative importance of the predictors intensity of exposure (Intensity_exposure_Dutch), type of inflection (Inflection_type), proficiency at Frisian inflection (Proficiency_Frisian) and AoO (AoO_Dutch_resid) with respect to children’s accuracy at using Dutch inflection

Effects of AoO in relation to cross-linguistic overlap

The third research question is concerned with the overlap between Dutch and Frisian, and how overlap may interact with AoO. The difference in accuracy between the set of items that overlap across Frisian and Dutch and the set of items that do not overlap is statistically significant as indicated by the outcomes of a paired sample t-test, $t(110) = 13.91, p < .001$: the children performed better with the overlap set than the set without overlap (see Table 2-3). Most items without overlap are irregular items ($n = 6$), fewer items without overlap have medium regularity ($n = 3$) and the lowest number of items without overlap is highly regular ($n = 2$). Good performance on overlapping items and poorer performance on items without overlap can therefore not solely be attributed to positive versus negative transfer from Frisian to Dutch, but could also be an effect of regularity.

A follow-up analysis was performed in which noun plurals and past participles were analyzed separately, as the confound is only relevant to noun plurals. A two-way repeated measures ANOVA with Inflection type (noun plurals, past participles) and Overlap (overlap, no overlap) as the within subject variables indicates a significant main effect of Inflection
type, $F(1, 109) = 4.83, p = .03, \eta^2_p = .04$, a main effect of Overlap, $F(1, 109) = 178.33, p < .001, \eta^2_p = .62$, and a significant interaction between Inflection type and Overlap, $F(1, 109) = 22.35, p < .001, \eta^2_p = .16$. Paired-sample t-tests indicate that the children are more accurate with the overlapping items than with the items without overlap with noun plurals, $t(109) = 24.88, p < .001, \eta^2_p = .85$, and with past participles, $t(109) = 4.98, p < .001, \eta^2_p = .19$. Both effects remain significant after a Bonferroni adjusted alpha level of .025 (.05/2 = .025) for multiple comparisons. The interaction effect is caused by the difference in effect size, which is clearly larger for noun plurals than past participles. Table 2-3 lists the mean accuracies ($SD$).

<table>
<thead>
<tr>
<th></th>
<th>Mean accuracy overlap ($SD$)</th>
<th>Mean accuracy no overlap ($SD$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>.72 (.12)</td>
<td>.52 (.18)</td>
</tr>
<tr>
<td>Noun plurals</td>
<td>.75 (.07)</td>
<td>.52 (.11)</td>
</tr>
<tr>
<td>Past participles</td>
<td>.65 (.29)</td>
<td>.53 (.25)</td>
</tr>
</tbody>
</table>

Next, two mixed logistic regressions were performed, one on the set of items that overlap between Frisian and Dutch and one on the set of items that do not overlap between the two languages. AoO (decorrelated) and intensity of exposure to Dutch were entered as fixed-effect predictors, and Child and Item were entered as random-effect predictors. In the overlap set only AoO emerged as a significant predictor and in the set without overlap both predictors were significant (Appendix 2-3, models 4 and 5). However, AoO did not emerge in the two classification trees.

**Discussion and conclusion**

The main goal of this study was to investigate whether differences exist between children who start to learn a new language at a very early age or somewhat later. As such, the findings of our study bear on the question of whether children should start learning a new language as early as possible. Previous research has indicated that for vocabulary growth an older AoO can be helpful (Golberg et al. 2008; Snedeker et al., 2007, 2012), a finding which we sought to replicate in our study with Frisian-Dutch bilingual children. The children in the present study were exposed to Frisian from birth and to Dutch between 0 and 4.
development of grammar, and more specifically closed class elements and bound and free grammatical morphemes, results about the effect of AoO are mixed (Blom & Paradis, 2015; Snedeker et al., 2007; Unsworth et al., 2014). As part of this study, we also investigated effects of AoO on noun plural and past participle formation in the same group of bilingual Frisian-Dutch children. Transfer and exposure were included in the study because these factors are related to and easily confounded with AoO.

In line with previous research on immigrant children learning English L2 (Golberg et al., 2008) and internationally adopted children (Snedeker et al., 2007, 2012), we found that an older AoO supports bilingual Frisian-Dutch children’s vocabulary development (research question 1). When a model was run with AoO for Dutch and intensity of exposure to Dutch as predictors, no effects emerged. However, AoO was confounded with length of exposure and when we created a new, decorrelated predictor AoO, it did predict vocabulary size in the expected direction. Thus, the positive effect of a later AoO on vocabulary development is valid across various bilingual child populations: not only internationally adopted children and English L2 learners in an immigration setting but also bilingual Frisian-Dutch children seem to develop their vocabulary in their new language more rapidly when they are older. The AoO range investigated in our study was smaller than in previous studies. Combining the outcomes of the various studies, we can conclude that the positive effect of a later AoO on vocabulary development holds (at least) for an AoO range between ages 0 and approximately 6 years old, where the lower limit is based on the present study and the upper boundary is based on Golberg et al. (2008). Besides AoO for Dutch, intensity of exposure to Dutch emerged as a significant predictor of vocabulary size. This parallels findings reported in previous research. For instance, Cobo-Lewis, Pearson, Eiler, and Umbel (2002) found that extent of exposure predicted bilingual children’s vocabulary.

Regarding inflectional rules, our study shows that AoO for Dutch (decorrelated), intensity of exposure to Dutch, and proficiency at Frisian inflection predict bilingual Frisian-Dutch children’s accuracy at using noun plurals and past participles in Dutch (research question 2). Non-parametric classification procedures demonstrated effects of type of inflection, intensity of exposure to Dutch, and proficiency at Frisian inflection. AoO also emerged as a significant predictor – children with an older AoO performed better than children with a younger AoO – but the effect of AoO was only relevant to a small subset of the data. The low importance of AoO was confirmed by the variable importance plot and when the analyses were performed on a smaller but more balanced subsample of the data, AoO did not emerge as a significant predictor. Based on these outcomes, we conclude that a
later AoO had some positive effects on grammar, but the effects were limited, and possibly negligible, which is in line with findings on closed class morphemes in internationally adopted children (Snedeker et al., 2007) and tense inflection in immigrant children learning English L2 with a typical language development (Blom & Paradis, 2015). Intensity of exposure to Dutch was a more important predictor than AoO, which is in line with findings reported by Unsworth et al. (2014) for grammatical morphemes expressing gender.

The above findings reveal that a later AoO affects both vocabulary and grammar positively. At the same time, a contrast was found because AoO had clearly more influence on vocabulary than on grammar. Both vocabulary and grammar development could benefit from more cognitive resources, such as a larger verbal short-term memory, better attention spans and more declarative knowledge. The difference between vocabulary and grammar could be explained by the relevance of conceptual development for vocabulary versus grammar. In order to learn vocabulary, a child has to map conceptual and phonological information. Older children know more concepts than younger children and therefore their L2 vocabulary may show faster growth. Consequently, children with an older AoO have larger vocabularies than children with a younger AoO. Conceptual development is less important for learning how to form noun plurals and past participles than for vocabulary development.

Intensity of exposure affected both vocabulary and grammar, as AoO did. The influence of AoO on vocabulary was more prominent than the influence of intensity of exposure, whereas regarding inflection the influence of intensity of exposure was more prominent than the influence of AoO. In this study, intensity of exposure to Dutch may have had a relatively small effect on the children’s Dutch receptive vocabulary because of the extensive lexical overlap between Frisian and Dutch. Consequently, even with little exposure to and limited knowledge of Dutch, a Frisian-speaking child can perform accurately on a Dutch receptive vocabulary task because of experience with Frisian (see for a similar point regarding other closely related languages: Kelley & Kohnert, 2012; Stadthagen-González, Gathercole, Pérez-Tattam & Yavas, 2013).

With respect to the larger effect that intensity of exposure to Dutch has on vocabulary than on inflection, it is also important to consider task effects. Vocabulary was tested with a multiple-choice task in which children heard a word and they indicated its meaning by choosing one of four pictures. The four pictures provided children with cues regarding the meaning of the words and the children could also select a picture by reasoning and excluding options. Inflection was tested using an elicitation task with no cues regarding the target inflected form. Thus, the multiple-choice task used to test vocabulary may be a less sensitive
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measure of children’s knowledge of Dutch and hence less sensitive to the intensity of exposure to Dutch compared to the ‘open’ production task that was used to test inflection.

Finally, we investigated effects of transfer between Frisian and Dutch in relation to AoO (research questions 2 & 3). We tentatively predicted a global negative transfer effect for past participles and an interaction between AoO and inflection type. The descriptive statistics indicated that the children indeed performed better with noun plurals than with past participles, which was confirmed by the outcomes of the classification procedures. The binary recursive partitioning tree demonstrated an interaction between AoO and inflection type: AoO emerged as a predictor for past participles only. However, an older AoO was associated with fewer errors instead of more errors as was tentatively predicted. Also, the children hardly ever omitted the participial prefix when they used Dutch past participles. Based on this we conclude that past participle use in Dutch was not affected by global negative transfer from Frisian. The predictive value of accuracy at using Frisian inflection revealed a global positive transfer effect. More granular analysis at the level of lexical items suggested that this may be due to lexical overlap between Frisian and Dutch. Taken together, these findings suggest that the Frisian-Dutch bilingual children separate their inflectional rules in Frisian and Dutch, but when lexical items are identical in the two languages, children seem to rely on the language other (Frisian) than the one tested (Dutch), suggesting a partly shared lexicon.

Based on a suggestion by Unsworth et al. (2014) we hypothesized that a later AoO may have a negative effect in the set of items that do not overlap between the two languages. The opposite was found: a later AoO had some small positive effect in both sets. Note, however, that Unworth et al.’s suggestion was based on data on grammatical gender, that is, morphosyntactic rules, whereas in our analysis negative effects of a later AoO were investigated at the level of lexical items that do or do not overlap between the L1 and L2. Our findings do not rule out the possibility that with respect to grammatical features that are not present in the L1 and have to be learned in the L2, a later AoO of exposure to the L2 could be detrimental. Given the hypothesis that effects of (negative) transfer are more prominent when L1 and L2 have less overlap (McDonald, 2000; Monaghan & Ellis, 2002; Sabourin et al., 2006; Zevin & Seidenberg, 2002, 2004), it would be pertinent to manipulate overlap at the level of grammar and contrast children with an inflecting versus non-inflecting L1 in order to investigate whether greater familiarization with a non-inflecting language delays learning inflection in the L2.

There are a number of limitations to our study that are relevant to mention. In this study, we decorrelated AoO and length of exposure, which were highly confounded.
Although the correlation between the decorrelated predictor AoO and the original predictor was significant, the correlation was small to medium. Thus, the original AoO predictor and the decorrelated AoO predictor overlap in what they measure but there is also a substantial amount of variance that is not shared by the two measures of AoO. Moreover, although we used a decorrelated measure of AoO and included intensity of (current) exposure as a covariate, we cannot exclude the possibility that AoO was still to some degree confounded with exposure because we did not include cumulative exposure, which combines length and intensity of exposure. Note furthermore that in this study, AoO ranged between 0 and 4. Within this age range, AoO had hardly any effect on the development of grammatical morphemes, but this does not rule out the possibility that AoO shows an effect with a broader age range. Finally, this study was limited to accuracy data, and we did not systematically investigate AoO in relation to error types (Meisel, 2009). In this respect it is relevant to note that the error types in Tables 2-1 and 2-2 are not specific to bilingual children but are found in Dutch monolinguals as well (De Houwer & Gillis, 1998; Van Wijk, 2006).

In this study, we investigated effects of age of onset on vocabulary and grammar (inflection) in a sample of 5- and 6-year-old bilingual Frisian-Dutch children. A later age of onset of exposure to Dutch, which ranged from 0 to 4, had a positive effect on the children’s Dutch receptive vocabulary, reflecting the role of conceptual development on vocabulary acquisition. Accuracy at using inflection, in contrast, was hardly influenced by age of onset, showing that during early childhood, cognitive maturing has little influence on the acquisition of inflection. Taken together, the main finding of this study is that the common idea that it is better to start as soon as possible with learning a new language, does not necessarily hold. In fact, this study with Frisian-Dutch bilinguals shows that for the correct use of grammatical morphemes, it does not matter whether children start at age 0 or 4. For rapidly learning words in a new language it may be helpful to first build a substantial vocabulary in the first language before learning a new language.
The influence of age of onset, degree of exposure and transfer

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Appendix 2-1. Items of the Dutch TAK word formation test and their Frisian translations

<table>
<thead>
<tr>
<th>Regularity</th>
<th>Noun plurals Dutch-Frisian</th>
<th>Participles Dutch-Frisian</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>brillen–brillen (‘glasses’): overlap</td>
<td>gekookt–sean (‘cooked’): no overlap</td>
</tr>
<tr>
<td></td>
<td>oren–earen (‘ears’): overlap</td>
<td>geplakt–plakt (‘glued’): overlap</td>
</tr>
<tr>
<td></td>
<td>kranten–kranten (‘papers’): overlap</td>
<td>gespeeld–boarte (‘played’): no overlap</td>
</tr>
<tr>
<td></td>
<td>ogen–eagen (‘eyes’): overlap</td>
<td>gefietst–fyts (‘cycled’): overlap</td>
</tr>
<tr>
<td>Medium</td>
<td>vlinders–flinters (‘butterflies’): overlap</td>
<td>gezeten–sitten (‘sat’): no overlap</td>
</tr>
<tr>
<td></td>
<td>lepels–leppels (‘spoons’): overlap</td>
<td>gevlogen–flein (‘flown’): no overlap</td>
</tr>
<tr>
<td></td>
<td>emmers–amers (‘buckets’): overlap</td>
<td>gekeken–sjoen(d) (‘watched’): no overlap</td>
</tr>
<tr>
<td></td>
<td>trommels–trommels (‘drums’): overlap</td>
<td>gedronken - dronken (‘drunk’): overlap</td>
</tr>
<tr>
<td>Low (irregular)</td>
<td>wegen–dyken (‘roads’): no overlap</td>
<td>gebracht–brocht (‘brought’): no overlap</td>
</tr>
<tr>
<td></td>
<td>daken–dakken (‘roofs’): no overlap</td>
<td>gezocht–socht (‘sought’): overlap</td>
</tr>
<tr>
<td></td>
<td>sloten–slotten (‘locks’): no overlap</td>
<td>verloren–ferlern (‘lost’): no overlap</td>
</tr>
<tr>
<td></td>
<td>gaten–gatten (‘holes’): no overlap</td>
<td>gekocht–kocht (‘bought’): overlap</td>
</tr>
</tbody>
</table>
### Appendix 2-2. Model specifications full data set

Model 1 full model, full data set, fixed effects:

|                     | Estimate | Std. Error | z value | Pr(>|z|) |
|---------------------|----------|------------|---------|----------|
| (Intercept)         | 1.77505  | 1.03275    | 1.719   | .09      |
| AoO_Dutch_resid     | -0.05148 | 0.01934    | -2.662  | <.01     |
| Intensity_exposure_Dutch | -2.86347 | 0.61414    | -4.663  | <.001    |
| Proficiency_Frisian | -0.09552 | 0.03054    | -3.128  | <.01     |
| Inflection_type (plur)| -1.47511 | 1.22961    | -1.200  | .23      |

* p < .01  
* p < .001

Model 2 reduced model, full data set, fixed effects:

|                     | Estimate | Std. Error | z value | Pr(>|z|) |
|---------------------|----------|------------|---------|----------|
| (Intercept)         | 1.05641  | 0.85109    | 1.241   | .21      |
| AoO_Dutch_resid     | -0.05153 | 0.01936    | -2.662  | <.01     |
| Intensity_exposure_Dutch | -2.86728 | 0.61469    | -4.665  | <.001    |
| Proficiency_Frisian | -0.09563 | 0.03056    | -3.129  | <.01     |

* p < .01  
* p < .001

Model 3 reduced model, balanced data set, fixed effects:

|                     | Estimate | Std. Error | z value | Pr(>|z|) |
|---------------------|----------|------------|---------|----------|
| (Intercept)         | 0.59128  | 0.88160    | 0.671   | .50      |
| AoO_Dutch_resid     | -0.03477 | 0.02146    | -1.621  | .11      |
| Intensity_exposure_Dutch | -2.42206 | 0.67616    | -3.582  | <.001    |
| Proficiency_Frisian | -0.07572 | 0.03619    | -2.092  | .04      |

* p < .05  
* p < .001
Appendix 2-3. Model specifications and classification trees for data sets with and without overlap

Model 4 data set with overlap, fixed effects:

|                      | Estimate | Std. Error | z value | Pr(>|z|) |
|----------------------|----------|------------|---------|----------|
| (Intercept)          | -1.88183 | 0.93028    | -2.023  | .04      |
| AoO_Dutch_resid      | -0.05178 | 0.02398    | -2.159  | .03      |
| Intensity_exposure_Dutch | -0.80327 | 0.57688    | -1.392  | .16      |

Model 5 data set without overlap, fixed effects:

|                      | Estimate | Std. Error | z value | Pr(>|z|) |
|----------------------|----------|------------|---------|----------|
| (Intercept)          | 0.59762  | 0.79414    | 0.753   | .45      |
| AoO_Dutch_resid      | -0.04721 | 0.02085    | -2.264  | .02      |
| Intensity_exposure_Dutch | -2.21545 | 0.50823    | -4.359  | < .001   |

*p < .05; p < .001
This chapter has been published as:

Chapter 3

A longitudinal study on the gradual cognate facilitation effect in bilingual children’s Frisian receptive vocabulary

This chapter has been published as:

Abstract
This longitudinal study investigated to what extent the acquisition of cognates among bilingual children depends on the degree of cross-language similarity and intensity of exposure to the tested language, and whether children’s sensitivity to cognates with different degrees of cross-language similarity changes over time. For three consecutive years, 120 Frisian-Dutch bilingual children were tested on their Frisian receptive vocabulary. The sample was split into three groups that differed with respect to intensity of exposure to Frisian at home. In the receptive vocabulary task, cross-language similarity was systematically manipulated through four cognate categories, differing in their degree of overlap between Frisian and Dutch. The results showed a gradual cognate facilitation effect for children with a low intensity of exposure to Frisian. The higher the degree of cross-language similarity, the better their performance. This implies that the co-activation of the two languages depends on the degree of cross-language similarity. Over time, their performance improved the most on non-identical cognates with a cross-linguistic phonological regularity between Frisian and Dutch. This suggests that as they grow older, children with a low intensity of exposure to Frisian become better at recognizing regularities in the overlap of the Frisian and Dutch phonological systems.
Abstract
This longitudinal study investigated to what extent the acquisition of cognates among bilingual children depends on the degree of cross-language similarity and intensity of exposure to the tested language, and whether children's sensitivity to cognates with different degrees of cross-language similarity changes over time. For three consecutive years, 120 Frisian-Dutch bilingual children were tested on their Frisian receptive vocabulary. The sample was split into three groups that differed with respect to intensity of exposure to Frisian at home. In the receptive vocabulary task, cross-language similarity was systematically manipulated through four cognate categories, differing in their degree of overlap between Frisian and Dutch. The results showed a gradual cognate facilitation effect for children with a low intensity of exposure to Frisian. The higher the degree of cross-language similarity, the better their performance. This implies that the co-activation of the two languages depends on the degree of cross-language similarity. Over time, their performance improved the most on non-identical cognates with a cross-linguistic phonological regularity between Frisian and Dutch. This suggests that as they grow older, children with a low intensity of exposure to Frisian become better at recognizing regularities in the overlap of the Frisian and Dutch phonological systems.

The gradual cognate facilitation effect
Over the last two decades it has become clear that the two vocabularies of bilingual children and adults are intertwined depending on similarities in form and meaning between individual words in the two languages. The co-activation of information in both linguistic systems of a bilingual is apparent when both a word's meaning and its form overlap between languages, as in the case of cognates (e.g. Dijkstra, Grainger, & Van Heuven, 1999; Versloot & Hoekstra, 2016). Examples of cognate pairs are the English-German translations apple-Apfel and the English-Spanish translations elephant-elefante.

Part of the evidence for this co-activation comes from reaction time (RT) studies in the second language (L2) in which both bilingual adults (e.g. De Groot et al., 1994; Dijkstra et al., 1999; Lotto & De Groot, 1998; Rosselli et al., 2014) and bilingual children (e.g. Brenders et al., 2011; Poarch & Van Hell, 2012a) respond faster and with fewer errors to cognate items in comparison to non-cognate items. The faster responses for cognates can be seen as evidence that the phonological representations have become active in both languages and that they influence each other (Dijkstra et al., 2010; Poarch & Van Hell, 2012a).

Some studies with bilingual adults have shown that the degree of this cognate facilitation effect depends on the similarity between the two words of a cognate pair. As far as we know, it has not been investigated yet if this works the same in bilingual children. In a lexical decision task with adults, RTs for orthographically identical cognates were faster than RTs for orthographically non-identical cognates, which were faster than RTs for non-cognates (Dijkstra et al., 2010; Duyck et al., 2007). Furthermore, Dijkstra et al. (2010) found that only within the set of orthographically identical cognates, phonological similarity resulted in an additional effect. Other studies have found a continuous cognate facilitation effect, based on Van Orden’s (1987) orthographic overlap measure (Van Assche, Duyck, Hartsuiker, & Diependaele, 2009; Van Assche, Drieghe, Duyck, Welvaert, & Hartsuiker, 2011). In an eye-tracking reading study with bilingual adults with Dutch as their first language (L1) and English as their L2, Van Assche et al. (2011) found that the recognition of English words was facilitated by a higher degree of orthographic similarity to Dutch. In a similar type of experiment, Van Assche et al. (2009) found the same effect in the L1: the reading of Dutch words was facilitated by a higher degree of orthographic similarity to English.

The results of the studies described above show that for the co-activation of cognates, the cognate pair does not have to be identical. Partial similarity also results in a cognate facilitation effect, but to a lesser degree than complete similarity, showing that the effect is not binary, but gradual. Theoretically, this is an important finding, because it implies that the
spreading of activation of words in the bilingual lexicon is a function of cross-language similarity between lexical representations. The graduality of the cognate facilitation effect demonstrates that a word in the input activates semantic, phonological and orthographic representations in both languages depending on the overlap with that particular word in the input. How fast cognates get activated in comparison to non-cognates depends on the degree of the semantic, phonological and orthographic overlap between the two words of a cognate pair.

Most previous research on the effect of cognates on bilingual vocabularies focused on bilingual adults, and it is still unknown if the degree of cross-language similarity also affects lexical acquisition in bilingual children. Moreover, little is known about the developmental trajectory of cognate effects. The aim of the present study was to fill this empirical gap by investigating a gradual cognate effect in Frisian-Dutch bilingual children. In the next section, previous research on cognate facilitation in child L2 learners is discussed.

**Cognate facilitation in child L2 learners**

Further evidence for the co-activation of the two lexicons comes from vocabulary tests with child L2 learners and children with a low intensity of exposure to the tested language. These children obtained higher accuracy scores on cognates than on non-cognates (Kelley & Kohnert, 2012; Malabonga et al., 2008; Schellete, 2002). The explanation is that children with a low intensity of exposure to the tested language use their other, more developed, language to understand cognate items. For non-cognate items, their knowledge of the other language is not helpful, since these words do not show overlap in form across the two languages. The advantage for cognates over non-cognates was not found in the studies with bilingual children by Umbel and Oller (1994) and Umbel, Pearson, Fernández and Oller (1992). However, these studies did not control for item difficulty. Not controlling for item difficulty could result in cognates being more difficult than non-cognates, because cognates tend to be biased towards more complex, less frequent vocabulary items (Kelley & Kohnert, 2012; Méndez Pérez, Peña, & Bedore, 2010; Stadthagen-González et al., 2013). Furthermore, differences between studies may be the result of variations in exposure, since not all studies report the children’s amount of exposure to each language.

How intensity of exposure influences children’s performance on cognates and non-cognates is shown by Dijkstra (2013) for Frisian-Dutch and Méndez Pérez and colleagues (2010) for Spanish-English bilingual children. Dijkstra (2013) tested 2.5- to 4-year-old Frisian-Dutch bilingual children on a Frisian receptive vocabulary task. With respect to non-
cognate items (defined as non-cognates and non-identical cognates), the children who spoke Frisian at home performed significantly better than the children who spoke Dutch at home. However, on cognate items (defined as identical cognates), the results showed no difference between the two groups. These results line up with the observation that children with a low intensity of exposure perform better on cognates than non-cognates, because children who speak Dutch at home can use their knowledge of Dutch to understand Frisian words that are cognates with Dutch, but they cannot use their Dutch to understand Frisian words that are non-cognates.

A similar result for non-cognate items was found by Méndez Pérez et al. (2010), who tested the English receptive vocabulary skills of 5- and 6-year-old Spanish-English bilingual children. Children who were more exposed to English and children who were equally exposed to the two languages scored higher on non-cognate items than children who were more exposed to Spanish. In contrast, children who were more exposed to Spanish and children who were equally exposed to Spanish and English knew more Spanish-English cognates than children who were more exposed to English. This latter finding could be explained by the fact that Spanish-English cognates often belong to the higher registers in English, but to the lower registers in Spanish (Stadthagen-González et al., 2013). For example, the meaning of the English word ‘floral’ can be guessed when a child knows the Spanish word flor ‘flower’. These register differences may explain why exposure affected the results for cognates in Spanish-English bilingual children, but not in Frisian-Dutch bilingual children.

A few studies investigated how exposure affects cognate facilitation in bilingual children, but it is virtually unknown to what extent the cognate facilitation effect is gradual, as in bilingual adults. To our knowledge, one child vocabulary study took into account different kinds of cognates, but the purpose of that study was not to investigate the graduality of the cognate effect and no statistical comparisons were made. Bosch and Ramon-Casas (2014) tested the expressive vocabulary of 18-month-old Catalan-Spanish bilingual children through parent report using a bilingual questionnaire with 152 lexical items. Items were identified as translation equivalents if the child produced them in both languages. Form-identical translation equivalents represented 28% of the children’s total lexicon, whereas form-similar and form-dissimilar translation equivalents represented only 1% and 0.33% respectively. These results suggest a non-gradual cognate advantage, with better scores for form-identical cognates in comparison to form-similar cognates and non-cognates, but no advantage for form-similar cognates in comparison to non-cognates.
Since the children in this study were very young it could be that their sensitivity to form-similar cognates had not been fully developed yet. As age has been shown to be positively related to cognate performance (Kelley & Kohnert, 2012; Malabonga et al., 2008), the cognate effect may work differently in children than in adults. On average, the 8- to 13-year-old Spanish-speaking English language learners in Kelley and Kohnert’s (2012) study scored higher on cognate items than on non-cognate items in a receptive vocabulary task, but not all children demonstrated this advantage. Age was found to be a significant predictor of cognate performance, accounting for 26% of the variance. In a longitudinal study, Malabonga and colleagues (2008) measured cognate awareness in 9- and 10-year-old Spanish-speaking English language learners using the Cognate Awareness Test (CAT). In this English multiple-choice task, children have to choose the right definition of a cognate item out of four possible definitions. The results showed that in the second year, children’s performance on English vocabulary had improved and that this was mainly due to an improved performance on cognates.

Kelley and Kohnert (2012) argue that growing cognate sensitivity could be the result of growing metalinguistic skills. Since metalinguistic skills have been shown to be positively related to age (Corthals, 2010; Edwards & Kirkpatrick, 1999), the relationship between age and cognate sensitivity could be explained by developing metalinguistic skills. In particular with respect to the graduality of the cognate effect, vocabulary growth may also play a role, as smaller vocabularies will provide fewer possibilities for the spreading of activation of words in the bilingual lexicon. This raises the question whether children are sensitive to different degrees of cross-language similarity and if so, how this sensitivity develops over time.

The studies described above show that children with a low intensity of exposure to the tested language use their knowledge of the other language to understand the meaning of cognate items. This provides further evidence for the co-activation of the two languages of a bilingual, next to the fact that in RT studies, bilinguals respond faster and with fewer errors to cognate items in comparison to non-cognate items. In RT studies with bilingual adults, the degree of the cognate facilitation effect has been shown to depend on the similarity between the two words of a cognate pair. This implies that the spreading of activation of words in the bilingual lexicon is a function of cross-language similarity between lexical representations. However, if the degree of cross-language similarity affects lexical acquisition in bilingual children is still unknown. Therefore, the present longitudinal study explored the graduality of the cognate facilitation effect in bilingual children’s lexical acquisition. It was examined whether a gradual cognate effect could be found in the Frisian receptive vocabulary scores of
Frisian-Dutch bilingual children with a low intensity of exposure to Frisian and if children’s sensitivity to different degrees of cross-language similarity changed as they grew older. Before we describe the present study, we will give an overview of the Frisian-Dutch bilingual context.

**Frisian and Dutch**

Fryslân is a bilingual province in the Netherlands, where both the national majority language Dutch and the regional minority language Frisian have official status. Outside of the Netherlands, the regional language is known as West Frisian to avoid confusion with the Frisian languages spoken in Germany. In this article, whenever the term Frisian is used, it refers to the West Frisian language. Frisian is predominantly used in informal domains and is much stronger in rural than in urban areas (Breuker, 2001). In a recent survey, 55.3% of the population of Fryslân reported to speak Frisian as a mother tongue. About 45.6% of the population speaks Frisian with their partner and 47.5% speaks it with their children. About 66.6% of the inhabitants reported to speak the language well, but only 14.5% can write it well (Proevinsje Fryslân, 2015).

Dutch-Frisian bilingual schools have been legally allowed since 1955 (Mercator, 2007) and more and more primary schools are becoming trilingual (Dutch, Frisian and English) in the Trijetalige skoalle (‘trilingual school’) project (Van Ruijven & Ytsma, 2008). However, Dutch is still the dominant language in education. At the end of primary school, all pupils take the national test on the Dutch language as developed by the Dutch national test institute Cito. However, for Frisian as a subject, the educational goals depend on the pupils’ linguistic backgrounds and competences (Mercator, 2011). As a result, most children who speak Frisian at home become balanced bilinguals, whereas children who speak Dutch at home do not (Ytsma, 1995).

Both Dutch and Frisian are West Germanic languages. Traditionally, three Frisian dialects are distinguished: Klaaifrysk (clay Frisian) in the west of the province, Wâldfrysk (forest Frisian) in the east and Südwesthoeks (southwest quarter) in the southwest (Hof, 1933; Tiersma, 1999). These dialects are mutually intelligible, differing slightly on the lexical and phonological level. Historically, Frisian is more closely related to English than to Dutch. However, over time English and Frisian have diverged, while Dutch and Frisian have converged (Gooskens & Heeringa, 2004). As a result, the Frisian and Dutch languages that are spoken nowadays share a large part of their vocabularies and cognates occur at all levels of acquisition, from easy to difficult words.
It has been argued that bilingual speakers of phonologically overlapping languages make use of cross-linguistic phonological regularities (Rys, 2009; Sjölin, 1976; Taeldeman, 2013). Two examples of a phonological regularity across Frisian and Dutch are Frisian -ân [ɔːn] and Dutch -and [ant], and Frisian -âld [ɔːt] and Dutch -oud [aut], as in the cognate pairs below:

<table>
<thead>
<tr>
<th>Frisian</th>
<th>Dutch</th>
</tr>
</thead>
<tbody>
<tr>
<td>hân [hɔːn]</td>
<td>hand [hɑnt]</td>
</tr>
<tr>
<td>lân [lɔːn]</td>
<td>land [lɑnt]</td>
</tr>
<tr>
<td>strân [strɔːn]</td>
<td>strand [strɑnt]</td>
</tr>
<tr>
<td>kâld [kɔːt]</td>
<td>koud [kɔut]</td>
</tr>
<tr>
<td>wâld [wɔːt]</td>
<td>woud [wɔut]</td>
</tr>
<tr>
<td>sâlt [sɔːt]</td>
<td>zout [sɔut]</td>
</tr>
</tbody>
</table>

In contrast, the following words are cognates, but without a cross-linguistic phonological regularity:

<table>
<thead>
<tr>
<th>Frisian</th>
<th>Dutch</th>
</tr>
</thead>
<tbody>
<tr>
<td>trijeling</td>
<td>[trεiɔln]</td>
</tr>
<tr>
<td>skjirre</td>
<td>[skjIrə]</td>
</tr>
</tbody>
</table>

Once a speaker of Dutch is aware of the cross-linguistic phonological regularities, it becomes easier to understand the Frisian language. In light of the cognate facilitation effect, one would expect that cognates with a phonological regularity with only a few phonemes are easier to understand for bilinguals with a low intensity of exposure to Frisian than cognates without or with a more complex phonological regularity. This was taken into account in the present study.

**Research questions and predictions for the present study**

The current longitudinal study examined if the degree of cross-language similarity affects lexical acquisition in bilingual children. More specifically, it was investigated whether Frisian-Dutch bilingual children with various levels of exposure to Frisian at home (low, middle, high) showed a gradual cognate facilitation effect on a Frisian receptive vocabulary.
Gradual cognate facilitation in Frisian receptive vocabulary

With respect to the first research question, Frisian-Dutch bilingual children with a low intensity of exposure to Frisian were expected to perform better on cognate items in comparison to non-cognate items, since they could use their knowledge of Dutch to understand Frisian words that are cognates to Dutch, but they could not use their Dutch to understand non-cognates. In line with previous evidence from RT studies with adults showing that the cognate facilitation effect is gradual, the performance of this group of children was expected to be affected by the degree of similarity between the two words of a cognate pair. Performance on identical cognates was expected to be better than performance on non-identical cognates, and performance on non-identical cognates was expected to be better than performance on non-cognates. Within the group of non-identical cognates, performance on cognates with a cross-linguistic phonological regularity with only one, two or three phonemes was expected to be better than performance on cognates without or with a more complex phonological regularity.

In contrast, the performance of Frisian-Dutch bilingual children with a high intensity of exposure to Frisian was not expected to be influenced by the degree of cross-language similarity, since these children do not need to rely on their knowledge of Dutch. The expectations for the children with a middle intensity of exposure to Frisian were less clear. Their performance could be similar to the high exposure group, but it could also be more similar to the low exposure group.
With respect to the second research question, it was expected that in the low exposure group, the relative performance on different types of cognates would shift over time as a result of children’s developing sensitivity to cross-language similarity. We hypothesized that children’s performance would improve the most on those cognates where more developed metalinguistic skills could help them recognize patterns in the similarity to Dutch, that is, non-identical cognates with a cross-linguistic phonological regularity. It was expected that over the course of time, performance on this type of cognates would become more similar to performance on identical cognates and more different from performance on non-identical cognates without a phonological regularity.

Method

Participants
A total of 122 children took part in the first year of the study. After the first wave of data collection, two children dropped out, leaving 120 children for the present longitudinal study. They were 5 or 6 years old at time 1, 6 or 7 years old at time 2 and 7 and 8 years old at time 3. The sample was split into three exposure groups using visual binning (SPSS 23). The cut-off points of these groups were 50% and 80% of exposure to Frisian at home. The intensity of exposure to Frisian at home ranged from 0% to 50% in the low exposure group \((n = 42, 20 \text{ girls}, 22 \text{ boys})\), from 50% to 80% in the middle exposure group \((n = 40, 23 \text{ girls}, 17 \text{ boys})\), and from 80% to 100% in the high exposure group \((n = 38, 18 \text{ girls}, 20 \text{ boys})\). Table 3-1 provides an overview of the participants’ age in months in the first year of the study, non-verbal IQ scores, socio-economic status (SES) and intensity of exposure to Frisian at home. The three groups did not differ with respect to age (time 1), \(F(2,117) = 0.09, p = .91\), and non-verbal IQ, \(F(2,117) = 0.48, p = .62\), but they did differ with respect to SES, \(F(2,117) = 3.52, p = .03, \eta^2_p = .06\), and, as expected, intensity of exposure to Frisian, \(F(2,117) = 330.93, p < .001, \eta^2_p = .85\). Therefore, SES was added as a control variable in the analyses.

Non-verbal IQ was estimated with the subsets Matrices and Recognition of the Wechsler Nonverbal Scale of Ability (Wechsler & Naglieri, 2006). SES scores and information about intensity of exposure to Frisian were obtained through a parental questionnaire, based on the Questionnaire for Parents of Bilingual Children (COST Action IS0804, 2011; Tuller, 2015). SES was calculated as the mean educational level of the father and the mother of the child, which was measured on a 1-9 scale, ranging from no education (1) to university degree (9). Intensity of exposure to Frisian was measured as the mean percentage of Frisian input the child received from his mother, father, siblings and other...
adults who looked after the child at least once per week. For each of these people the question had to be answered how often (s)he spoke Frisian to the child: ‘never’ (0%), ‘seldom’ (25%), ‘sometimes’ (50%), ‘usually’ (75%) and ‘always’ (100%). Exposure to Dutch was 100% minus exposure to Frisian.

**Table 3-1. Mean and standard deviation characteristics of the children with a low, middle and high intensity of exposure to Frisian**

<table>
<thead>
<tr>
<th>Group</th>
<th>Low exposure group (n = 42)</th>
<th>Middle exposure group (n = 40)</th>
<th>High exposure group (n = 38)</th>
<th>Max score</th>
<th>F(2,117)</th>
<th>p</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>70 (7)</td>
<td>70 (6)</td>
<td>70 (7)</td>
<td>0.09</td>
<td>.91</td>
<td>&lt; .01</td>
<td></td>
</tr>
<tr>
<td>IQ</td>
<td>106 (16)</td>
<td>108 (14)</td>
<td>105 (13)</td>
<td>144</td>
<td>0.48</td>
<td>.62</td>
<td>.01</td>
</tr>
<tr>
<td>SES</td>
<td>7.3 (1.25)</td>
<td>6.7 (1.4)</td>
<td>6.6 (1.2)</td>
<td>9</td>
<td>3.52</td>
<td>.03</td>
<td>.06</td>
</tr>
<tr>
<td>% FR</td>
<td>28 (17)</td>
<td>71 (7)</td>
<td>92 (6)</td>
<td>100</td>
<td>330.93</td>
<td>&lt; .001</td>
<td>.85</td>
</tr>
</tbody>
</table>

Age = age in months at time 1; SES = socio-economic status; % FR = intensity of exposure to Frisian at home; $\text{p} \leq .05$ $\text{p} \leq .001$

Participants were recruited by contacting primary schools in the countryside of the province of Fryslân. A total of 14 schools participated. The schools distributed consent forms and folders providing information about the experiment among the parents of the children. Only children whose parents had signed the consent form were tested.

**Measurement instruments**

For the purpose of this study, we developed a Frisian receptive vocabulary test, which was based on the Peabody Picture Vocabulary Test-III-NL (PPVT-III-NL; Schlichting, 2005), which is the Dutch version of the PPVT-III (Dunn & Dunn, 1997). We adapted the PPVT in such a way that it was suitable for the measurement of cognate sensitivity, next to the measurement of general vocabulary knowledge. The adaptation process will be explained below. Permission was obtained from the publisher to use this Frisian adaptation for research purposes.

The PPVT measures the understanding of spoken words. It is a standardized multiple choice test for people between 2;3 and 90 years of age, and it is taken individually. The PPVT contains 204 items in total divided over 17 sets, each containing 12 items. The sets are ordered by difficulty. The test starts with the easier, more frequent items in the first set after which the degree of complexity gradually increases towards the higher sets. Each item is
represented on a sheet with four pictures from which the participant has to choose one in order to demonstrate understanding of the stimulus word. For the present study, the first 12 sets, that is, 144 items, were translated and adapted. These sets suffice to test the vocabulary knowledge of the children in our age range. We did not use basal and ceiling criteria to ensure that all children completed all items. The adaptation was done in the following way.

As in Dijkstra’s (2013) Frisian adaptation of the Dutch PPVT, words with dialectal variation were removed, since the aural stimulus should be equally recognizable for speakers of the three main Frisian dialects. Furthermore, items were removed that differed with respect to register across Frisian and Dutch. Some of these items were removed, because they are commonly used in Dutch, but not in Frisian. There were also some Frisian translations with another Dutch translation equivalent next to the original Dutch word. If the alternative Dutch translation equivalent belonged to a more everyday register, the Frisian translation was removed.

Special attention was paid to cognates, which are the focus of the present study. The first 144 words of the PPVT-III-NL contain 69 Dutch words that are identical in form and meaning to their Frisian translation equivalents (47%), and 13 Dutch-Frisian non-cognates (9%), reflecting the fact that Frisian and Dutch are closely related languages with many similarities in vocabulary. The proportion of cognates increases with the degree of difficulty of the sets, as a result of the presence of internationalisms in the higher sets, which are cognates by definition (see also Kelley & Kohnert, 2012; Méndez Pérez et al., 2010; Stadthagen-González et al., 2013, who observe something similar for Spanish-English).

In order to systematically investigate to what extent the acquisition of cognates among bilingual children depends on the degree of cross-language similarity, this factor was operationalized by four different cognate categories to which the words in the Frisian receptive vocabulary task were assigned. These four categories are a proxy for what we assume to be a continuum of cognateness, that is, a continuum of similarity in form: identical cognates (category 1), for example, Frisian poes and Dutch poes ‘cat’, non-cognates (category 4), for example, Frisian bern and Dutch kind ‘child’, and two categories in between those two with non-identical cognates, that is, words that share some, but not all phonological properties with their Dutch translation equivalents. Category 2 consists of cognates with a cross-linguistic phonological regularity of one, two or three phonemes. This makes the phonological overlap between the translation equivalents systematic. In this category there is one phonological regularity that deserves some more explanation, as it includes vowel breaking. Vowel breaking is the change of a monophthong into a diphthong or triphthong (see for vowel
breaking in Frisian, Tiersma, 1999, 17-20; Van der Meer, 1985). The broken vowel that is included in category 2 is [je] in the suffix -earje [jerja], for example, Frisian dosearje [dosjerja] and Dutch doceren [do:slarən]. An overview of all cross-linguistic phonological regularities of category 2 and some examples can be found in Table 3-2. The phonological overlap of the cognates in category 3 is less systematic, which makes these cognates harder to convert than the cognates in category 2. This category comprises three types of cognates: (1) cognates without a cross-linguistic phonological regularity, (2) cognates with a cross-linguistic phonological regularity involving four phonemes and (3) cognates with a cross-linguistic phonological regularity involving vowel breaking with the diphthong [wa], such as Frisian woarst [wast] versus Dutch worst [voorst] ‘sausage’. The words with [wa] vowel breaking were assigned to this category for two reasons: (1) this Frisian diphthong mostly corresponds to Dutch /o:/ and /o/, which have more regular correspondences in Frisian, namely Dutch /o:/ ~ Frisian /o.a/ (which would fit category 2) and Dutch /o/ ~ Frisian /o/ or /a/ (which would fit category 1); (2) the lexical distribution of the correspondence of the broken diphthong [wa] with Dutch /o:/ or /o/ is unpredictable. An overview of the cross-linguistic phonological regularities of category 3 is given in Table 3-3.

The cognate categories were evenly distributed over the task. Thus, there were three items of each category in each set. In order to obtain this even distribution, the Frisian translation of the Dutch PPVT was minimally adapted, adding words and illustrations as needed. In most sets, this resulted in the removal of overrepresented identical cognates and the addition of underrepresented non-cognates. The final version of the Frisian task differed from the Dutch PPVT in the following way. One word was replaced by an alternative word that suited the target picture, 6 words were replaced by an alternative word that suited the target picture of another item, 18 words were replaced by an alternative word that suited 1 of the 3 distractor pictures and 12 words were replaced by another word that suited a distractor picture of another item. In those cases, the distractor picture became the target picture. If this was not possible, new words were added using new pictures. This procedure was applied to 22 words. In the Frisian adaptation of the PPVT-NL-III a total amount of 59 words were replaced by another word. In order to maintain the degree of difficulty, frequency was taken into account in the selection of new words.
Table 3-2. *Cross-linguistic phonological regularities category 2*

<table>
<thead>
<tr>
<th>Frisian phoneme(s)</th>
<th>Frisian example</th>
<th>Dutch phoneme(s)</th>
<th>Dutch example</th>
<th>English translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>[u:]</td>
<td>klûs [klu:s]</td>
<td>[œy]</td>
<td>kluis [kloëys]</td>
<td>safe</td>
</tr>
<tr>
<td>[u]</td>
<td>pûlfrucht [pulfrɔxt]</td>
<td>[ø:]</td>
<td>peulvrucht [pølvrɔxt]</td>
<td>legume</td>
</tr>
<tr>
<td>ünder [undør]</td>
<td>[o]</td>
<td>onder [ondær]</td>
<td>under</td>
<td></td>
</tr>
<tr>
<td>[sk]</td>
<td>skep [skẹp]</td>
<td>[sx]</td>
<td>schep [sxẹp]</td>
<td>shovel</td>
</tr>
<tr>
<td>[ɔ:n]</td>
<td>hân [hɔ:n]</td>
<td>[ant]</td>
<td>hand [hant]</td>
<td>hand</td>
</tr>
<tr>
<td>[ɔ:t]</td>
<td>kâld [kɔ:t]</td>
<td>[aut]</td>
<td>koud [kaut]</td>
<td>cold</td>
</tr>
<tr>
<td>[ɑ:]</td>
<td>daam [da:m]</td>
<td>[a]</td>
<td>dam [dam]</td>
<td></td>
</tr>
<tr>
<td>[ər]</td>
<td>ferstelber [færstelbær]</td>
<td>[ər]</td>
<td>verstelbaar [værstelba:R]</td>
<td>adjustable</td>
</tr>
<tr>
<td>[I.ə]</td>
<td>easten [I.əstən]</td>
<td>[o:]</td>
<td>oosten [o:stən]</td>
<td>east</td>
</tr>
<tr>
<td>[i]</td>
<td>dolfyn [dolfin]</td>
<td>[ei]</td>
<td>dolfijn [dolfi:n]</td>
<td>dolphin</td>
</tr>
<tr>
<td>[(k)jə]</td>
<td>timmerje [tɪmərje]</td>
<td>[ən]</td>
<td>timmeren [tɪmərən]</td>
<td>to hammer</td>
</tr>
<tr>
<td>[tsjə]</td>
<td>kadootsje [kɑdo:tʃə]</td>
<td>[tʃə]</td>
<td>cadeautje [kɑdo:tʃə]</td>
<td>(little) present</td>
</tr>
<tr>
<td>[kə]</td>
<td>groepke [gruːpə]</td>
<td>[ʃə]</td>
<td>groepje [xɾuːpə]</td>
<td>(small) group</td>
</tr>
<tr>
<td>boeid [bʊiːt]</td>
<td>[χə]</td>
<td>geboeid [xəbuːt]</td>
<td>chained</td>
<td></td>
</tr>
</tbody>
</table>

Table 3-3. *Cross-linguistic phonological regularities category 3*

<table>
<thead>
<tr>
<th>Frisian phoneme(s)</th>
<th>Frisian example</th>
<th>Dutch phoneme(s)</th>
<th>Dutch example</th>
<th>English translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>[juwə]</td>
<td>skriuwe [skrjuuwa]</td>
<td>[ɛiʋən]</td>
<td>schrijven [sxreivən]</td>
<td>to write</td>
</tr>
<tr>
<td>[wa]</td>
<td>woarst [waːst]</td>
<td>[ø]</td>
<td>worst [uɔrst]</td>
<td>sausage</td>
</tr>
<tr>
<td></td>
<td>boarch [bwarx]</td>
<td>[ø]</td>
<td>burcht [bɔrxt]</td>
<td>castle</td>
</tr>
</tbody>
</table>

It was ensured that there were no word frequency differences between the four categories. Van Heuven, Mandera, Keuleers and Brysbaert (2014) proposed a standardized measure of word frequency, the Zipf scale, which uses logarithmic (10-log) instead of absolute frequencies, because frequency is perceived logarithmically. For all the words in the Frisian receptive vocabulary test, logarithmic Zipf scores were calculated based on frequencies per million words from two Dutch corpora: CELEX (Center for Lexical Information, 1993), a corpus of written Dutch that was also used for the PPVT-III-NL, and Corpus Gesproken.
Nederlands (CGN; Nederlandse Taalunie, 2004), a corpus of spoken Dutch. Dutch frequencies were used instead of Frisian frequencies, since the only available Frisian corpus is a non-lemmatized database of standardized written language, which is not representative of the language that is spoken by speakers of Frisian (Breuker, 1993). As Frisian and Dutch are closely related languages, the Dutch frequencies were thought to be representative of the Frisian frequencies. Words that belong to different registers in Frisian and Dutch could present a potential problem. However, those items were removed from the task, as described above.

The four cognate categories each had about the same frequencies in CELEX and CGN. There was a high correlation between the CELEX and the CGN Zipf frequencies, $r = .75, p < .001$. A One-Way ANOVA with category as the independent variable and CELEX Zipf frequencies as the dependent variable showed that there was no significant effect of CELEX Zipf frequency, $F(3,140) = 0.24, p = .87$, and that the CELEX frequencies of category 1 ($M = 3.82, SD = 0.92$), category 2 ($M = 3.85, SD = 1.39$), category 3 ($M = 4.04, SD = 1.22$) and category 4 ($M = 3.96, SD = 1.37$) could be assumed to be the same. A One-Way ANOVA with category as the independent variable and CGN Zipf frequencies as the dependent variable showed that there was also no significant effect of CGN Zipf frequency, $F(3,140) = 0.40, p = .76$, and that the CGN frequencies of category 1 ($M = 3.71, SD = 0.66$), category 2 ($M = 3.79, SD = 0.86$), category 3 ($M = 3.93, SD = 1.05$) and category 4 ($M = 3.85, SD = 0.99$) could be assumed to be the same. Cronbach’s alpha, as calculated at time 1, showed that the internal consistency of the items in the test was sufficient, $\alpha = .76$.

**Procedure**

All participants were tested at their school during school hours, except for one child in the first year, four children in the second year and five children in the third year, who were tested at home. The Frisian receptive vocabulary test, which took about 10 minutes, was administered as the first test in a larger battery of language and cognitive tasks that were divided over two sessions of one hour. Each child was tested individually by a bilingual speaker of Frisian and Dutch. Afterwards the children were rewarded with a gel pen.

**Results**

**Descriptive statistics**

Descriptive statistics of the three groups’ performance on the four cognate categories are shown in Table 3-4.
Chapter 3

Table 3-4. Children’s performance on the four cognate categories

<table>
<thead>
<tr>
<th>Year</th>
<th>Category</th>
<th>Low exposure group (n = 42)</th>
<th>Middle exposure group (n = 40)</th>
<th>High exposure group (n = 38)</th>
<th>Maximum possible score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>23.62 (2.42)</td>
<td>22.70 (2.28)</td>
<td>23.16 (2.54)</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>21.74 (3.04)</td>
<td>22.70 (2.76)</td>
<td>22.92 (2.73)</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>21.17 (3.82)</td>
<td>24.05 (2.52)</td>
<td>23.47 (1.91)</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>19.33 (4.53)</td>
<td>23.13 (2.54)</td>
<td>24.16 (2.77)</td>
<td>36</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>25.36 (2.20)</td>
<td>25.33 (1.89)</td>
<td>24.82 (2.40)</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>23.95 (2.91)</td>
<td>24.65 (2.52)</td>
<td>24.68 (2.26)</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>23.29 (2.95)</td>
<td>25.10 (2.47)</td>
<td>25.24 (2.28)</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>20.98 (3.54)</td>
<td>25.42 (2.33)</td>
<td>25.42 (2.79)</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>26.50 (2.51)</td>
<td>26.30 (1.79)</td>
<td>25.84 (2.30)</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>26.60 (3.05)</td>
<td>26.30 (2.26)</td>
<td>25.74 (2.86)</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>24.62 (2.48)</td>
<td>26.70 (2.19)</td>
<td>26.76 (2.17)</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>22.86 (2.92)</td>
<td>25.30 (2.32)</td>
<td>26.34 (2.31)</td>
<td>36</td>
</tr>
</tbody>
</table>

First research question

The first research question of this study was whether Frisian-Dutch bilingual children with a low intensity of exposure to Frisian, as opposed to bilingual children with a middle or a high intensity of exposure to Frisian, perform better on cognate items than on non-cognate items, and if so, whether the effect is determined by degree of cognateness. In the analyses, SES was added as a control variable, since the groups differed significantly in this respect. A mixed-design ANCOVA with cognate category as within-subject variable, exposure group as between-subject variable and SES as covariate revealed a significant difference between the three exposure groups, \( F(2,116) = 12.61, p < .001, \eta^2_p = .18 \). LSD post-hoc tests revealed that the children in the low exposure group performed significantly worse than the children in the middle, \( p < .001 \), and high exposure groups, \( p < .001 \), but there was no significant difference between the middle and high exposure groups, \( p = .79 \). Mauchly’s Test for Sphericity was significant for category, \( p < .001 \). Therefore, sphericity was not assumed and, with respect to the within-subject variables, the Greenhouse-Geisser test was applied. There was a significant
interaction effect of category and group, $F(5.19,301.26) = 21.73$, $p < .001$, $\eta^2_p = .27$, and no main effect of category.

LSD *post-hoc* tests were performed to interpret the interaction effect. There was a significant effect of category within the low exposure group, $F(3,114) = 37.13$, $p < .001$, $\eta^2_p = .49$, and within the middle exposure group, $F(3, 114) = 2.76$, $p = .05$, $\eta^2_p = .07$, but not within the high exposure group, $F(3,114) = 1.99$, $p = .12$, $\eta^2_p = .05$. Within the low exposure group, the effect was gradual. Performance on category 1 was significantly better than on category 2, $p < .001$, performance on category 2 was significantly better than on category 3, $p = .001$, and performance on category 3 was significantly better than on category 4, $p < .001$. Within the middle exposure group, the effect was not gradual. Performance on category 3 was significantly better than on category 2, $p = .02$, and category 4, $p = .02$, and there was no significant difference between category 1 and category 2, $p = .50$.

**Second research question**

The second research question of this study was whether sensitivity to different degrees of cross-language similarity changes over time. Since only the low exposure group showed a gradual cognate facilitation effect, the other two exposure groups were not taken into account in the following analysis. A repeated measures ANOVA with cognate category and time as within-subject variables showed a significant effect of time, $F(2,82) = 87.63$, $p < .001$, $\eta^2_p = .68$, and a significant interaction between time and category, $F(6,246) = 2.64$, $p = .02$, $\eta^2_p = .06$. Based on the effect sizes, we can conclude that performance on category 2 improved the most, $F(2,40) = 58.99$, $p < .001$, $\eta^2_p = .75$, followed by category 3, $F(2,40) = 30.67$, $p < .001$, $\eta^2_p = .61$, category 4, $F(2,40) = 20.64$, $p < .001$, $\eta^2_p = .51$, and category 1, $F(2,40) = 19.061$, $p < .001$, $\eta^2_p = .49$.

LSD *post-hoc* tests were performed to interpret the interaction effect (Figure 3-1). At time 1, performance on category 1 ($M = 23.62$, $SD = 2.42$) was significantly better than performance on category 2 ($M = 21.74$, $SD = 3.04$), $p < .001$, and performance on category 3 ($M = 21.17$, $SD = 3.82$) was significantly better than on category 4 ($M = 19.33$, $SD = 4.53$), $p < .01$. However, there was no significant difference between performance on category 2 and 3.

At time 2, performance on category 1 ($M = 25.36$, $SD = 2.20$) was significantly better than performance on category 2 ($M = 23.95$, $SD = 2.91$), $p < .01$, and performance on category 3 ($M = 23.29$, $SD = 2.95$) was significantly better than on category 4 ($M = 20.98$, $SD
= 3.54), \( p < .001 \). However, there was still no significant difference between performance on category 2 and 3.

At time 3, performance on category 2 (\( M = 26.60, SD = 3.05 \)) was significantly better than on category 3 (\( M = 24.62, SD = 2.48 \)), \( p < .001 \), and performance on category 3 was significantly better than on category 4 (\( M = 22.86, SD = 2.92 \)), \( p = .001, p < .001 \), but there was no significant difference between performance on category 1 (\( M = 26.50, SD = 2.51 \)) and 2.

![Figure 3-1](image)

**Figure 3-1.** Effect of time and cognate category within the low exposure group. Only significance notations between adjacent categories are shown. The differences between category 1-3, 2-4 and 1-4 were significant at each time of testing.

**Discussion**

In this study we examined the role of the degree of cross-language similarity in bilingual children’s lexical acquisition. It was investigated whether the cognate facilitation effect that has previously been found in vocabulary studies with other groups of child L2 learners and children with a low intensity of exposure to the tested language (Kelley & Kohnert, 2012; Malabonga et al., 2008; Schelletter, 2002), could also be observed among Frisian-Dutch bilingual children. In addition, it was examined whether the effect is gradual, that is, whether
the size of the effect depends on the degree of similarity between the two words of a cognate pair, which has been shown to be the case in adult RT studies (Dijkstra et al., 2010; Duyck et al., 2007). The graduality of the cognate effect implies that the spreading of activation of words in the bilingual lexicon is a function of cross-language similarity between lexical representations. Since it has been shown that age is positively associated with the cognate effect (Kelley & Kohnert, 2012), this graduality may work differently in children than in adults. Therefore, the question was raised whether children are sensitive to different degrees of cross-language similarity and whether their sensitivity to different degrees of cross-language similarity changes over time (age 5 and 6 at time 1, age 6 and 7 at time 2, age 7 and 8 at time 3). As previous studies have shown that the cognate effect is affected by intensity of exposure (Dijkstra, 2013; Méndez Pérez et al., 2010), a group of Frisian-Dutch bilingual children with a low intensity of exposure to Frisian was compared to groups of Frisian-Dutch bilingual children with a middle or a high intensity of exposure to Frisian.

These three groups were tested with a Frisian receptive vocabulary test in which the degree of similarity between Dutch and Frisian word pairs was systematically manipulated through four different cognate categories. Category 1 was defined as identical cognates, that is, words that have the same pronunciation in Dutch and Frisian. Category 2 consisted of non-identical cognates with a simple cross-linguistic phonological regularity of maximally three phonemes. Category 3 comprised non-identical cognates without a cross-linguistic phonological regularity and cognates with a cross-linguistic phonological regularity with four phonemes or with the broken vowel [wa]. Category 4 consisted of non-cognate items. To control for item difficulty (Kelley & Kohnert, 2012; Méndez Pérez et al., 2010; Stadthagen-Gonzáleze et al., 2013), the four cognate categories in the Frisian receptive vocabulary test were equally represented across the different sets of the test and did not differ with respect to word frequency.

There was a significant effect of category in the groups of children with a low and a middle intensity of exposure to Frisian, but no effect of category in the group of children with a high intensity of exposure to Frisian. For the low exposure group, the effect size was very large, whereas for the middle exposure group, the effect size was small to medium. In the low exposure group, there was a gradual cognate facilitation effect: performance on category 1 was better than on category 2, performance on category 2 was better than on category 3, and performance on category 3 was better than on category 4. In the middle exposure group, the effect was not gradual: performance on category 3 was better than on categories 2 and 4, and there was no significant difference between categories 1 and 2.
A further examination of the effect across time showed that, within the low exposure group, children’s sensitivity to different degrees of cross-language similarity changed as they grew older. Their performance on category 2 improved the most, which led to a shift in their relative performance on the four different cognate categories. At time 1 and 2, performance on category 1 was better than on category 2, and performance on category 3 was better than on category 4, but there was no significant difference between performance on categories 2 and 3. In contrast, at time 3, performance on category 2 was better than on category 3, and performance on category 3 was better than on category 4, but there was no difference between performance on categories 1 and 2.

These results confirm, first, that there is a cognate facilitation effect in Frisian-Dutch bilingual children and replicates in this respect previous studies with vocabulary tests that showed that children with a low intensity of exposure to the tested language perform better on cognates than on non-cognates (Kelley & Kohnert, 2012; Malabonga et al., 2008; Schelletter, 2002). Second, the effect is gradual, which is in line with previous RT studies with bilingual adults (Dijkstra et al., 2010; Duyck et al., 2007). Third, the (gradual) cognate facilitation effect is affected by exposure, confirming previous research with bilingual children (Dijkstra, 2013; Méndez Pérez et al., 2010). Fourth, the effect changes over time. In the low exposure group, performance on category 2 improved the most, resulting in a shift in relative performance on the four cognate categories. As the children got older, their performance on category 2 became more similar to their performance on category 1 and more different from their performance on category 3.

A possible explanation for the cognate effect in a group of children with a low intensity of exposure to Frisian is that these children use their knowledge of Dutch to understand the cognate items in the Frisian receptive vocabulary task. As non-cognate items do not show overlap between Dutch and Frisian, their knowledge of Dutch is not applicable for this category, causing significantly better performance on the cognate items compared to the non-cognate items. The observation that the cognate facilitation effect is gradual confirms previous evidence (Dijkstra et al., 2010; Duyck et al., 2007) that the cognate facilitation effect depends on the similarity between the two words of a cognate pair. The current study extends this finding to bilingual children and to offline tasks measuring receptive vocabulary. This finding implies that when children hear a word in the input, semantic and phonological representations of both languages get activated, depending on the cross-language overlap of the cognate pair. The more overlap between a word in the child’s weaker language and a word in the child’s more developed language, the higher the chances that the cognate word in the
more developed language gets activated, helping the child to understand the meaning of the word in the weaker language. The finding that the graduality of the cognate facilitation effect changes over time shows that children’s sensitivity to items with a lower degree of cross-language similarity improves when they get older. As children’s performance improved the most on cognates with a cross-linguistic phonological regularity, this is probably the result of developing metalinguistic skills. The results imply that over the course of time, children with a low intensity of exposure to Frisian discover the regularities in the overlap of the Frisian and Dutch phonological systems.

To our knowledge, this is the first study that shows a gradual cognate facilitation effect in children and it is also the first that shows that over time, children’s relative performance on different types of cognates changes. On a practical note, our findings imply that the ratio of different types of cognates in a receptive vocabulary task has implications for the performance of children with a low intensity of exposure to the tested language. The more items with a high degree of cross-language similarity in a test, the better the performance of these children. In line with Stadthagen-González et al. (2013), we suggest that future work on cognates should differentiate different types of cognates. More research on the graduality of the cognate facilitation effect could shed light on how cognates are represented in the bilingual mental lexicon, and more longitudinal research with bilingual children could provide insight into the role of development.

It is important to note that the four cognate categories in this study are only an attempt to classify different types of cognates on a continuous cognate scale. It is a limitation of the present study that the scale is not continuous and that the defined categories are only an approximation of this scale. Moreover, next to the degree of cross-language similarity and the cross-linguistic phonological regularities, other factors that have an impact on the recognizability of cognate items were not taken into account. For instance, Gooskens, Van Bezooijen and Van Heuven (2015) pointed to the role of neighbourhood density and Nespor, Peña and Mehler (2003) argued that the recognition of words depends more on consonants than on vowels. Next to these item-related factors there are also some child-related factors that may be worth further exploration. Kelley and Kohnert (2012) already pointed to the influence of age and IQ on cognate performance in general, but it would be interesting to investigate their influence on different types of cognates as well. Another issue that deserves future attention is the influence of literacy on the cognate facilitation effect. As most children in the current study had not yet received reading instruction at time 1, knowledge of written language was thought to play a minimal role. However, as the children had received reading
instruction at time 3, there is a possibility that instruction in written Dutch is a factor that influences the cognate facilitation effect somewhat by equalizing the groups.

Taken together, the main finding of this study is that within bilingual children, the activation of semantic and phonological representations of both languages depends on the cross-language overlap of a cognate pair, thus implying a gradual cognate facilitation effect. The overlap between Frisian and Dutch words helps children with a low intensity of exposure to Frisian to understand Frisian words that are cognates to Dutch. The more similar these words are to Dutch, the easier they are to understand for this group of children. Over time, these children improve their sensitivity to items with a lower degree of cross-language similarity, especially those items with a cross-linguistic phonological regularity.
Chapter 4

The relationship between verbal working memory and the acquisition of cross-linguistic phonological regularities

This chapter has been submitted to a peer-reviewed journal as:

Abstract

Closely related languages share cross-linguistic phonological regularities, such as Frisian -âld [ɔːt] and Dutch -oud [aut], as in the cognate pairs kâld [kɔːt] - koud [kaut] ‘cold’ and wâld [wɔːt] - woud [waut] ‘forest’. Within Bybee’s network model (1995, 2001, 2008, 2010), these regularities are, just like grammatical rules within a language, generalizations that emerge from schemas of phonologically and semantically related words. Previous research has shown that verbal working memory is related to the acquisition of grammar, but not vocabulary. This suggests that it supports the acquisition of linguistic regularities. In order to test this hypothesis we investigated whether verbal working memory is also related to the acquisition of cross-linguistic phonological regularities. For three consecutive years, 5- to 8-year-old Frisian-Dutch bilingual children (n = 120) were tested annually on verbal working memory and a Frisian receptive vocabulary task that comprised four cognate categories: (1) identical cognates, (2) non-identical cognates that either do or (3) do not exhibit a phonological regularity between Frisian and Dutch, and (4) non-cognates. The results showed that verbal working memory had a significantly stronger effect on cognate category (2) than on the other three cognate categories. This confirms the hypothesis that verbal working memory is related to the acquisition of cross-linguistic phonological regularities. More generally, it suggests that verbal working memory plays a role in the acquisition of linguistic regularities.
Introduction

Closely related languages such as Frisian and Dutch share cross-linguistic phonological regularities (Rys, 2009; Sjölin, 1976; Taeldeman, 2013). These regularities connect a fixed sequence of phonemes in one language to another fixed sequence of phonemes in the other language. An example of such a regularity is Frisian -äld [ɔ:t] and Dutch -oud [aut], as in the cognate pairs kâld [kɔ:t] - koud [kaut] ‘cold’ and wâld [wɔ:t] - woud [waut] ‘forest’. It is thought that bilingual speakers make use of these regularities to relate the vocabulary of one language to the other and to quickly switch between languages (Rys, 2009; Sjölin, 1976; Taeldeman, 2013). However, as far as we know, there is no psycholinguistic evidence for this claim. Recent research, though, suggests that cross-linguistic phonological regularities do have a mental reality, as children seem to start using them as they grow older (Bosma, Blom, Hoekstra, & Versloot, 2016).

In the present study, we investigated whether the acquisition of cross-linguistic phonological regularities is related to verbal working memory. This could not only give us more insight into the acquisition of these regularities themselves. As we will explain, it may also shed more light on the mechanisms that support language acquisition in general. In what follows, we will first describe our previous study (Bosma et al., 2016) in more detail, followed by a proposal of how cross-linguistic phonological regularities could be represented in the brain. Within Bybee’s usage-based network model (1995, 2001, 2008, 2010), applied to a bilingual learning context, phonological regularities across languages are similar to grammatical rules within a language. As the acquisition of grammar, but not vocabulary is supported by verbal working memory (Engel de Abreu & Gathercole, 2012; Gottardo et al., 1996; McDonald, 2008; Verhagen & Leseman, 2016), this suggests that verbal working memory supports the acquisition of linguistic regularities. If this is the case, then we would expect verbal working memory to be related to the acquisition of cognates with a cross-linguistic phonological regularity, but not to the acquisition of other types of cognates and non-cognates.

In a longitudinal study with three consecutive annual measurements, Bosma and colleagues (2016) tested 5- to 8-year-old Frisian-Dutch bilingual children on a Frisian receptive vocabulary task that comprised four cognate categories: (1) identical cognates, (2) non-identical cognates with a simple cross-linguistic phonological regularity, (3) non-identical cognates without or with a more complex cross-linguistic phonological regularity, and (4) non-cognates. The results showed a gradual cognate facilitation effect for children with a low intensity of exposure to Frisian at home: the higher the degree of cross-language...
similarity, the better their performance. Furthermore, over time, the children with a low intensity of exposure to Frisian at home improved the most on non-identical cognates with a cross-linguistic phonological regularity. In the first and second year of the study, their performance on this type of cognates was comparable to their performance on non-identical cognates without such a regularity, whereas in the third year of the study, it was similar to their performance on identical cognates. This suggests that as they grow older, children become better at recognizing regularities between the Frisian and Dutch phonological systems.

The graduality of the cognate facilitation effect shows that a word in the input co-activates semantically and phonologically similar words in the other language depending on their degree of similarity. In fact, the spreading of activation in the bilingual lexicon is probably no different from the spreading of activation in the monolingual lexicon (Costa, Santesteban, & Caño, 2005), which has also been shown to depend on the degree of phonological and semantic similarity between words (Gonnerman et al., 2007). This spreading of lexical activation as a function of similarity is the basis of Bybee’s (1995, 2001, 2008, 2010) network model, which proposes that the lexicon is a complex network of linguistic items in which phonologically and semantically related words are stored as spatially proximate. In this model, it is argued that similarity-based categorization and analogy are two of the domain-general mechanisms that support language acquisition. As speakers categorize linguistic items for storage, so-called schemas arise. These are organizational patterns in the lexicon that capture phonological and semantic generalizations about linguistic items. For example, English past tense verbs with the allomorph /d/ are stored together because they have the same final consonant and share a past-tense meaning. The connections between these past tense forms lead to the identification of the suffix. When a speaker creates novel items based on analogy to this schema, the past tense suffix becomes productive. In contrast to what is traditionally thought of as grammar, the generalizations that arise from schemas in the lexicon do not necessarily have a cognitive representation that is independent of the individual linguistic items that together form the schema. This means that there is no separate storage of the rule. Within Bybee’s network model, grammar is not seen as a system that is separate from the lexicon (as in Pinker’s (1991) dual-processing model or Ullman’s (2004) declarative/procedural model), but rather as the structure that arises from the complex network of phonological and semantic relations within the lexicon.

As similarity-based activation of lexical items occurs both within (Gonnerman et al., 2007) and across languages (Bosma et al., 2016; Dijkstra et al., 2010), it can be assumed that
phonologically and semantically similar words are stored closely together, regardless of whether they belong to the same or to a different language. Thus, the network model is not only able to account for regularities within a language, but also for regularities across languages. This suggests that cross-linguistic phonological regularities resemble grammatical rules, as they can both be thought of as generalizations that arise from schemas of phonologically and semantically related words.

Previous research has shown that grammar acquisition is related to verbal working memory (Engel de Abreu & Gathercole, 2012; Gottardo et al., 1996; McDonald, 2008; Verhagen & Leseman, 2016). The precise cognitive architecture of the verbal working memory system is still under debate, but although different researchers work with different definitions (for an overview, see Cowan, 2016), most views support that it is used for both the temporary storage, also referred to as verbal short-term memory, and the processing of verbal information. Following Baddeley and Hitch (1974) and Baddeley (1986), verbal short-term memory is thus considered to be part of the larger verbal working memory system. Verbal short-term memory has been shown to play a role in children’s first (L1) (Engel de Abreu & Gathercole, 2012; Gathercole, Hitch, & Martin, 1997; Gathercole, Willis, Emslie, & Baddeley, 1992; Verhagen & Leseman, 2016) and second language (L2) vocabulary acquisition (Cheung, 1996; Engel de Abreu & Gathercole, 2012; Masoura & Gathercole, 2005; Verhagen & Leseman, 2016) as well as in children’s L1 (Montgomery, 1995) and L2 grammar acquisition (French & O’Brien, 2008; Verhagen & Leseman, 2016; Verhagen et al., 2015). The processing component of verbal working memory is also argued to be important for children’s L1 (Engel de Abreu & Gathercole, 2012; Gottardo et al., 1996; Verhagen & Leseman, 2016) and L2 grammar acquisition (Engel de Abreu & Gathercole, 2012; McDonald, 2008; Verhagen & Leseman, 2016), as has been shown by studies involving receptive grammar (Engel de Abreu & Gathercole, 2012), sentence repetition (Verhagen et al., 2016), grammaticality judgment (Gottardo et al., 1996; McDonald, 2008) and inflectional morphology (Verhagen et al., 2016). However, no relationship has been found between verbal working memory and vocabulary acquisition (Engel de Abreu & Gathercole, 2012; Verhagen et al., 2016). This suggests that verbal short-term memory and verbal working memory are differentially associated with language learning.

As both vocabulary and grammar are related to verbal short-term memory, it is argued that verbal short-term memory is important for the development of stable phonological representations in long-term memory (Baddeley, Gathercole, & Papagno, 1998). After all, children can only transfer words and multiword units to long-term memory after they have
first stored them in short-term memory (Speidel, 1993). The observation that verbal working memory is related to the acquisition of grammar, but not vocabulary suggests that verbal working memory is important for the processing of linguistic regularities. In terms of Bybee’s network model, this suggests that it plays a role in the construction of linguistic schemas through categorization and/or their productive use through analogy, a view that is supported by the finding that verbal working memory also plays a role in the categorization of non-linguistic items (Lewandowsky, 2011; Lewandowsky, Yang, Newell, & Kalish, 2012) and in non-linguistic analogical reasoning (Waltz, Lau, Grewal, & Holyoak, 2000).

In the current study, we investigated the hypothesis that verbal working memory is related to the acquisition of linguistic regularities. Although previous studies did not find a relationship between verbal working memory and the acquisition of vocabulary (Engel de Abreu & Gathercole, 2012; Verhagen et al., 2016), we expected to find this relationship when the words follow a particular pattern. To this end, we investigated children’s vocabulary acquisition in a bilingual context with two closely related languages that share cross-linguistic phonological regularities. We hypothesized that verbal working memory would have an effect on the acquisition of cognates that follow a cross-linguistic phonological regularity, but not on the acquisition of other types of cognates and non-cognates. In order to answer this question, we used the longitudinal data from the 5- to 8-year-old children in our previous cognate study (Bosma et al., 2016) and investigated associations with verbal working memory, thereby controlling for verbal short-term memory (Engel de Abreu & Gathercole, 2012), SES (Rice & Hoffman, 2015), exposure (Pearson et al., 1997), non-verbal IQ (Rice & Hoffman, 2015) and age, which have previously been shown to be related to vocabulary learning.

**Method**

**Participants**

Participants were recruited by contacting primary schools in the countryside of the Dutch province of Fryslân. A total of 122 children from 14 different schools took part in the first year of our study. Two children dropped out after the first wave of data collection, leaving 120 children for the present study (61 girls, 59 boys). They were 5 or 6 years old at time 1, 6 or 7 years old at time 2 and 7 or 8 years old at time 3. Table 4-1 provides an overview of participants’ age, non-verbal IQ scores, socioeconomic status (SES) and intensity of exposure to Frisian at home. Non-verbal IQ was measured with the subsets Matrices and Recognition of the *Wechsler Nonverbal Scale of Ability* (WNV; Wechsler & Naglieri, 2006). Information about SES and intensity of exposure to Frisian at home was obtained through a parental
questionnaire, based on the *Questionnaire for Parents of Bilingual Children* (PaBiQ) (COST Action IS0804, 2011; Tuller, 2015). SES was calculated as the mean educational level of the father and the mother of the child, which was measured on a 1 to 9 scale, ranging from no education (1) to university degree (9). Intensity of exposure to Frisian was measured as the mean percentage of Frisian input the child received from his/her mother, father, siblings and other adults who looked after the child at least once per week. For each of these people the question had to be answered how often (s)he spoke Frisian to the child: ‘never’ (0%), ‘seldom’ (25%), ‘sometimes’ (50%), ‘usually’ (75%) and ‘always’ (100%). Intensity of exposure to Dutch at home was 100% minus intensity of exposure to Frisian at home. As SES and IQ (Rice & Hoffman, 2015) and exposure (Pearson et al., 1997) have been shown to be related to vocabulary learning we included these as control variables.

**Table 4-1. Descriptive characteristics of the participants**

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Range</th>
<th>Maximum possible score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at time 1</td>
<td>70 (7)</td>
<td>59-83</td>
<td></td>
</tr>
<tr>
<td>Age at time 2</td>
<td>82 (7)</td>
<td>71-95</td>
<td></td>
</tr>
<tr>
<td>Age at time 3</td>
<td>94 (7)</td>
<td>83-107</td>
<td></td>
</tr>
<tr>
<td>IQ</td>
<td>106 (15)</td>
<td>73-144</td>
<td>144</td>
</tr>
<tr>
<td>SES</td>
<td>6.9 (1.3)</td>
<td>3.5-9</td>
<td>9</td>
</tr>
<tr>
<td>% FR</td>
<td>63 (29)</td>
<td>0-100</td>
<td>100</td>
</tr>
</tbody>
</table>

*Age = age in months; IQ = intelligence quotient; SES = socioeconomic status; % FR = intensity of exposure to Frisian at home*

**Frisian receptive vocabulary measure**

Frisian receptive vocabulary was measured with a task that was based on the Peabody Picture Vocabulary Test-III-NL (PPVT-III-NL; Schlichting, 2005), which is the Dutch version of the PPVT-III (Dunn & Dunn, 1997). Permission was obtained from the publisher to use this Frisian adaptation for research purposes. In this Frisian adaptation (see Bosma et al. (2016) for more details), only the first 144 words of the Dutch PPVT were used and words were assigned to four different cognate categories: (1) identical cognates, (2) non-identical cognates that either do or (3) do not exhibit a simple phonological regularity between Frisian and Dutch, and (4) non-cognates. Category (2) comprised items that exhibit a regularity of one, two or three phonemes. The vast majority of the items in category (3) were cognates
without a cross-linguistic regularity (34 items). Two items followed a more complex cross-linguistic regularity that involves four phonemes. In order to check if the outcomes, in particular differences between category 2 and category 3, were affected by these two items, analyses were run both with and without these items.

**Verbal memory measure**

Both verbal short-term memory and verbal working memory were measured, as this allowed us to separate the storage component of verbal working memory from the processing component. Verbal short-term memory was measured with the Forward Digit Span and verbal working memory with the Backward Digit Span. These tasks were based on the Alloway Working Memory Assessment (AWMA; Alloway, 2012) and translated to Dutch. It was assumed that all children were able to count to ten in Dutch, since Dutch is the main language of education and all children had spent at least one year in education at the first time of testing. In the Forward Digit Span, children had to repeat sequences of digits in the same order, whereas in the Backward Digit Span, they had to repeat them in reversed order. The Forward Digit Span is considered a measure of verbal short-term memory, because it only requires the storage of the digits. The Backward Digit Span, in contrast, is considered a measure of verbal working memory, because the added requirement to recall the digits in reversed order imposes a substantial processing load on the child (Alloway, 2008).

The task started with sequences of one digit, after which the sequences became increasingly longer. Per block, there were six trials and after three incorrect trials within one block the task stopped. When the child repeated the first four trials within one block correctly, (s)he automatically continued with the next block and received a score of six. When the child repeated four out of the first five trials correctly, (s)he also automatically continued with the next block and received a score of five. The AWMA procedure (Alloway, 2012) was applied for scoring. Trials were scored as incorrect if (part of) the sequence was incorrect, if children recalled one or more digits incorrectly, or if they omitted one or more digits. There were seven blocks for both the Forward and the Backward Digit Span, so the scores could range from 0 to 42.

**Procedure**

The schools distributed consent forms and folders providing information about the experiment among the parents of the children. Children whose parents had signed the consent form were tested individually in a quiet room at school, except for one child at time 1, four children at
time 2 and five children at time 3, who were tested at home. The children were tested by the first author and two research assistants, who all had a native level command of both Frisian and Dutch. The tasks in this study were part of a larger test battery that included language and cognitive tasks that are not reported on in the current study.

Results

Descriptive statistics
Means and standard deviations for the Forward Digit Span, the Backward Digit Span and the four cognate categories are given in Table 4-2. Repeated measures ANOVAs showed that over time, children improved on all measures, \( p < .001 \). Bivariate correlations among all variables at time 1, 2 and 3 are reported in Tables 4-3, 4-4 and 4-5, respectively.

Table 4-2. Means and standard deviations for the Forward Digit Span, the Backward Digit Span and the four cognate categories

<table>
<thead>
<tr>
<th></th>
<th>Time 1</th>
<th>Time 2</th>
<th>Time 3</th>
<th>( p )</th>
<th>( \eta^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Memory measures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward Digit Span</td>
<td>20.21 (3.46)</td>
<td>22.47 (3.92)</td>
<td>24.11 (3.35)</td>
<td>&lt;.001</td>
<td>.53</td>
</tr>
<tr>
<td>Backward Digit Span</td>
<td>12.81 (2.87)</td>
<td>14.90 (2.88)</td>
<td>16.47 (3.57)</td>
<td>&lt;.001</td>
<td>.39</td>
</tr>
<tr>
<td><strong>Cognate categories</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>category 1</td>
<td>23.17 (2.42)</td>
<td>25.18 (2.16)</td>
<td>26.23 (2.22)</td>
<td>&lt;.001</td>
<td>.44</td>
</tr>
<tr>
<td>category 2</td>
<td>22.43 (2.87)</td>
<td>24.42 (2.59)</td>
<td>26.23 (2.75)</td>
<td>&lt;.001</td>
<td>.48</td>
</tr>
<tr>
<td>category 3</td>
<td>22.86 (3.14)</td>
<td>24.51 (2.73)</td>
<td>25.99 (2.49)</td>
<td>&lt;.001</td>
<td>.40</td>
</tr>
<tr>
<td>category 4</td>
<td>22.13 (4.00)</td>
<td>23.87 (3.61)</td>
<td>24.78 (2.92)</td>
<td>&lt;.001</td>
<td>.28</td>
</tr>
</tbody>
</table>

\( p \leq .001 \).
Chapter 4

Table 4-3. Bivariate correlations among all variables at Time 1

<table>
<thead>
<tr>
<th></th>
<th>SES</th>
<th>IQ</th>
<th>% FR</th>
<th>FW DS</th>
<th>BW DS</th>
<th>cat1</th>
<th>cat2</th>
<th>cat3</th>
<th>cat4</th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
<td>-.12</td>
<td>-.02</td>
<td>.10</td>
<td>.25</td>
<td>.26</td>
<td>.33</td>
<td>.40</td>
<td>.16</td>
<td>.26</td>
</tr>
<tr>
<td>SES</td>
<td>-</td>
<td>.04</td>
<td></td>
<td>-.24</td>
<td>.11</td>
<td>.00</td>
<td>.08</td>
<td>-.10</td>
<td>.02</td>
</tr>
<tr>
<td>IQ</td>
<td>-</td>
<td>-.01</td>
<td></td>
<td>.19</td>
<td>.36</td>
<td>.26</td>
<td>.36</td>
<td>.06</td>
<td>.14</td>
</tr>
<tr>
<td>% FR</td>
<td>-</td>
<td>.02</td>
<td>.05</td>
<td>-.03</td>
<td>.26</td>
<td>.50</td>
<td>.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FW DS</td>
<td>-</td>
<td></td>
<td>.46</td>
<td>.28</td>
<td>.23</td>
<td>.07</td>
<td>.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BW DS</td>
<td>-</td>
<td></td>
<td>.24</td>
<td>.40</td>
<td>.07</td>
<td>.16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cat1</td>
<td>-</td>
<td></td>
<td>.37</td>
<td>.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cat2</td>
<td>-</td>
<td></td>
<td>.34</td>
<td>.49</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cat3</td>
<td>-</td>
<td></td>
<td>.59</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% FR = intensity of exposure to Frisian at home; FW DS = Forward Digit Span; BW DS = Backward Digit Span; cat = cognate category; [p ≤ .05], [p ≤ .01], [p ≤ .001]

Table 4-4. Bivariate correlations among all variables at Time 2

<table>
<thead>
<tr>
<th></th>
<th>SES</th>
<th>IQ</th>
<th>% FR</th>
<th>FW DS</th>
<th>BW DS</th>
<th>cat1</th>
<th>cat2</th>
<th>cat3</th>
<th>cat4</th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
<td>-.12</td>
<td>-.03</td>
<td>.10</td>
<td>.07</td>
<td>.13</td>
<td>.30</td>
<td>.40</td>
<td>.33</td>
<td>.16</td>
</tr>
<tr>
<td>SES</td>
<td>-</td>
<td>.04</td>
<td></td>
<td>.24</td>
<td>.13</td>
<td>.14</td>
<td>.09</td>
<td>.18</td>
<td>.06</td>
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<tr>
<td>IQ</td>
<td>-</td>
<td>-.01</td>
<td></td>
<td>.21</td>
<td>.27</td>
<td>-.08</td>
<td>.15</td>
<td>.12</td>
<td>.05</td>
</tr>
<tr>
<td>% FR</td>
<td>-</td>
<td>.02</td>
<td>-.12</td>
<td>.19</td>
<td>.41</td>
<td>.62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FW DS</td>
<td>-</td>
<td></td>
<td>.49</td>
<td>.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BW DS</td>
<td>-</td>
<td></td>
<td>.12</td>
<td>.28</td>
<td>.18</td>
<td>.12</td>
<td></td>
<td></td>
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<tr>
<td>cat1</td>
<td>-</td>
<td></td>
<td>.35</td>
<td>.18</td>
<td>.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cat2</td>
<td>-</td>
<td></td>
<td>.53</td>
<td>.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cat3</td>
<td>-</td>
<td></td>
<td>.54</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% FR = intensity of exposure to Frisian at home; FW DS = Forward Digit Span; BW DS = Backward Digit Span; cat = cognate category; [p ≤ .01], [p ≤ .001]
Table 4-5. Bivariate correlations among all variables at Time 3

<table>
<thead>
<tr>
<th></th>
<th>SES</th>
<th>IQ</th>
<th>% FR</th>
<th>FW DS</th>
<th>BW DS</th>
<th>cat1</th>
<th>cat2</th>
<th>cat3</th>
<th>cat4</th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
<td>-0.12</td>
<td>-0.03</td>
<td>0.10</td>
<td>0.12</td>
<td>0.10</td>
<td>0.28</td>
<td>0.25</td>
<td>0.15</td>
<td>0.24</td>
</tr>
<tr>
<td>SES</td>
<td>-</td>
<td>0.04</td>
<td></td>
<td>-0.24</td>
<td>0.17</td>
<td>0.15</td>
<td>0.07</td>
<td>0.25</td>
<td>0.12</td>
</tr>
<tr>
<td>IQ</td>
<td></td>
<td></td>
<td>-0.01</td>
<td></td>
<td>0.17</td>
<td></td>
<td>0.33</td>
<td>0.21</td>
<td>0.25</td>
</tr>
<tr>
<td>% FR</td>
<td>-</td>
<td>-0.04</td>
<td>0.00</td>
<td>-0.12</td>
<td>-0.10</td>
<td></td>
<td>0.45</td>
<td></td>
<td>0.59</td>
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<tr>
<td>FW DS</td>
<td>-</td>
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<td>0.27</td>
<td>0.07</td>
</tr>
<tr>
<td>BW DS</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.29</td>
<td>0.38</td>
<td>0.15</td>
</tr>
<tr>
<td>cat1</td>
<td>-</td>
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<td></td>
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<td>0.59</td>
<td>0.19</td>
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<td>cat2</td>
<td>-</td>
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<td>0.34</td>
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<tr>
<td>cat3</td>
<td>-</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

% FR = intensity of exposure to Frisian at home; FW DS = Forward Digit Span; BW DS = Backward Digit Span; cat = cognate category; \( p \leq 0.05 \), \( p \leq 0.01 \), \( p \leq 0.001 \)

Mixed models analysis

The research question of the current study was whether verbal working memory is related to the acquisition of cross-linguistic phonological regularities. We investigated this research question by examining whether the Backward Digit Span (verbal working memory) had a stronger effect on vocabulary items from cognate category (2) than on vocabulary items from cognate category (1), (3) and (4). In order to answer the research question we used a cumulative link mixed model. The mixed model was run, using the clmm function as implemented in the R package ordinal (Christensen, 2015). We entered Frisian receptive vocabulary accuracy as the ordered dependent variable, with 1 indicating a correct answer and 0 indicating an incorrect answer. We included random intercepts for Subject and Item, as both of these variables had repeated values. Including random intercepts would allow us to generalize the outcomes to the larger population of Frisian-Dutch bilingual children and to other items. A manual stepwise model selection procedure was carried out in which factors were added in such a way that the Akaike Information Criterion (AIC) was minimized. This procedure was applied with Category and Backward Digit Span as the main predictors of our study. In addition, the following predictors were added as control variables: Time, Frisian exposure at home, SES, IQ, Age and Forward Digit Span (verbal short-term memory). Time was added as an ordered factor, with \( 1 < 2 < 3 \). All of the predictors, except for Category, improved the model fit and were thus included in the final model. As expected, higher scores on exposure, SES, non-verbal IQ, age and Backward Digit Span were related to better
performance on Frisian receptive vocabulary. Time was not a significant predictor, but was added to the final model, as the AIC showed that it did improve the fit. Furthermore, it must be noted that the Forward Digit Span was only significant when the Backward Digit Span was not included in the model.

The model was further refined in an exploratory way by adding potential interactions between the predictors, including Category. This was done in order to increase the amount of explained variance, which would give a better focus on the variables of interest. Interactions between Category and Exposure, Category and Forward Digit Span, and Category and Backward Digit Span significantly improved the model fit and were therefore included in the final model. In order to examine the interaction effects in more detail, the model was run four times with different reference levels for Category (1, 2, 3, 4). We will first discuss the control interactions (Category × Exposure, Category × Forward Digit Span), followed by the interaction of interest (Category × Backward Digit Span). The interaction effect between Category and Exposure showed that the effect of Exposure on Frisian vocabulary was strongest for category (4), followed by category (3), category (2), and category (1) (4 > 3 > 2 > 1). The interaction effect between Category and Forward Digit Span showed that the effect of Forward Digit Span on Frisian vocabulary was significantly stronger for items from category (1) than for items from category (3) and (4), and stronger for items from category (2) than for items from category (4) (1 > 3, 4; 2 > 4). This shows that there was a gradual effect, although the effect of Forward Digit Span on two adjacent categories was never significantly different. Finally, we examined the interaction effect between Category and Backward Digit Span, which was the focus of the current study. The results showed that the Backward Digit Span had a significantly stronger effect on vocabulary items from category (2) than on vocabulary items from category (1), (3) and (4) (2 > 1, 3, 4). The results of the final model are reported in Table 4-6, with category (2) as the reference level, as this category was the focus of our study. Figure 4-1 shows the interaction effect between Category and Backward Digit Span. In this figure, it can be seen that the slope of category (2) is steeper than the slope of the other three categories.

As explained in the Method section, there were two items from category (3) that followed a more complex cross-linguistic phonological regularity. In order to check if these items affected the outcomes, the analyses described above were rerun without these items. The results showed that excluding these two items did not affect the outcomes.

<table>
<thead>
<tr>
<th>Effect</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>t-value</th>
<th>p-value</th>
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<td>Time.Linear</td>
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<td>0</td>
<td>.51</td>
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<td>Category 4</td>
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<td>.03</td>
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</tr>
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<td>Forward Digit Span</td>
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</tr>
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Table 4-6. Fixed effects from the final model with Frisian receptive vocabulary accuracy as dependent variable

<table>
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</tr>
<tr>
<td>Non-verbal IQ</td>
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</table>

*p < .05 | *p < .01 | *p < .001
Discussion

Previous research has shown that verbal working memory is related to the acquisition of grammar, but not vocabulary (e.g. Engel de Abreu & Gathercole, 2012; Verhagen & Leseman, 2016). This suggests that verbal working memory supports the acquisition of linguistic regularities. In the present study, we investigated this hypothesis by examining whether verbal working memory is also related to the acquisition of cross-linguistic phonological regularities, such as Frisian -âld [ɔ:lt] and Dutch -ould [aut], as in the cognate pairs kâld [kɔ:lt] - koud [kaut] ‘cold’ and wâld [wɔ:lt] - woud [waut] ‘forest’. In order to answer this question, 5- to 8-year-old Frisian-Dutch bilingual children were tested annually for a three-year period on verbal working memory and a Frisian receptive vocabulary task with four cognate categories: (1) identical cognates, (2) non-identical cognates that either do or (3) do not exhibit a phonological regularity between Frisian and Dutch, and (4) non-cognates. As age, non-verbal IQ (Rice & Hoffman, 2015), exposure (Pearson et al., 1997), SES (Rice & Hoffman, 2015) and verbal short-term memory (Engel de Abreu & Gathercole, 2012) have previously been shown to be related to vocabulary acquisition, these were also measured and included as control variables.

In line with previous studies, the results showed significant main effects of age, SES, non-verbal IQ and exposure on Frisian receptive vocabulary, with higher scores on these

\[ \text{Figure 4-1. Interaction effect between Category and Backward Digit Span on Frisian receptive vocabulary accuracy} \]
variables resulting in better vocabulary scores. Verbal short-term memory was only significant when verbal working memory was not included in the model. When a model was run that included both verbal short-term memory and verbal working memory, only verbal working memory came out as a significant predictor. This is probably due to the fact that, according to some definitions (Baddeley, 1986; Baddeley & Hitch, 1974), verbal short-term memory is part of verbal working memory. In addition to these main effects, we found interaction effects between cognate category and exposure, cognate category and verbal short-term memory, and cognate category and verbal working memory. As the first two interactions were only added as control variables to improve the model, we will not discuss these here, but instead concentrate on the interaction between cognate category and verbal working memory, which was the focus of the current study. The interaction between cognate category and verbal working memory showed that verbal working memory had a significantly stronger effect on cognate category (2) than on cognate category (1), (3) and (4). This suggests that verbal working memory supports the acquisition of regularities across the Frisian and Dutch phonological systems.

The finding that verbal working memory supports the acquisition of cross-linguistic phonological regularities is noteworthy for the following reasons. First, it provides psycholinguistic evidence for the existence of cross-linguistic phonological regularities (Rys, 2009; Sjölin, 1976; Taeldeman, 2013). Second, it confirms that bilingual children learn these regularities (Bosma et al., 2016) by showing that they do so on the basis of a general cognitive capacity, namely verbal working memory. Third, the results suggest that the acquisition of phonological regularities across languages shares important characteristics with the acquisition of grammatical rules within a language, which has previously been shown to be related to verbal working memory (Engel de Abreu & Gathercole, 2012; Gottardo et al., 1996; McDonald, 2008; Verhagen & Leseman, 2016). Fourth, as both the acquisition of grammar and the acquisition of cross-linguistic phonological regularities are related to verbal working memory, this suggests that verbal working memory plays a role in the acquisition of linguistic regularities.

As verbal working memory is a cognitive capacity that also supports non-linguistic categorization (Lewandowsky, 2011; Lewandowsky et al., 2012) and analogical reasoning (Waltz et al., 2000), our results fit well within Bybee’s (1995, 2001, 2008, 2010) usage-based network model, in which categorization and analogical reasoning are argued to be the general cognitive mechanisms that underlie the acquisition of linguistic regularities. Since words in the input co-activate semantically and phonologically similar words (Gonnerman et al., 2007),
the network model proposes that related words are stored as spatially proximate. As speakers categorize linguistic items for storage, so-called schemas arise that capture phonological and semantic generalizations about these items. Within this model, grammar is thus not seen as something that is separate from the lexicon, but rather as the structure that emerges from the complex network of phonological and semantic relations within the lexicon. When a speaker creates novel items based on analogy to existing patterns in the lexicon, the grammar becomes productive.

As Costa and colleagues (2005) already mentioned, the spreading of activation within the bilingual lexicon (Bosma et al., 2016; Dijkstra et al., 2010) is similar to the spreading of activation within the monolingual lexicon (Gonnerman et al., 2007), which implies that related words are stored together, regardless of whether they belong to the same or to a different language. This suggests that the acquisition of phonological regularities across languages shares important characteristics with the acquisition of grammatical relations within a language, as they are both generalizations that emerge from schemas of phonologically and semantically related words. Our finding that the acquisition of cross-linguistic phonological regularities is related to verbal working memory supports this suggestion, as previous research has shown that the acquisition of grammar is also related to verbal working memory (Engel de Abreu & Gathercole, 2012; Gottardo et al., 1996; McDonald, 2008; Verhagen & Leseman, 2016). In terms of Bybee’s network model, this parallel between cross-linguistic regularities and grammar suggests that verbal working memory plays a role in the formation of linguistic schemas through categorization and/or their productive use through analogy.

There are a number of limitations to the present study that are relevant to mention. First, although we only investigated the role of verbal working memory in the acquisition of cross-linguistic phonological regularities, other cognitive skills might play a role as well. An example of another skill that may influence the acquisition of cross-linguistic phonological regularities is phonological awareness, which is the conscious ability to detect and differentiate between the sounds of a word and to manipulate phonemes to create new words. Previous research has shown that phonological awareness positively influences reading and spelling acquisition, because children with high phonological awareness skills are better able to identify and use letter-sound correspondences (Ehri et al., 2001). In the same way, phonological awareness might help children to identify and use correspondences between the phonological systems of two languages.
A second limitation of the current study is that we investigated the acquisition of cross-linguistic phonological regularities in general, without zooming in on differences that might exist between different types of regularities. Within the network model, it is argued that the productivity of a regularity is to a large extent determined by its type frequency, that is, the number of items that follow that regularity. The more items a schema encompasses, the stronger it is, and the higher the likelihood that the pattern will be extended to novel items. Type frequency interacts with degree of schematicity, that is, the degree of dissimilarity of the members of a class. Highly schematic classes include a wide range of dissimilar items. For example, the English past tense has a high degree of schematicity, as it can be applied to all verbs, no matter their phonological form. In the network model, it is argued that a high type frequency in combination with a high degree of schematicity results in a maximally productive construction. For future research, it would be interesting to examine to what extent the acquisition of cross-linguistic phonological regularities depends on type frequency and degree of schematicity and whether type frequency and schematicity interact with verbal working memory.

Taken together, the main finding of this study is that verbal working memory is related to the acquisition of cross-linguistic phonological regularities. This supports the hypothesis that verbal working memory plays a role in the acquisition of linguistic regularities, thus providing more insight into the mechanisms that facilitate language acquisition.
Chapter 5

Language balance and cognitive advantages in Frisian-Dutch bilingual children

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Abstract
Previous research has shown that bilingual children outperform monolingual children on tasks that test executive functioning (EF) (e.g. Bialystok, 2009). The present study investigated the influence of language balance in terms of language proficiency on this bilingual EF advantage by comparing two groups of children that differ in balance of Frisian and Dutch. 30 Dutch-dominant bilingual children were compared to 30 balanced bilingual children on two attention tasks and two working memory tasks. The two groups were matched on age (5- and 6-year-olds), non-verbal IQ, socioeconomic status and Dutch language abilities. In contrast to many previous studies, the current study provided detailed information about the participants’ bilingual language proficiency. The balanced bilingual children outperformed the Dutch-dominant children on two of the four EF tasks, namely the selective attention task and the verbal working memory task. However, there was no significant difference between the two groups on interference suppression and visuospatial working memory. The results of this highly constrained study suggest that bilingual EF advantages are related to language balance, although variation was observed between the different EF tasks.
Abstract

Previous research has shown that bilingual children outperform monolingual children on tasks that test executive functioning (EF) (e.g. Bialystok, 2009). The present study investigated the influence of language balance in terms of language proficiency on this bilingual EF advantage by comparing two groups of children that differ in balance of Frisian and Dutch. 30 Dutch-dominant bilingual children were compared to 30 balance bilingual children on two attention tasks and two working memory tasks. The two groups were matched on age (5- and 6-year-olds), non-verbal IQ, socioeconomic status and Dutch language abilities. In contrast to many previous studies, the current study provided detailed information about the participants' bilingual language proficiency. The balanced bilingual children outperformed the Dutch-dominant children on two of the four EF tasks, namely the selective attention task and the verbal working memory task. However, there was no significant difference between the two groups on interference suppression and visuospatial working memory. The results of this highly constrained study suggest that bilingual EF advantages are related to language balance, although variation was observed between the different EF tasks.

Introduction

Previous research has shown that bilingual children outperform monolingual children on tasks that require executive control (e.g. Bialystok, 2009), which is an umbrella term for a range of different executive functions (EFs) that are used to control and regulate actions and thought. EFs comprise, for instance, switching between mental sets, inhibition of a prepotent response and updating or refreshing the content of the working memory (Miyake et al. 2000). In Baddeley’s (1986) model of the working memory, EFs are associated with the central executive, which enables to attend selectively to stimuli and ignore others. It has been argued that the management of two languages in one brain leads to the enhanced executive control system in bilinguals (e.g. Bialystok et al., 2004; Costa et al., 2009; Green, 1998). Since the two languages are co-activated (e.g. Van Hell & Dijkstra, 2002), bilinguals have a continuous training in selecting and inhibiting one of their two languages, which may result in a domain-general EF advantage. Previous research has shown that the bilingual executive control advantage is also observed in majority-minority language settings with closely related languages, such as Italian and Sardinian (Lauchlan, Parisi, & Fadda, 2012). However, not all studies have found a cognitive advantage for bilinguals (e.g. Duñabeitia et al. 2014) and many studies that did find the effect did not find it on all tasks (e.g. Gathercole et al. 2014; Lauchlan et al., 2012; see also De Bruin, Treccani, & Della Sala, 2015).

In various studies with children it has been suggested that bilingual EF advantages are moderated by bilingual proficiency and language balance. Carlson and Meltzoff (2008) found that 6 months of immersion in a second language (L2) were not enough for enhanced cognitive performance. On conflict tasks, the simultaneous bilinguals in their study performed better than both the monolinguals and the L2 learners. Poarch and Van Hell (2012b) observed that L2 learners’ EF performance was in between those of simultaneous bilinguals and monolinguals, and Bialystok and Barac (2012) found that length of time in an immersion program was related to performance on executive control tasks. In another study (Blom et al., 2014), bilingual children were tested twice, at age 5 and age 6. At age 6, proficiency in both languages had increased. Bilingual proficiency predicted verbal working memory for 6-year-old children, but not for 5-year-old children. Together with the fact that the effect size was larger at age 6 than at age 5, this suggests that enhanced cognitive control emerged when the children became more bilingually proficient. In a study with multilingual children, Videsott and colleagues (2012) found that highly proficient multilinguals outperformed less proficient multilingual children on an attention task, and Tse and Altarriba (2014) found that L2 proficiency, but not L1 proficiency, significantly predicted performance on attention and
working memory tasks. Furthermore, Crivello et al. (2016) showed that growth in toddlers’ bilingual proficiency, as measured by an increase in the number of translation equivalents, improved performance on a conflict task.

It is argued that more proficient, balanced bilinguals show more enhancement of executive control performance than less proficient, unbalanced bilinguals, since balanced bilinguals engage more often in language selection. Therefore, they probably have to deal with more competition between their two languages (Yow & Li, 2015). For example, the bilingual toddlers in Crivello et al’s study (2016) who had learned more translation equivalents had more experience with switching between their two lexicons than their peers who had learned less translation equivalents. However, most studies do not describe participants’ language proficiency in both languages in enough detail to be able to draw clear conclusions about the role of language balance on the bilingual cognitive effect (Treffers-Daller, 2015). The aim of the current study was to investigate the role of balance by comparing two matched groups that differ in balance of Frisian and Dutch with respect to several aspects of language proficiency.

Measurement of language balance
Different researchers have different views about what language balance is and how it should be measured. Some researchers define language balance as the relative proficiency in each language (e.g. Deuchar & Muntz, 2003; Unsworth, 2015), whereas others define it as the relative input (e.g. Argyri & Sorace, 2007; Méndez Pérez et al., 2010) or use of both languages (e.g. Dunn & Fox Tree, 2009). In the present study, we defined language balance in terms of language proficiency. Ideally, a balanced bilingual would be a bilingual who is equally proficient in both languages across different aspects of language, such as vocabulary and grammar, or speaking, writing, listening and reading. When talking about language balance in terms of proficiency, it is important to take into account different aspects of language, as it is almost never the case that a bilingual is perfectly balanced in all domains.

In the present study, the influence of language balance on EF was investigated by comparing two groups of bilinguals. These groups differed with respect to language balance in terms of relative proficiency in four aspects of language, capturing both expressive and receptive skills, namely morphology, receptive vocabulary and the production and comprehension of narratives.
The bilingual situation in Fryslân

The national majority language Dutch and the regional minority language Frisian are closely related West Germanic languages. They are spoken in the Dutch province of Fryslân, where both are recognized as official languages. Outside of the Netherlands, the regional language is known as West Frisian to avoid confusion with the Frisian languages spoken in Germany. In this article, whenever the term Frisian is used, it refers to the West Frisian language. Historically, Frisian is more closely related to English than to Dutch, but over the course of time, Dutch and Frisian have converged, while English and Frisian have diverged (Gooskens & Heeringa, 2004). As a result, Frisian and Dutch share a large part of their vocabularies nowadays.

Both languages are firmly anchored in the Frisian society, especially in the rural areas, but Dutch is the dominant language in formal domains and Frisian is predominantly used in informal domains (Breuker, 2001). In a survey, more than half of the population of Fryslân reported to speak Frisian as a mother tongue and a bit less than half of the inhabitants reported to speak Frisian at home with his/her partner and children. The majority of the population (66.6%) speaks Frisian well. However, most people are not literate in Frisian, since there are only few people (14.5%) who can write the language well (Provinsje Fryslân, 2015).

In education, Dutch is the dominant language, although Dutch-Frisian bilingual schools have been legally allowed since 1955 (Mercator, 2007) and more and more primary schools are becoming trilingual (Dutch, Frisian and English) in the Trijetalige skoalle (‘trilingual school’) project (Van Ruijven & Ytsma, 2008). At the end of primary school, all pupils take the national test on Dutch language as developed by the Dutch national test institute Cito. For Frisian as a subject, however, the educational goals depend on the pupils’ linguistic backgrounds and competences. For children who speak Frisian at home the goals are higher than for children who speak Dutch at home (Mercator, 2011). As a result, most children who speak Frisian at home become proficient in both Frisian and Dutch, whereas most children who speak Dutch at home do not become proficient in Frisian (Dijkstra, 2013; Ytsma, 1995). Dijkstra (2013) showed that by the time native Frisian children enter primary school, they perform similarly to their native Dutch peers with respect to Dutch receptive vocabulary, the number of different words they produce in Dutch and the length of their Dutch utterances.
The present study

For the present study we investigated the influence of language balance on the bilingual EF advantage. More specifically, we investigated whether a group of Frisian-Dutch balanced bilingual children outperformed a group of Dutch-dominant bilingual children on EF tasks that require attention (Engel de Abreu, Cruz-Santos, Tourinho, Martin, & Bialystok, 2012; Martin-Rhee & Bialystok, 2008) and working memory (Blom et al., 2014; Morales, Calvo, & Bialystok, 2013). The balanced group was defined as children whose proficiency in Frisian and Dutch did not differ significantly and the Dutch-dominant group was defined as children who scored significantly better on Dutch than on Frisian language tasks. The research question is formulated in (1).

(1) Do balanced Frisian-Dutch bilingual children perform better on tasks testing attention and working memory than Dutch-dominant Frisian-Dutch bilingual children?

It was hypothesized that language balance plays a role here. Balanced Frisian-Dutch bilinguals were expected to perform better than Dutch-dominant children on both attention and working memory, since the balanced bilinguals probably have to deal with more competition between their two languages.

Method

Participants

In total, 122 5- and 6-year-old children were tested. All participants lived in the countryside of the Dutch province of Fryslân and were recruited through 14 schools. All children had some knowledge of both Frisian and Dutch, as both languages are spoken in the region, but they differed substantially with respect to language balance. Language balance was defined in terms of relative proficiency in Frisian and Dutch on four aspects of language: morphology, receptive vocabulary and the production and comprehension of narratives. Some children were more or less equally proficient in both languages, whereas others were clearly more proficient in one of the two, most often Dutch. For the purpose of this study, we selected those children who were on the two extremes of the scale: the most balanced children were compared to the least balanced children. This led to a sample that consisted of 30 balanced bilingual children and 30 Dutch-dominant children (16 girls and 14 boys in each group). As children from the same classroom were assigned to different groups, the two groups differed
minimally with respect to education. The participant characteristics of the two groups are shown in Table 5-1.

The two groups of participants were selected as follows. The production part of the Dutch and Frisian version of the Multilingual Assessment Instrument for Narratives (MAIN; Gagarina et al., 2012) was used to select children who were able to tell a story in Dutch, but not in Frisian. From this group, 30 children were selected whose accuracy at using Dutch morphology ($M = 16.90, SD = 2.91$) was significantly better than their accuracy at using Frisian morphology ($M = 6.33, SD = 3.02$), $t(29) = 16.53, p < .001, d = 3.56$. Morphology was thought to be the best measure for this selection, since it has been shown that Dutch children experience great difficulty with the acquisition of more structural aspects of Frisian, in contrast to vocabulary, which is easier to acquire due to similarities with Dutch (Ytsma, 1995). Dutch morphology was measured with the subtest Word Formation of the Taaltoets Alle Kinderen (TAK; “Language assessment all children”, Verhoeven & Vermeer, 2002) and Frisian morphology was measured with a Frisian morphology task developed for the purpose of this project. Like the TAK Word Formation test, the Frisian morphology test contained items testing noun plural and past participle formation (see Blom & Bosma, 2016).

These 30 Dutch-dominant children were matched on age and Dutch morphology scores to 30 children who were able to tell a story in both languages and whose Dutch and Frisian morphology scores were comparable. This second group will be referred to as ‘balanced bilinguals’, i.e. bilinguals with a ‘relative similarity’ in proficiency across their two languages. The two groups were matched on Dutch morphology scores to make sure that they did not differ with respect to expressive language abilities. Regarding Dutch morphology, the scores of the Dutch-dominant children ($M = 16.90, SD = 2.91$) were comparable to the scores of the balanced bilingual children ($M = 16.00, SD = 2.52$), $t(58) = 1.28, p = .20, d = 0.33$, but with respect to Frisian morphology, the Dutch-dominant children ($M = 6.33, SD = 3.02$) performed significantly worse than the balanced bilingual children ($M = 16.30, SD = 3.10$), $t(58) = -12.62, p < .001, d = -3.26$. The balanced bilinguals’ scores on Dutch and Frisian morphology were comparable, $t(29) = -.63, p = .53, d = -0.11$.

Further analyses of the language abilities of the children showed that the two groups also performed similarly on other Dutch language tasks: the production of Dutch narratives (MAIN; Blom & De Jong, 2013; Gagarina et al. 2012), Dutch-dominant ($M = 7.90, SD = 1.71$), balanced ($M = 8.40, SD = 1.83$), $t(58) = -1.09, p = .28, d = -0.28$, Dutch receptive vocabulary (PPVT-III-NL; Dunn & Dunn, 1997; Schlichting, 2005), Dutch-dominant ($M = 92.27, SD = 8.59$), balanced ($M = 95.03, SD = 7.46$), $t(58) = -1.33, p = .19, d = -0.34$, and the
comprehension of Dutch narratives (MAIN; Blom & De Jong, 2013; Gagarina et al. 2012), Dutch-dominant (M = 9.57, SD = 0.77), balanced (M = 9.40, SD = 0.89), t(58) = 0.77, p = .44, d = 0.20. The Dutch-dominant bilinguals (M = 83.50, SD = 11.53) scored significantly worse than the balanced bilinguals (M = 93.97, SD = 5.33) on Frisian receptive vocabulary, t(58) = -4.51, p < .001, d = -1.17, and the Dutch-dominant bilinguals (M = 6.87, SD = 2.36) also performed significantly worse than the balanced bilinguals (M = 9.17, SD = 0.99) on the comprehension of Frisian narratives, t(58) = -4.93, p < .001, d = -1.27. Frisian receptive vocabulary was measured with a Frisian receptive vocabulary task developed for the purpose of this project and the comprehension of Frisian narratives was measured with a translation of the MAIN. Intragroup statistical analyses showed that the balanced bilinguals performed similarly on the Frisian and Dutch versions of all the language tasks, (p = .08 to p = .53). In contrast, the Dutch-dominant bilinguals performed significantly better on the Dutch versions (p < .001) of the language tasks.

The two bilingual groups did not differ with respect to age, t(58) = -0.35, p = .72, d = -0.09, socioeconomic status (SES), t(58) = 1.15, p = .25, d = 0.30, and non-verbal IQ, t(58) = -0.61, p = .54, d = -0.16. Non-verbal IQ was estimated with the subsets Matrices and Recognition of the Wechsler Nonverbal Scale of Ability (WNV; Wechsler & Naglieri, 2006). SES scores and information about intensity of exposure to Frisian and Dutch were obtained through a parental questionnaire, based on the Questionnaire for Parents of Bilingual Children (PaBiQ) (COST Action IS0804, 2011; Tuller, 2015). SES was defined as the average educational level of the parents on a 9-point scale, ranging from no education to a university degree, which captures the Dutch educational system in a fine-grained manner.

The two groups differed with respect to intensity of exposure to Frisian at home. The Dutch-dominant children (M = 24%, SD = 18) had a lower intensity of exposure to Frisian at home than the balanced bilingual children (M = 79%, SD = 15), t(58) = -13.08, p < .001, d = -3.38. In the Netherlands, children go to school from the age of four and most children go to Dutch or bilingual Dutch-Frisian daycare, so the children in the sample had already received Dutch in school for some time when they were tested. Intensity of exposure to Frisian was measured as the mean percentage of Frisian input that the child received from his/her mother, father, siblings and other adults who looked after the child regularly. For each of these people we wanted to know how often he or she spoke Frisian and Dutch to the child. Possible answers were ‘never’ (0%), ‘seldom’ (25%), ‘sometimes’ (50%), ‘usually’ (75%) and ‘always’ (100%).
Table 5-1. Mean and standard deviation characteristics of the Dutch-dominant and the balanced bilingual children

<table>
<thead>
<tr>
<th>Measure</th>
<th>Dutch-dominant children (n = 30)</th>
<th>Balanced bilingual children (n = 30)</th>
<th>Maximum score</th>
<th>t(58)</th>
<th>p</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in months</td>
<td>70 (7)</td>
<td>70 (6)</td>
<td>-0.35</td>
<td>.73</td>
<td>-0.09</td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>7.30 (1.3)</td>
<td>6.90 (1.1)</td>
<td>9</td>
<td>1.15</td>
<td>.25</td>
<td>0.30</td>
</tr>
<tr>
<td>IQ</td>
<td>105 (16)</td>
<td>108 (15)</td>
<td>-0.61</td>
<td>.54</td>
<td>-0.16</td>
<td></td>
</tr>
<tr>
<td>% Frisian at home</td>
<td>24 (18)</td>
<td>79 (15)</td>
<td>-13.07</td>
<td>&lt; .001</td>
<td>-3.38</td>
<td></td>
</tr>
</tbody>
</table>

Expressive language

<table>
<thead>
<tr>
<th>Measure</th>
<th>Dutch morphology</th>
<th>Frisian morphology</th>
<th>Dutch narrative prod</th>
<th>Frisian narrative prod</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16.90 (2.91)</td>
<td>6.33 (3.02)</td>
<td>7.90 (1.71)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.52)</td>
<td>(3.10)</td>
<td>(1.83)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>24</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.28</td>
<td>-12.62</td>
<td>-1.09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.20</td>
<td>&lt; .001</td>
<td>.28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.33</td>
<td>-3.26</td>
<td>-0.28</td>
<td></td>
</tr>
</tbody>
</table>

Receptive language

<table>
<thead>
<tr>
<th>Measure</th>
<th>Dutch receptive voc</th>
<th>Frisian receptive voc</th>
<th>Dutch narrative comp</th>
<th>Frisian narrative comp</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>92.27 (8.59)</td>
<td>83.50 (11.53)</td>
<td>9.57 (0.77)</td>
<td>6.87 (2.36)</td>
</tr>
<tr>
<td></td>
<td>(7.46)</td>
<td>(5.33)</td>
<td>(0.89)</td>
<td>(0.99)</td>
</tr>
<tr>
<td></td>
<td>144</td>
<td>144</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>-1.33</td>
<td>-4.51</td>
<td>0.77</td>
<td>-4.93</td>
</tr>
<tr>
<td></td>
<td>.19</td>
<td>&lt; .001</td>
<td>.44</td>
<td>&lt; .001</td>
</tr>
<tr>
<td></td>
<td>-0.34</td>
<td>-1.17</td>
<td>0.20</td>
<td>-1.27</td>
</tr>
</tbody>
</table>

SES = socio-economic status; prod = production; voc = vocabulary; comp = comprehension; p < .001

Attention measures

Selective attention was measured with the Sky Search task from the Test of Everyday Attention for Children (TEA-Ch; Manly, Robertson, Anderson, & Nimmo-Smith, 1998). The test comprised an A3 sheet displaying 128 pairs of spaceships, 20 of them being identical. The participants’ task was to encircle these 20 target spaceship pairs as quickly as possible, ignoring the non-identical distractor pairs. The second part of the task consisted of a motor-control version of the test. The participants were given a new A3 sheet without distractors, containing only the 20 target pairs. The attention score of the Sky Search task was calculated by taking the mean time per target in both versions of the task, and subtracting the motor-control time in the second part of the task from the target time in the first part of the task. In this way, differences between children could not be due to differences in motor skills. Note that on this task, lower scores indicated better performance.

Interference suppression was measured with the Flanker task from Engel de Abreu et al. (2012), who adapted the task from Rueda et al. (2004). On a laptop, participants were
presented displays with a horizontal row of five equally spaced yellow fishes. They had to indicate the direction of the central fish by pressing a left or right response button on the laptop’s keyboard, thus ignoring the four flanking fishes. Half of the trials were congruent, i.e. the flanker fishes pointed in the same direction as the target fish. The other half of the trials were incongruent, i.e. the flanker fishes pointed in the opposite direction. Each trial started with a 1000 ms fixation cross in the middle of the screen, after which the row of fishes was presented during 5000 ms or until a response is given. This was followed by 2500 ms feedback and a blank interval of 400 ms. The task consisted of eight practice trials and two blocks of 20 trials in which congruent and incongruent trials were randomized. Reaction times (RTs) and accuracy (ACC) were recorded. Incorrect responses (n = 198), correct responses with RTs below 200 ms (n = 4) and correct responses with RTs above three standard deviations of children’s individual congruent (n = 12) and incongruent means (n = 7) were excluded from the analyses (9.2% of trials). The measure that we were particularly interested in was the difference between the RTs of the incongruent trials and the RTs of the congruent trials (Flanker effect), since this measure controlled for general speed of responding.

**Working memory measures**

Verbal and visuospatial working memory measures were based on the *Alloway Working Memory Assessment* (AWMA; Alloway, 2012) and translated to Dutch. Two tasks were selected: the Backward Digit Span task for verbal working memory and the Backward Dot Matrix task for visuospatial working memory. In the Backward Digit Span task, the children had to repeat sequences of digits in reversed order. In the Backward Dot Matrix task, children were shown sequences of blue dots appearing in a 4 x 4 matrix on a computer screen. Each dot appeared on the computer screen for 2 seconds and after the last dot of the trial the child’s task was to recall the coordinates of the dots. Instructions were provided in Dutch, which all children understood. It was assumed that all children were able to count to ten in Dutch, since Dutch is the main language of education. The AWMA procedure was applied for scoring. Trials were scored as incorrect if the sequence was incorrect, if children recalled one or more digits/dots incorrectly, or if they omitted one or more of the digits/dots. There was a maximum score of 6 points per block. After three incorrect trials within one block the task stopped. When the child repeated the first four trials within one block correctly, he or she automatically continued with the next block and received a score of 6. The scores could range from 0 to 36 for the Dot Matrix and from 0 to 42 for the Digit Span, so there were six and seven blocks respectively.
**Procedure**

Children were tested in a quiet room at their school by the first author or a research assistant, who both had a native level command of Dutch and Frisian. There were two sessions with a minimum of 5 days between the two to minimize influence from the Frisian language tests in the first session on the Dutch language tests in the second session. Each testing session lasted approximately 60 minutes, including tasks that are not reported in the current study. The language tasks and cognitive tasks reported on in this study were administered in the following order: Frisian receptive vocabulary, Frisian morphology, Frisian MAIN, Digit Span, Sky Search and Flanker in the first session; Dutch receptive vocabulary, Dutch morphology, Dot Matrix and Dutch MAIN in the second session. The experimenters controlled their use of Frisian and Dutch during the language tasks by only speaking the target language to the child. In case the child was unable to speak the target language, (s)he was allowed to answer in the other language.

**Results**

Correlations between the cognitive tasks are reported in Table 5-2. As we expected, the results of the two working memory measures, the Backward Digit Span and the Backward Dot Matrix, were correlated, \( r(60) = .47, p < .001 \). However, in contrast to what we expected, the results of the two attention tasks, the Sky Search and the Flanker, were not, \( r(60) = .05, p = .71 \). Descriptive statistics for all cognitive measures are reported in Table 5-3. The two functions that we were interested in are attention, measured with the attention score of the Sky Search task and the difference between the incongruent and congruent RTs of the Flanker task, and working memory, measured with the Backward Digit Span and the Backward Dot Matrix. Four ANOVAs were conducted with the cognitive measures as dependent variables and bilingual group as between-subject variable. On the Sky Search task, the balanced bilingual children \( (M = 7.82, SD = 3.97) \) outperformed the Dutch-dominant children \( (M = 11.97, SD = 7.74) \), \( F(1,58) = 6.83, p = .01, \eta^2_p = .11 \). On the Flanker task, the difference between the incongruent and congruent RTs of the balanced bilingual children \( (M = 165, SD = 334) \) did not differ statistically from those of the Dutch-dominant children \( (M = 174, SD = 234) \), \( F(1,58) = 0.01, p = .91 \). On the Backward Digit Span, the balanced bilingual children \( (M = 13.93, SD = 2.57) \) performed significantly better than the Dutch-dominant children \( (M = 11.97, SD = 7.74) \) with a maximum score of 6 points per block. After three incorrect trials within one block the task was to recall the coordinates of the dot appeared on the computer screen for 2 seconds and after the last dot of the trial the child's answers were scored as correct if the sequence was incorrect, if children recalled one or more digits/dots incorrectly, or if they omitted one or more of the digits/dots. There was a minimum of 60 minutes, including tasks that are not reported in the current study. The language tasks and cognitive tasks reported on in this study were administered in the following order: Frisian receptive vocabulary, Frisian morphology, Frisian MAIN, Digit Span, Sky Search and Flanker in the first session; Dutch receptive vocabulary, Dutch morphology, Dot Matrix and Dutch MAIN in the second session. The experimenters controlled their use of Frisian and Dutch during the language tasks by only speaking the target language to the child. In case the child was unable to speak the target language, (s)he was allowed to answer in the other language.

---

1 In the second session, an extra task was included which is not part of the present study. As this task was challenging for the children, we decided to administer it at the beginning of the second session. We wanted to make sure that the Digit Span task in the first session and the Dot Matrix task in the second session were administered after about the same amount of time. Therefore, the Dutch MAIN was administered after the Dot Matrix.
Chapter 5

12.50, SD = 2.78), $F(1, 58) = 4.30, p = .04, \eta^2 = .07$. We did not apply a Bonferroni correction here, as Perneger (1998) argues that this correction should not be used when assessing evidence about specific hypotheses. On the Backward Dot Matrix, there was no significant difference between the balanced bilingual children ($M = 13.70, SD = 3.91$) and the Dutch-dominant children ($M = 13.63, SD = 4.58$), $F(1, 58) < .01, p = .95$.

**Table 5-2. Correlations between the cognitive measures**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Flanker effect</th>
<th>BW Digit Span</th>
<th>BW Dot Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sky Search</td>
<td>.05</td>
<td>-.19</td>
<td>-.22</td>
</tr>
<tr>
<td>Flanker effect</td>
<td>-</td>
<td>-.21</td>
<td>-.14</td>
</tr>
<tr>
<td>BW Digit Span</td>
<td>-</td>
<td>-</td>
<td>.47</td>
</tr>
</tbody>
</table>

$p < .001$

**Table 5-3. Descriptive statistics for cognitive task measures by language group**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Dutch-dominant children ($n = 30$)</th>
<th>Balanced bilingual children ($n = 30$)</th>
<th>$F(1, 58)$</th>
<th>$p$</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sky Search$^1$</td>
<td>11.97 (7.74)</td>
<td>7.82 (3.97)</td>
<td>6.83</td>
<td>.01</td>
<td>.11</td>
</tr>
<tr>
<td>Flanker effect</td>
<td>174 (234)</td>
<td>165 (334)</td>
<td>0.01</td>
<td>.91</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>BW Digit Span</td>
<td>12.50 (2.78)</td>
<td>13.93 (2.57)</td>
<td>4.30</td>
<td>.04</td>
<td>.07</td>
</tr>
<tr>
<td>BW Dot Matrix</td>
<td>13.63 (4.58)</td>
<td>13.70 (3.91)</td>
<td>&lt; .01</td>
<td>.95</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

$^1$ On the Sky Search and the Flanker task, lower scores indicate better performance. On the other tasks, higher scores indicate better performance. RT = reaction times; inc = incongruent; con = congruent; BW = backward;

Discussion

The goal of the present study was to investigate the role of language balance on the bilingual EF advantage. We investigated whether there is a difference between balanced Frisian-Dutch bilingual children and Dutch-dominant bilingual children with respect to EF. More specifically, we investigated whether the balanced Frisian-Dutch bilingual children outperformed the Dutch-dominant bilingual children on EF tasks that require attention and working memory. These groups differed statistically with respect to language balance in terms of proficiency, as measured by several Frisian and Dutch language tasks testing morphology, receptive vocabulary and the production and comprehension of narratives. On
all tasks, the balanced bilinguals were equally proficient in Dutch and Frisian, but the Dutch-
dominant bilinguals performed significantly better on the Dutch tasks than on the Frisian
tasks. The dominant home language of the balanced bilingual children was Frisian, whereas
the dominant home language of the Dutch-dominant children was Dutch. Since the dominant
language in education is Dutch, the former group could become equally proficient in both
languages, whereas the latter did not become as proficient in Frisian as they were in Dutch.
As the two groups differed minimally with respect to age, non-verbal IQ, SES, education and
Dutch language skills, the risk of confounding variables was reduced to a minimum.

The results of this study are mixed for both attention and working memory. They show
some evidence for an EF advantage for balanced bilingual children, but the effects are small
to medium and are not found on all tasks. With respect to attention, the balanced bilinguals
outperformed the Dutch-dominant bilinguals on the Sky Search task, but not on the Flanker
task. On verbal working memory, as measured with the Backward Digit Span task, the
balanced bilinguals performed significantly better than the Dutch-dominant bilinguals. There
was no significant difference between the two groups with respect to visuospatial working
memory as measured with the Backward Dot Matrix task. Thus, it can be concluded that our
hypothesis was confirmed for selective attention and for verbal working memory, but not for
interference suppression and visuospatial working memory.

The mixed results in our study are in line with mixed results in previous studies (e.g.
Gathercole et al., 2014; Lauchlan et al., 2012; see also De Bruin, Treccani, & Della Sala,
2015). In fact, the results are both consistent with studies that do show effects (e.g. Blom et
al., 2014; Engel de Abreu et al., 2012) and studies that do not (e.g. Duñabeitia et al., 2014).
The reasons for these inconsistencies in the literature, as well as the mixed results in the
present study, remain as yet unclear. With respect to the present study, it is important to bear
in mind that we did not compare the two groups to monolingual children. It could be that
some measures did not show a significant difference between the two groups, because the
Dutch-dominant children might also have a small EF advantage in comparison to monolingual
children. This brings us to a second point. Like in studies that compare bilinguals to
monolinguals, the results of our study show that the effect of bilingualism is task-dependent.
An explanation for this observation can only be speculated about. Research has provided
evidence for EF as a construct that consists of interrelated but distinct components (Miyake et
al., 2000) with somewhat different developmental trajectories for the different components
(Best & Miller, 2010). Hence, bilingualism may influence certain EF components more than
others (Martin-Rhee & Bialystok, 2008) and effects of bilingualism may surface at different
ages for different components, necessitating a longitudinal and multidimensional approach to the effect of bilingual proficiency on children’s cognitive development.

Although the results do not show an effect on all cognitive tasks, the present study provides some evidence that bilingual EF advantages are moderated by language balance. This is in line with previous evidence that the cognitive bilingual advantage develops as a function of growing bilingual proficiency (Bialystok & Barac, 2012; Blom et al., 2014; Carlson & Meltzoff, 2008; Crivello et al., 2016; Poarch & Van Hell, 2012b; Tse & Altarriba, 2014; Videsott et al., 2012). In contrast to previous studies, the current study provided detailed information about the participants’ bilingual language proficiency, taking into account several language tasks, capturing both expressive and receptive skills. Since the participants of the present study were carefully selected in terms of (un)balanced bilingual language proficiency and since the two groups of bilinguals differed minimally with respect to age, SES, non-verbal IQ, education and Dutch language skills, the differences in EF between the two groups can be attributed to language balance. The EF advantage for balanced bilinguals could be explained by a higher competition between the two languages.

The results of this highly constrained study partially confirm that bilingualism enhances children’s EF development (e.g. Bialystok, 2009). The main finding of the study is that bilingual EF advantages are related to language balance to some extent. The balanced Frisian-Dutch bilinguals in this study outperformed the Dutch-dominant bilinguals on two of the four EF tasks. However, we would like to stress that the differences between the two groups were moderate and inconsistent: the task that showed the biggest effect, the selective attention task, had a small to medium effect size. Therefore, we would like to conclude that the cognitive advantage of bilingualism should not be overstated. The biggest advantage of bilingualism is the ability to speak two languages, rather than the cognitive effects discussed in the present and previous studies.
Chapter 6

The short-lived effects of minority language exposure on the executive functions of Frisian-Dutch bilingual children

An adapted version of this chapter will be published as:

Chapter 6

**Abstract**

Various studies have shown that bilingual children need a certain degree of proficiency in both languages before their bilingual experiences enhance their executive functioning (EF). In the current study, we investigated if degree of bilingualism in Frisian-Dutch bilingual children influenced EF and if this effect was sustained over a three-year period. To this end, longitudinal data were analyzed from 120 Frisian-Dutch bilingual children who were 5 or 6 years old at the first time of testing. EF was measured with two attention and two working memory tasks. Degree of bilingualism was defined as language balance based on receptive vocabulary and inflectional morphology scores in both languages. In a context with a minority and a majority language, such as the Frisian-Dutch context, chances for becoming proficient in both languages are best for children who speak the minority language at home. Therefore, in a subsequent analysis, we examined whether minority language exposure predicted language balance and whether there was a relationship between minority language exposure and EF, mediated by language balance. The results showed that intensity of exposure to Frisian at home, mediated by language balance, had an impact on one of the attention tasks only. It predicted performance on this task at time 1, but not at time 2 and 3. This partially confirms previous evidence that the cognitive effects of bilingualism are moderated by degree of bilingualism and reveals that substantial minority language exposure at home indirectly affects bilingual children’s cognitive development. However, the findings also demonstrate that the effect of bilingualism on EF is limited and unstable.
The short-lived effects of minority language exposure on executive functioning

Introduction

The benefits of being proficient in two languages extend beyond the domain of language itself. Various studies have shown that bilingualism improves executive functioning (EF) (Adesope et al., 2010), a term which covers a broad range of cognitive functions that are used to control and regulate actions and thought (Miyake et al., 2000). Previous findings show that the cognitive effects of bilingualism are not found in all bilinguals, but require a sufficient degree of bilingualism (e.g. Bialystok & Barac, 2012).

In a bilingual context with two majority languages, more or less equal exposure to both languages at home provides the best basis for becoming a proficient bilingual. For example, in Quebec, children who had been exposed equally to French and English scored similarly to monolingual children on receptive vocabulary tests in each language (Thordardottir, 2011). However, in a bilingual context with a minority and a majority language the situation is different. A minority language is a language that is different from the language used by the majority of the inhabitants of a given country and that is spoken by a non-dominant group, who wish to maintain their own linguistic, and usually also cultural, identity (Hogan-Brun & Wolff, 2003). In such a context, a larger amount of home input in the minority language improves the chances for a high degree of bilingualism. For example, in Wales, all children become proficient speakers of English, regardless of their home language situation. Proficiency in Welsh, in contrast, depends on the amount of input in Welsh at home and at school (Gathercole & Thomas, 2009). In the United States, Spanish-English bilingual children’s development of Spanish receptive vocabulary is influenced by the amount of input at home, whereas this is not the case for the development of English receptive vocabulary (Hammer, Davison, Lawrence, & Miccio, 2009).

In the current study, we first investigated whether there is an effect of degree of bilingualism on EF in a group of Frisian-Dutch bilingual children, and whether this effect is maintained over time. Second, we examined whether there is an effect of Frisian exposure on EF that is mediated by degree of bilingualism. In what follows, we will first introduce the debate on bilingualism and EF. Subsequently, we will provide more information about the Frisian-Dutch bilingual context.

Cognitive effects of bilingualism

Several studies have shown that bilingual children outperform monolingual children on EF (Adesope et al., 2010). Two EF components that have found to be enhanced in bilinguals are attention (Engel de Abreu et al., 2012; Martin-Rhee & Bialystok, 2008) and working memory.
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Attention is the ability to focus on category-relevant aspects of the stimuli while ignoring category-irrelevant ones (Gazzaley & Nobre, 2012). Working memory refers to the capacity to store and manipulate information (Baddeley, 2007). The mechanism that is argued to lead to enhancement of EF in bilinguals is the monitoring of two co-activated languages in the brain. According to some researchers, the central process of this mechanism is inhibition of interference from the non-target language (Green, 1998), whereas others suggest that it is attention to the target language (Chung-Fat-Yim et al., 2016; Costa et al., 2006). In any case, it is argued that this linguistic practice of inhibition/attention generalizes to other, non-linguistic, domains, resulting in the bilingual EF advantage (Bialystok et al., 2004; Chung-Fat-Yim et al., 2016; Costa et al., 2009; Green, 1998). Previous studies have also found cognitive effects of bilingualism in majority-minority language settings with closely related languages, such as Italian and Sardinian (Garraffa et al., 2015; Lauchlan et al., 2012) and Cypriot Greek and Standard Modern Greek (Antoniou et al., 2016).

Although many studies have reported cognitive effects of bilingualism, these effects are not consistently replicated (e.g. Antón et al., 2014; Duñabeitia et al., 2014), thus calling into question the robustness of the bilingual advantage (Ross & Melinger, 2016). Most research on this topic has taken a cross-sectional approach, comparing monolinguals to bilinguals at one single point in time. However, group comparisons can never completely exclude the possibility of confounds (Woumans & Duyck, 2015). For example, as monolinguals and bilinguals often come from different cultural backgrounds, it can be difficult to disentangle effects of culture (Oh & Lewis, 2008) from effects of bilingualism. As confounds can lead to misinterpretations, this is a potential reason for inconsistencies in the literature.

One way to overcome the problem of confounds is to avoid group comparisons and to treat bilingualism as a continuous, rather than as a binary variable. After all, bilingualism is not a matter of all or none, but comes in different degrees (Luk & Bialystok, 2013). Treating bilingualism as a gradient furthermore allows investigating if the effect of bilingualism on EF is moderated by degree of bilingualism. As the bilingual cognitive advantage is argued to arise from maintaining attention to the appropriate language system, the extent of this advantage should depend on how much effort is needed to monitor the two language systems. Since bilinguals with equal proficiency in both languages have to deal with a more active second language than bilinguals with unequal proficiency, it is thought that bilinguals with equal proficiency need more effort to maintain attention to the appropriate language system (Yow & Li, 2015).
Defining degree of bilingualism

Various studies with children found support for the effect of degree of bilingualism on EF (Bialystok & Barac, 2012; Blom et al., 2014; Bosma, Blom, & Versloot, 2017; Crivello et al., 2016; Poarch & Van Hell, 2012b; Prior, Goldwasser, Ravet-Hirsh, & Schwartz, in press; Thomas-Sunesson, Hakuta, & Bialystok, 2016; Tse & Altarriba, 2014; Videsott et al., 2012). While some of these studies defined degree of bilingualism in terms of language balance (Bosma et al., 2017; Prior et al., in press; Thomas-Sunesson et al., 2016), other studies defined it in terms of bilingual proficiency (Blom et al., 2014; Crivello et al., 2016; Tse & Altarriba, 2014; Videsott et al., 2012). Bilingual proficiency refers to the absolute and relative level of proficiency in both languages, while language balance only concerns the relative proficiency. These two constructs are related, because a high degree of bilingual proficiency implies a high degree of balance. However, they are not the same, because the reverse is not true. A high degree of balance does not necessarily imply a high degree of bilingual proficiency, since a child can be balanced with poor proficiency in both languages.

Following Yow and Li’s (2015) argument, balanced bilingual children with low proficiency in both languages are also thought to benefit from their bilingualism. This is one reason to define degree of bilingualism in terms of language balance rather than bilingual proficiency. Another reason is that previous research has shown that language proficiency in monolingual children also predicts EF (Bohlmann, Maier, & Palacios, 2015; Fuhs & Day, 2011; Hughes & Ensor, 2007; Kuhn, Willoughby, Vernon-Feagans, Blair, & The Family Life Project Key Investigators, 2016), an observation that has so far not been taken into account in studies on the cognitive effects of bilingualism (but see Bohlman et al., 2015). However, it implies that defining degree of bilingualism in terms of bilingual proficiency could create the risk that an observed effect of bilingual proficiency on EF is not an effect of bilingualism, but (partially) an effect of language proficiency that is independent of bilingualism. Therefore, it may be better to define degree of bilingualism in terms of language balance, because this measure does not include language proficiency.

In a recent study based on a subsample of the Frisian-Dutch bilingual children in the current study, we found that a group of 5- and 6-year-old balanced bilingual children outperformed a group of Dutch-dominant bilingual peers on a selective attention and a verbal working memory task, but not on an interference suppression and a visuospatial working memory task (Bosma et al., 2017). In this previous study, children from the same classroom were assigned to either a balanced or a Dutch-dominant group. These two groups were matched on age, socioeconomic status (SES), non-verbal IQ scores and Dutch language
abilities. By selecting matched groups we could exclude confounding variables, but also reduced the sample size and lost the precision of graduality. Therefore, in the present study, the full sample was included and degree of bilingualism was defined as a continuous variable. In doing so, we followed other studies in which children’s degree of bilingualism was defined in one of the following ways: as L2 proficiency (Tse & Altarriba, 2014), as the length of time in an immersion program (Bialystok & Barac, 2012), as a formula for language balance based on children’s receptive vocabulary scores in both languages (Thomas-Sunesson et al., 2016), as a formula for bilingual proficiency based on children’s receptive vocabulary scores in both languages (Blom et al., 2014), or as growth in the number of non-cognate translation equivalents between two measurements (Crivello et al., 2016). All these studies showed that degree of bilingualism predicts performance on EF tasks.

The present study extended previous research by investigating if the effect of degree of bilingualism was maintained over time. Since children’s linguistic and cognitive skills are still developing, it is possible, or even likely, that the cognitive effects of bilingualism are not stable. For example, Blom and colleagues (2014) found bilingual proficiency to predict verbal working memory at age 6, but not at age 5. As the children became more proficient in both languages between the ages of 5 and 6, this suggests that enhanced EF emerged as the children became more bilingually proficient. In contrast to Blom et al. (2014) we did not define degree of bilingualism in terms of bilingual proficiency, but in terms of language balance. As we have argued above, this is a slightly different measure. The children who participated in the present study were followed over a period of three years, starting with 5- and 6-year-olds. Previous findings of enhanced EF in bilinguals cover the whole age range of our study, from 5- and 6-year-olds (Blom et al., 2014; Bosma et al., 2017; Prior et al., in press; Tse & Altarriba, 2014) to 7- and 8-year-olds (Bialystok & Barac, 2012; Engel de Abreu et al., 2012; Thomas-Sunesson et al., 2016), but the present study is, to our knowledge, the first that uses a three-year longitudinal design to investigate the development of the effect of bilingualism on EF.

**Frisian-Dutch bilingual context**

Frisian is a regional minority language that is spoken in the Dutch province of Fryslân, where it has official status next to the national majority language Dutch. Outside of the Netherlands, Frisian is known as West Frisian, to avoid confusion with the Frisian languages that are spoken in Germany. In this study, Frisian refers to West Frisian.
In 1998, the European Charter for Regional and Minority Language (ECRML) went into force. With a recognition of the Frisian language under part III of this charter the Dutch government is obliged to take concrete actions to promote Frisian in domains like education, administration, and the media. For example, primary schools in Fryslân are required to teach Frisian as a subject for at least one hour per week and in many schools Frisian is used as one of the languages of instruction. In 2005, the Dutch government recognized the Frisians as the only national minority group under the Framework Convention on the Protection of National Minorities (FCNM). Finally, in 2014, Frisian was recognized as official language of the province of Fryslân, next to Dutch, when the Wet Gebruik Friese Taal (‘Law on the use of the Frisian language’) went into force in the Netherlands.

The province of Fryslân has approximately 650,000 inhabitants (Centraal Bureau voor de Statistiek, 2017). Although Frisian is predominantly spoken in informal domains and more in rural than in urban areas (Breuker, 2001), it still has quite a strong position in the province as a whole. In a recent survey, a little more than half of the population reported to speak Frisian as a mother tongue (55.3%) and a little less than half of the population reported to speak Frisian with their partner (45.6%) and children (47.5%). Furthermore, the survey shows that Frisian is used more as an oral than as a written language: while the majority of the population reported to speak Frisian well (66.6%), only a small minority reported to write it well (14.5%) (Proevinsje Fryslân, 2015).

Frisian and Dutch are both West Germanic languages. Historically, Frisian is most closely related to English, but over time English and Frisian have diverged, while Dutch and Frisian have converged (Gooskens & Heeringa, 2004). As a result, the Frisian and Dutch language that are spoken nowadays share a large part of their vocabularies and morphosyntactic structures. However, there are still quite a number of lexical and structural differences which clearly distinguish the two varieties.

Several studies have investigated how children’s proficiency in Frisian and Dutch develops before and during primary school and how this is related to home language exposure. Dijkstra (2013) showed that preschoolers with Frisian at home and preschoolers with Dutch at home (2.5- to 4-year-olds) performed similarly on a number of Dutch language measures, namely receptive vocabulary, mean length of utterance and number of different words. The only Dutch language task for which home language did matter was productive vocabulary. On the Frisian equivalents of all these tasks, the children with Frisian at home outperformed their peers with Dutch at home. Ytsma (1999) tested children’s Frisian and Dutch proficiency on a range of language tasks at the beginning and end of the first year of
primary school (4- and 5-year-olds). The results showed that the children with Frisian at home progressed more in Dutch than the children with Dutch at home progressed in Frisian. By the end of the first year, the former group of children was more balanced in their two languages than the latter group of children. Van Ruijven (2006) showed that by the fourth year of primary school (7- and 8-year-olds), children with Frisian at home had caught up in Dutch language proficiency relative to their monolingual Dutch peers in the rest of the Netherlands. However, as Ytsma (1995) showed, children with Dutch at home did not catch up in Frisian relative to their peers with Frisian at home. Although most Dutch children did acquire some lexical knowledge of Frisian, they experienced great difficulty with the acquisition of the more structural aspects of the language, such as verb conjugation.

From the studies described above it is clear that in the Frisian-Dutch situation, children with Frisian at home have a good chance to become proficient bilinguals, whereas this is unlikely for children with Dutch at home. However, in these studies, language exposure was defined as a binary variable, either Frisian or Dutch, whereas in practice, most children are exposed to both languages at home, albeit in different relative amounts. Therefore, we investigated to what extent intensity of exposure to Frisian at home, defined as a gradient, predicts language balance. Subsequently, we investigated whether intensity of exposure to Frisian at home also predicts EF and if this effect is mediated by language balance. Exploring these relationships would provide more insight into the child external factors that influence EF and the mechanism through which this can occur.

**Research questions and hypotheses**

In the current study, we investigated the relationship between EF, exposure and degree of bilingualism in terms of language balance. The research questions are formulated in (1) and (2).

1. Does degree of bilingualism predict Frisian-Dutch bilingual children’s performance on EF tasks that measure attention and working memory, and is this effect maintained over the course of three years?
2. Does intensity of exposure to Frisian at home predict EF and is this relationship mediated by degree of bilingualism?

With respect to the first research question, we expected EF to be influenced by degree of bilingualism (Bialystok & Barac, 2012; Blom et al., 2014; Thomas-Sunesson et al., 2016; Tse-
As cognitive effects of bilingualism have been found across the whole age range covered in our study (Bialystok & Barac, 2012; Blom et al., 2014; Bosma et al., 2017; Engel de Abreu et al., 2012; Prior et al., in press; Thomas-Sunesson et al., 2016; Tse & Altarriba, 2014), we expected an effect on all three measurements. However, as children’s cognitive and linguistic skills were still developing, the effect may not be stable. Furthermore, as the cognitive effects of bilingualism are not consistently replicated (Antón et al., 2014; Duñabeitia et al., 2014), our study may also show mixed results.

With respect to the second research question, we hypothesized that intensity of exposure would predict EF performance and that this relationship would be mediated by degree of bilingualism. In line with previous evidence that only children with Frisian as their home language become proficient in both Frisian and Dutch (Dijkstra, 2013; Van Ruijven, 2006; Ytisma, 1995; 1999), we hypothesized that intensity of exposure to Frisian at home would predict degree of bilingualism to a large extent. As we expected degree of bilingualism to predict EF (research question 1), we hypothesized that intensity of exposure to Frisian at home would also predict EF.

Method
Participants
Primary schools in the countryside of the Dutch province of Fryslân were contacted for the recruitment of participants. The 14 schools that were willing to participate distributed consent forms and information folders among the parents of the children. We only tested children whose parents had signed the consent form. These children were tested annually for three consecutive years. They were 5 or 6 years old at time 1, 6 or 7 years old at time 2, and 7 or 8 years old at time 3. In the first year of the study, a total of 122 children were assessed. After the first wave of data collection, two children dropped out, leaving 120 children for the present study (61 girls, 59 boys).

Table 6-1 provides an overview of the participants’ age, non-verbal IQ scores, SES and intensity of exposure to Frisian at home. As age (Best et al., 2009), IQ (Arffä, 2007; but see Ardila et al., 2000) and SES (Calvo & Bialystok, 2014) are found to be correlated with EF, these measures were included as control variables in the current study. Non-verbal IQ was measured with the subsets Matrices and Recognition of the Wechsler Nonverbal Scale of Ability (Wechsler & Naglieri, 2006), which was assessed in the first year of the study. Through a questionnaire, based on the Questionnaire for Parents of Bilingual Children (Tuller 2015), parents provided information regarding their own educational level, their children’s
intensity of exposure to both languages at home and their children’s language use with friends. The mean educational level of the father and the mother was used as a proxy of SES. Education was measured on a 9-point scale, ranging from no education (1) to university degree (9). Intensity of exposure to each language was measured as the mean percentage of input that the child received from his father, mother, siblings and other adults. Other adults were only included in this score if they looked after the child at least once per week. For each of these people, we wanted to know how often (s)he spoke each language to the child: ‘never’ (0%), ‘seldom’ (25%), ‘sometimes’ (50%), ‘usually’ (75%) and ‘always’ (100%). Language use with friends was measured by asking how often the child spoke each language to other children (s)he regularly played with: ‘never’ (0%), ‘seldom’ (25%), ‘sometimes’ (50%), ‘usually’ (75%) and ‘always’ (100%). Intensity of exposure to Dutch was 100% minus intensity of exposure to Frisian. The same applies to Dutch language use with friends.

Table 6-1. Descriptive characteristics of the participants

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Range</th>
<th>Maximum possible score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at time 1</td>
<td>70 (7)</td>
<td>59-83</td>
<td></td>
</tr>
<tr>
<td>Age at time 2</td>
<td>82 (7)</td>
<td>71-95</td>
<td></td>
</tr>
<tr>
<td>Age at time 3</td>
<td>94 (7)</td>
<td>83-107</td>
<td></td>
</tr>
<tr>
<td>IQ</td>
<td>106 (15)</td>
<td>73-144</td>
<td>144</td>
</tr>
<tr>
<td>SES</td>
<td>6.9 (1.3)</td>
<td>3.5-9</td>
<td>9</td>
</tr>
<tr>
<td>% FR home</td>
<td>63 (29)</td>
<td>0-100</td>
<td>100</td>
</tr>
<tr>
<td>% FR friends</td>
<td>42 (24)</td>
<td>0-100</td>
<td>100</td>
</tr>
</tbody>
</table>

Age = age in months; IQ = intelligence quotient; SES = socioeconomic status; % FR home = intensity of exposure to Frisian at home; % FR friends = intensity of Frisian language use with friends

**Degree of bilingualism measure**

We defined degree of bilingualism as relative proficiency in Frisian and Dutch. As language proficiency not only includes vocabulary, but also grammar (Treffers-Daller, 2015), we took into account both a receptive vocabulary and an inflectional morphology task to define language proficiency in each language.

Dutch receptive vocabulary was measured with the Peabody Picture Vocabulary Test-III-NL (PPVT-III-NL; Schlichting, 2005), which is the Dutch version of the PPVT-III (Dunn & Dunn, 1997). Frisian receptive vocabulary was measured with an adaptation of the PPVT-
III-NL, which was developed for the purpose of this project (see Bosma et al., 2016). In this receptive vocabulary task, children were presented sheets with four pictures from which they had to choose the one that best represented an orally presented word. In total, the PPVT-III-NL contains 17 sets of 12 items, and the sets are ordered by difficulty. For the present study, we only used the first 12 sets, that is, the first 144 items, as these sets suffice to measure the vocabulary knowledge of the children in our age range. To make sure that all children completed all items, we did not use basal and ceiling criteria.

Dutch morphology was assessed with the subtest Word Formation of the Taaltoets Alle Kinderen (“Language assessment all children”, Verhoeven & Vermeer, 2002). This expressive task contained 12 items testing noun plural formation and 12 items testing past participle formation. In both Dutch and Frisian, regular nouns are pluralized by adding the suffix -en (Dutch/Frisian boek-boeken ‘book’-‘books’) or the suffix -s (Dutch/Frisian tafel-tafels ‘table-tables’). Regular participles in Dutch are formed with the circumfix ge_t/d (dansen-gedanst ‘dance-danced’, rennen-gerend, ‘run-run’), while regular participles in Frisian are formed with the suffix -t/d (bakte-bakt ‘bake-baked’, draait-draaid ‘turn-turned’) or with the suffix -e (dünsje-dünse ‘dance-danced’), depending on the infinitival form. In addition to these regular noun plurals and participles, the two languages have different types of irregular forms. Some forms are regular in Dutch, but irregular in Frisian, or vice versa.

To elicit noun plurals, children were presented with pictures of objects and prompt sentences of the following type: *Dat is een X, dat zijn twee...* “This is an X, these are two...”. To elicit past participles, children were presented with pictures and prompt sentences like the following: *Rosita is een bal aan het gooien. Gisteren heeft zij ook al een bal...* “Rosita is throwing a ball. Yesterday she has also ... a ball.” Both the noun plural and the past participle part of the task contained items with different degrees of regularity. Frisian morphology was tested with a comparable morphology task that was developed for the purpose of this project (see Blom & Bosma, 2016).

For both the vocabulary and the morphology tasks, percentage scores were calculated. To create a language proficiency score for each language, the vocabulary and morphology percentage scores were averaged. These Frisian and Dutch proficiency scores were used to calculate children’s degree of bilingualism in terms of language balance. This was done by dividing the lowest score by the highest and multiplying by 100, so that 100% indicated perfect language balance and lower scores indicated less balance.
Attention measures

One of the attention tasks tested selective attention, which is the ability to filter information and focus on task-relevant cues, while the other tested interference suppression, which is the ability to suppress interference from distracting stimuli pulling for a competing response. Selective attention was measured with the Sky Search task from the *Test of Everyday Attention for Children* (Manly et al., 1998). The task consisted of an A3 sheet with 128 pairs of spaceships, 20 of which were identical. The children had to draw a circle around the identical spaceship pairs as fast as they could, while ignoring the non-identical spaceship pairs. The task was timed with a stop watch. After they had completed this first sheet, the children got a second A3 sheet on which only the 20 target spaceships were displayed. In this motor-control version of the test they had to encircle all pairs of displayed spaceships as fast as they could. The attention score of the Sky Search was calculated by subtracting the mean time per target (one identical pair of spaceships) of the second sheet from the mean time per target of the first sheet. In this way, differences between children could not be the result of differences in circle drawing speed. Note that lower scores in this task indicated better performance. In the first year of the study, there were four children who encircled fewer than 15 spaceships on the motor-control sheet. In line with the manual of the Sky Search task, they were excluded from the analysis.

Interference suppression was measured with the Flanker task from Engel de Abreu and colleagues (2012), who adapted the task from Rueda and colleagues (2004). On a laptop, children were shown a horizontal row of five equally spaced yellow fish. They had to ignore the flanking fish and focus on the fish in the middle. By pressing a left or right response button, they had to indicate the direction of this central fish. Half of the flanking fish swam in the same direction as the target fish (congruent condition), while the other half swam in the other direction (incongruent condition). Each trial started with a fixation cross in the middle of the screen, which was shown for 1000 ms. Then the row of fish was presented for 5000 ms or until a response was given by pressing a left or a right button. The test started with eight practice trials before the real test began. The real test consisted of two blocks of 20 trials in which congruent and incongruent trials were randomly presented. Reaction times (RTs) and accuracy were recorded. The following responses were excluded from the analyses (9.9% of trials at time 1, 5.2% at time 2, 3.5% at time 3): incorrect responses \(n = 425\) at time 1, \(n = 178\) at time 2, \(n = 102\) at time 3), correct responses with RTs below 200 ms \(n = 4\) at time 1, \(n = 3\) at time 2, \(n = 0\) at time 3) and correct responses with RTs above three standard deviations of children’s individual congruent \(n = 27\) at time 1, \(n = 31\) at time 2, \(n = 33\) at time 3) and
incongruent means \((n = 16 \text{ at time 1, } n = 36 \text{ at time 2, } n = 33 \text{ at time 3})\). We calculated the difference between the RTs of the incongruent trials and the RTs of the congruent trials, which is also known as the Flanker effect (mean \(RT_{\text{INCONGRUENT}} - \text{mean } RT_{\text{CONGRUENT}}\)). RTs for incongruent trials are usually slower than RTs for congruent trials, because of interference from the distracting flanking fish. The difference between the congruent and incongruent conditions is thought to measure interference inhibition: the smaller the Flanker effect, the better a child’s ability to suppress interference. At time 1, there was one child who only had one correct response in the incongruent condition. This child was excluded from the sample, as his mean RT for the incongruent condition could not be calculated reliably. At time 2 and 3, no children were excluded from the sample.

**Working memory measures**

Verbal working memory was measured with the Backward Digit Span task and visuospatial working memory with the Backward Dot Matrix task. These measures were based on the *Alloway Working Memory Assessment* (AWMA; Alloway, 2012) and translated to Dutch. In the Backward Digit Span, sequences of digits were auditorily presented and the children had to repeat them in reverse order. Since Dutch is the main language of education and all children had spent at least one year in education at the first time of testing, it was assumed that all children were able to count to ten in Dutch. In the Backward Dot Matrix, sequences of blue dots were presented in a 4 x 4 matrix on a computer screen. Each dot appeared on the screen for 2 seconds and when the dots had disappeared children were asked to point out the position of the dots in reverse order. For scoring, the AWMA procedure was applied. Per block, there was a maximum score of 6 points. When the child repeated the first four trials within one block correctly, he or she automatically continued with the next block and received a score of 6. After three incorrect trials within one block the task stopped. Trials were scored as incorrect if the sequence was incorrect, if children recalled one or more digits/dots incorrectly, or if they omitted one or more digits/dots. The scores could range from 0 to 36 for the Dot Matrix and from 0 to 42 for the Digit Span, so there were six and seven blocks respectively. In the first year of the study, the Backward Dot Matrix was aborted too early for one child. As this made the score unreliable, this data point was excluded from the analysis.
Procedure
The tasks in this study were part of a larger test battery that included (language) tasks that were not reported on in the current study. They were administered in the following order, divided over two sessions of about 60 minutes each: Frisian receptive vocabulary, Frisian morphology, Digit Span, Sky Search and Flanker in the first session; Dutch receptive vocabulary, Dutch morphology and Dot Matrix in the second session. Children were tested in a quiet room at school, except for one child at time 1, four children at time 2 and five children at time 3, who were tested at home. The children were tested by the first author and two research assistants, who all had a native level command of both Dutch and Frisian.

Results
Descriptive statistics
The mean scores and standard deviations of the language measures, degree of bilingualism and the cognitive measures are presented in Table 6-2. The vocabulary and morphology scores represent percentages correct, based on 144 and 24 items, respectively. Correlations between Frisian vocabulary and morphology scores ranged between \( r(120) = .44, \ p < .001 \), and \( r(120) = .51, \ p < .001 \). Correlations between Dutch vocabulary and morphology scores ranged between \( r(120) = .26, \ p < .01 \), and \( r(120) = .53, \ p < .001 \). Repeated measures ANOVAs showed that over time, children improved on all language measures, \( p < .001 \).

Degree of bilingualism in terms of language balance is based on Dutch and Frisian receptive vocabulary and morphology scores with a score of 100% representing perfect language balance. A repeated measures ANOVA showed that degree of bilingualism did not change over time, \( p = .27, \ \eta_p^2 = .01 \). For the Sky Search and the Flanker effect, lower scores indicate better performance, whereas for the Backward Digit Span and the Backward Dot Matrix, higher scores indicate better performance. Repeated measures ANOVAs showed that over time, children significantly improved on all four cognitive measures, \( p < .001 \). Correlations between age, IQ, SES, intensity of exposure, degree of bilingualism and the cognitive measures at time 1, 2 and 3 are reported in Tables 6-3, 6-4 and 6-5, respectively.
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**Table 6-2. Descriptive statistics of the language and cognitive measures**

<table>
<thead>
<tr>
<th></th>
<th>Time 1</th>
<th>Time 2</th>
<th>Time 3</th>
<th>$p$</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$ (SD)</td>
<td>$M$ (SD)</td>
<td>$M$ (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language measures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dutch receptive vocabulary</td>
<td>64.38 (5.34)</td>
<td>69.87 (4.51)</td>
<td>73.49 (4.94)</td>
<td>&lt;.001</td>
<td>.69</td>
</tr>
<tr>
<td>Dutch morphology</td>
<td>63.54 (13.28)</td>
<td>75.07 (12.52)</td>
<td>85.38 (10.23)</td>
<td>&lt;.001</td>
<td>.70</td>
</tr>
<tr>
<td>Frisian receptive vocabulary</td>
<td>62.91 (6.33)</td>
<td>68.03 (5.62)</td>
<td>71.68 (5.17)</td>
<td>&lt;.001</td>
<td>.64</td>
</tr>
<tr>
<td>Frisian morphology</td>
<td>54.03 (22.52)</td>
<td>60.69 (23.35)</td>
<td>65.63 (23.15)</td>
<td>&lt;.001</td>
<td>.32</td>
</tr>
<tr>
<td>Degree of bilingualism</td>
<td>82.21 (14.72)</td>
<td>82.98 (15.27)</td>
<td>83.39 (14.75)</td>
<td>.27</td>
<td>.01</td>
</tr>
<tr>
<td>Cognitive measures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sky Search</td>
<td>10.39 (7.50)</td>
<td>5.54 (2.63)</td>
<td>4.10 (1.61)</td>
<td>&lt;.001</td>
<td>.41</td>
</tr>
<tr>
<td>Flanker effect</td>
<td>225 (299)</td>
<td>123 (174)</td>
<td>93 (172)</td>
<td>&lt;.001</td>
<td>.10</td>
</tr>
<tr>
<td>Backward Digit Span</td>
<td>12.81 (2.87)</td>
<td>14.90 (2.88)</td>
<td>16.47 (3.57)</td>
<td>&lt;.001</td>
<td>.39</td>
</tr>
<tr>
<td>Backward Dot Matrix</td>
<td>13.27 (4.76)</td>
<td>18.16 (4.55)</td>
<td>20.69 (4.68)</td>
<td>&lt;.001</td>
<td>.57</td>
</tr>
</tbody>
</table>

$p < .001$

**Table 6-3. Correlations between age, IQ, SES, intensity of exposure to Frisian at home, degree of bilingualism and the cognitive measures at time 1**

<table>
<thead>
<tr>
<th></th>
<th>IQ</th>
<th>SES</th>
<th>% FR</th>
<th>DegBil</th>
<th>Sky Search</th>
<th>Flanker</th>
<th>BW Digit</th>
<th>BW Dot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-.02</td>
<td>-.12</td>
<td>.10</td>
<td>.09</td>
<td>-.30</td>
<td>.02</td>
<td>.26</td>
<td>.27</td>
</tr>
<tr>
<td>IQ</td>
<td>-</td>
<td>.04</td>
<td>-.01</td>
<td>.06</td>
<td>-.24</td>
<td>-.15</td>
<td>.36</td>
<td>.28</td>
</tr>
<tr>
<td>SES</td>
<td>-</td>
<td>-.24</td>
<td>-.09</td>
<td>.06</td>
<td>-.04</td>
<td>.00</td>
<td>.10</td>
<td></td>
</tr>
<tr>
<td>% FR</td>
<td>-</td>
<td></td>
<td>.68</td>
<td>-.22</td>
<td>.05</td>
<td>.05</td>
<td>-.05</td>
<td></td>
</tr>
<tr>
<td>DegBil</td>
<td>-</td>
<td></td>
<td></td>
<td>-.25</td>
<td>-.03</td>
<td>.14</td>
<td>.06</td>
<td></td>
</tr>
<tr>
<td>Sky Search</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.30</td>
<td>-.26</td>
<td></td>
</tr>
<tr>
<td>Flanker</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.24</td>
<td>-.19</td>
<td></td>
</tr>
<tr>
<td>BW Digit</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.44</td>
<td></td>
</tr>
</tbody>
</table>

% FR = intensity of exposure to Frisian at home; DegBil = degree of bilingualism; $p \leq .05$, $p \leq .01$, $p \leq .001$
Table 6-4. Correlations between age, IQ, SES, intensity of exposure to Frisian at home, degree of bilingualism and the cognitive measures at time 2

<table>
<thead>
<tr>
<th></th>
<th>IQ</th>
<th>SES</th>
<th>% FR</th>
<th>DegBil</th>
<th>Sky Search</th>
<th>Flanker</th>
<th>BW Digit</th>
<th>BW Dot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.03</td>
<td>-0.12</td>
<td>0.10</td>
<td>0.04</td>
<td>-0.35</td>
<td>-0.16</td>
<td>0.13</td>
<td>0.27</td>
</tr>
<tr>
<td>IQ</td>
<td>-</td>
<td>0.04</td>
<td>-0.01</td>
<td>0.05</td>
<td>-0.16</td>
<td>-0.02</td>
<td>0.27</td>
<td>0.32</td>
</tr>
<tr>
<td>SES</td>
<td>-</td>
<td>-</td>
<td>-0.24</td>
<td>-0.15</td>
<td>-0.04</td>
<td>0.15</td>
<td>0.14</td>
<td>0.03</td>
</tr>
<tr>
<td>% FR</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.78</td>
<td>-0.19</td>
<td>-0.06</td>
<td>0.02</td>
</tr>
<tr>
<td>DegBil</td>
<td>-</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.22</td>
<td>-0.01</td>
<td>0.14</td>
</tr>
<tr>
<td>Sky Search</td>
<td>-</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-38</td>
</tr>
<tr>
<td>Flanker</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-17</td>
</tr>
<tr>
<td>BW Digit</td>
<td>-</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.45</td>
</tr>
</tbody>
</table>

% FR = intensity of exposure to Frisian at home; DegBil = degree of bilingualism; \( p \leq .05 \); \( p \leq .01 \); \( p \leq .001 \)

Table 6-5. Correlations between age, IQ, SES, intensity of exposure to Frisian at home, degree of bilingualism and the cognitive measures at time 3

<table>
<thead>
<tr>
<th></th>
<th>IQ</th>
<th>SES</th>
<th>% FR</th>
<th>DegBil</th>
<th>Sky Search</th>
<th>Flanker</th>
<th>BW Digit</th>
<th>BW Dot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.03</td>
<td>-0.12</td>
<td>0.10</td>
<td>0.01</td>
<td>-0.26</td>
<td>-0.08</td>
<td>0.10</td>
<td>0.30</td>
</tr>
<tr>
<td>IQ</td>
<td>-</td>
<td>0.04</td>
<td>-0.01</td>
<td>0.07</td>
<td>-0.11</td>
<td>-0.24</td>
<td>0.33</td>
<td>0.28</td>
</tr>
<tr>
<td>SES</td>
<td>-</td>
<td>-</td>
<td>-0.24</td>
<td>-0.17</td>
<td>0.00</td>
<td>-0.13</td>
<td>0.15</td>
<td>0.09</td>
</tr>
<tr>
<td>% FR</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.81</td>
<td>-0.04</td>
<td>0.05</td>
<td>0.00</td>
</tr>
<tr>
<td>DegBil</td>
<td>-</td>
<td></td>
<td>-</td>
<td>-0.06</td>
<td>-0.06</td>
<td>0.14</td>
<td>0.00</td>
<td>0.07</td>
</tr>
<tr>
<td>Sky Search</td>
<td>-</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.37</td>
<td>-0.14</td>
<td>0.24</td>
</tr>
<tr>
<td>Flanker</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.06</td>
<td>-</td>
<td>-20</td>
</tr>
<tr>
<td>BW Digit</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.43</td>
</tr>
</tbody>
</table>

% FR = intensity of exposure to Frisian at home; DegBil = degree of bilingualism; \( p \leq .05 \); \( p \leq .01 \); \( p \leq .001 \)

The effect of degree of bilingualism on EF

The first research question of this study was whether degree of bilingualism predicts EF and whether this effect is stable over the course of three years. The correlation matrices in Tables 6-3 to 6-5 show that degree of bilingualism correlated with one of the four cognitive tasks, namely the Sky Search task. Therefore, follow-up regression analyses were performed for this task only. The correlation matrices also show that the Sky Search task significantly correlated with age and IQ, but not with SES. Therefore, only age and IQ were included as control
variables in the regression analyses. As the distribution of the Sky Search task deviated strongly from normality (time 1: skew = 2.33, kurtosis = 7.07; time 2: skew = 2.49, kurtosis = 9.83; time 3: skew = 2.68, kurtosis = 10.43), we applied a log-transformation to improve the distribution (time 1: skew = 0.37, kurtosis = 0.00; time 2: skew = 0.70, kurtosis = 0.89; time 3: skew = 0.93, kurtosis = 1.99). Three sequential hierarchical multiple regression analyses were conducted with the Sky Search task at time 1, time 2 and time 3 as dependent variables. In the first step of the model, age and IQ were included as control variables. In the second step of the model, degree of bilingualism at the time of testing was added as a predictor. The results are shown in Table 6-6. Degree of bilingualism predicted performance on the Sky Search task at time 1, $\beta = -0.19, p = 0.03$, but not at time 2, $\beta = -0.16, p = 0.06$, and time 3, $\beta = -0.03, p = 0.76$.

### Table 6-6. Sky Search at time 1, 2 and 3, regressed on degree of bilingualism at the time of testing, controlling for age and IQ

<table>
<thead>
<tr>
<th></th>
<th>Sky Search Time 1 $(n = 116)$</th>
<th>Sky Search Time 2 $(n = 120)$</th>
<th>Sky Search Time 3 $(n = 120)$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stage 1 ($\beta$)</td>
<td>Stage 2 ($\beta$)</td>
<td>Stage 1 ($\beta$)</td>
</tr>
<tr>
<td>Age Tx</td>
<td>-.37</td>
<td>-.35</td>
<td>-.34</td>
</tr>
<tr>
<td>IQ</td>
<td>-.20</td>
<td>-.19</td>
<td>-.12</td>
</tr>
<tr>
<td>Bilingualism Tx</td>
<td>-.19</td>
<td></td>
<td>-.16</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.18</td>
<td>.21</td>
<td>.13</td>
</tr>
<tr>
<td>$\Delta R^2$</td>
<td>.04</td>
<td></td>
<td>.03</td>
</tr>
<tr>
<td>$F$</td>
<td>12.09</td>
<td>10.06</td>
<td>8.75</td>
</tr>
</tbody>
</table>

$\text{Tx} = \text{time 1, 2 and 3, respectively; } p \leq .05 | p \leq .01 | p \leq .001$

**The effect of minority language exposure on EF**

The second research question of this study was whether there is a relationship between intensity of exposure to Frisian at home and EF, mediated by degree of bilingualism. In order to answer this question we first investigated to what extent intensity of exposure to Frisian at home predicted children’s degree of bilingualism. Second, we investigated whether intensity of exposure to Frisian at home predicted EF.

The correlation matrices in Tables 6-3 to 6-5 show that degree of bilingualism and intensity of exposure to Frisian were highly correlated, but that degree of bilingualism did not
significantly correlate with age, IQ and SES. Therefore, no control variables were included in the follow-up regression analyses. Three sequential hierarchical multiple regression analyses were conducted with degree of bilingualism at time 1, time 2 and time 3 as dependent variables and intensity of exposure to Frisian at home as predictor. The results (Table 6-7) showed that intensity of exposure to Frisian at home predicted degree of bilingualism to a large extent at time 1, $\beta = .68, p < .001$, time 2, $\beta = .78, p < .001$, and time 3, $\beta = .81, p < .001$.

Table 6-7. Degree of bilingualism at time 1, 2 and 3, regressed on intensity of exposure to Frisian at home, controlling for SES

<table>
<thead>
<tr>
<th>Exposure FR</th>
<th>Bilingualism Time 1 $(n=120)$</th>
<th>Bilingualism Time 2 $(n=120)$</th>
<th>Bilingualism Time 3 $(n=120)$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta$</td>
<td>$\beta$</td>
<td>$\beta$</td>
</tr>
<tr>
<td>Exposure FR</td>
<td>.68</td>
<td>.78</td>
<td>.81</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.47</td>
<td>.61</td>
<td>.66</td>
</tr>
<tr>
<td>$F$</td>
<td>102.60</td>
<td>187.72</td>
<td>227.85</td>
</tr>
</tbody>
</table>

The correlation matrices in Tables 6-3 to 6-5 show that intensity of exposure to Frisian at home correlated with the Sky Search task at time 1, $r(116) = .22, p = .02$, and time 2, $r(120) = .19, p = .04$. In order to further investigate this relationship we conducted three hierarchical multiple regression analyses with the Sky Search task at time 1, time 2 and time 3 as dependent variables. Again, we used the log-transformations of the Sky Search task. In the first step of the model, age and IQ were included as control variables. In the second step of the model, intensity of exposure to Frisian at home was added as a predictor. The results are shown in Table 6-8. Intensity of exposure to Frisian at home predicted performance on the Sky Search task in more or less the same way as degree of bilingualism did (research question 1). There was an effect at time 1, $\beta = -.17, p = .05$, but not at time 2, $\beta = -.13, p = .14$, and time 3, $\beta = -.02, p = .87$. 

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There was an effect at time 1, Sky Search task in more or less the same way as degree of bilingualism did (research question shown in Table the model, intensity of exposure to Frisian at home was added as a predictor. The results are first step of the model, age and IQ were included as control variables. In the second step of dependent variables. Again, we used the log multiple regression analyses with the Sky Search task at time 1, time 2 and time 3 as home correlated with the Sky Search task at time 1, showed that intensity of exposure to Frisian at home predicted degree of bilingualism to a large extent at time 1, variables and intensity of exposure to Frisian at home as predictor. The results (Table 6 of bilingualism at time 1, time 2 and time 3, regressed on intensity of exposure to Frisian at home, controlling for SES showed no significant relationship between intensity of exposure to Frisian at home and the Sky Search task at time 1, \( r(116) = -.07, p = .44 \), suggesting that the relationship between Frisian exposure and the Sky Search task at time 1 was indeed mediated by degree of bilingualism.

**Discussion**

The first aim of the study was to examine whether degree of bilingualism has an effect on Frisian-Dutch bilingual children’s EF and whether this effect is maintained as the children grow older. Whereas most previous studies on the cognitive effects of bilingualism compared monolinguals to bilinguals (e.g. Engel de Abreu et al., 2012), the current study adds to the few studies in which children’s bilingualism is defined as a gradient (Bialystok & Barac, 2012; Blom et al., 2014; Crivello et al., 2016; Thomas-Sunesson et al., 2016; Tse & Altarriba, 2014), doing justice to the graduality of bilingualism (Luk & Bialystok, 2013). In the present study, we defined degree of bilingualism in terms of language balance. Our results partly confirmed previous research showing that bilingualism enhances EF (e.g. Adesope et al., 2010) and that the effects are moderated by language balance (Bosma et al., 2017; Prior et al., in press; Thomas-Sunesson et al., 2016). However, the effect was limited to selective attention and disappeared over time, thus supporting previous scepticism about the robustness of the bilingual advantage (Ross & Melinger, 2016). There was a significant effect of degree of bilingualism on the Sky Search task at time 1 (age 5/6), a close to significant effect at time 6.

<table>
<thead>
<tr>
<th>Sky Search Time 1</th>
<th>Sky Search Time 2</th>
<th>Sky Search Time 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(( n = 116 ))</td>
<td>(( n = 120 ))</td>
<td>(( n = 120 ))</td>
</tr>
<tr>
<td>Stage 1 (( \beta ))</td>
<td>Stage 2 (( \beta ))</td>
<td>Stage 1 (( \beta ))</td>
</tr>
<tr>
<td>Age Tx</td>
<td>-.37</td>
<td>-.35</td>
</tr>
<tr>
<td>IQ</td>
<td>-.20</td>
<td>-.20</td>
</tr>
<tr>
<td>exposure FR</td>
<td>-.17</td>
<td>-.13</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>.18</td>
<td>.21</td>
</tr>
<tr>
<td>( \Delta R^2 )</td>
<td>.03</td>
<td>.02</td>
</tr>
<tr>
<td>( F )</td>
<td>12.09</td>
<td>9.63</td>
</tr>
</tbody>
</table>

\( p < .05 \) \( \quad p < .01 \) \( \quad p < .001 \)

Partial correlations controlling for degree of bilingualism showed no significant relationship between intensity of exposure to Frisian at home and the Sky Search task at time 1, \( r(116) = -.07, p = .44 \), suggesting that the relationship between Frisian exposure and the Sky Search task at time 1 was indeed mediated by degree of bilingualism.
2 (age 6/7) and no effect at time 3 (age 7/8). There was no effect on interference suppression, as measured with the Flanker task, and working memory, as measured with the Backward Digit Span and the Backward Dot Matrix. The absence of an effect on working memory is in contrast with Bosma et al. (2017), who used a subsample of the children in the current study and found that balanced Frisian-Dutch bilingual children outperformed Dutch-dominant bilingual children on verbal working memory and selective attention. The absence of an effect on verbal working memory in the current study suggests that the effect of bilingualism on verbal working memory is less robust than the effect of bilingualism on selective attention.

The finding that degree of bilingualism only had an effect on selective attention strengthens the view that selective attention, rather than interference suppression, is the core of the bilingual EF advantage (Chung-Fat-Yim et al., 2016). Chung-Fat-Yim and colleagues (2016) argue that the ability to selectively attend to visual stimuli and to disengage from the focus of attention when criteria are not met is similar to the kind of challenge that bilinguals face every day, namely to selectively attend to the linguistic structures of the target language and to disengage attention from structures that do not belong to the target language.

The second aim of the study was to investigate whether exposure to the minority language at home has an effect on EF and whether this effect is mediated by degree of bilingualism. Finding this relationship would provide more insight into the child external factors that influence EF and the mechanism through which this can occur. Although many studies have investigated the circumstances that support bilingual language acquisition (e.g. Dijkstra, 2013; Gathercole & Thomas, 2009; Hammer et al., 2009), it has only rarely been investigated whether these circumstances indirectly lead to cognitive enhancement (but see Bialystok & Barac, 2012). The results of our study showed that intensity of exposure to Frisian at home predicted degree of bilingualism to a large extent, a finding that is in line with previous evidence that in the province of Fryslân, only children with Frisian as their home language become proficient bilinguals (Dijkstra, 2013; Van Ruijven, 2006; Ytsma, 1995; 1999). Furthermore, intensity of exposure to Frisian at home predicted EF in the same way as degree of bilingualism did, that is, there was an effect on the Sky Search task at time 1, but not at time 2 and 3. The finding that exposure predicts EF lines up with Bialystok and Barac’s (2012) finding that length of time in an immersion program predicts EF, since more time in an immersion program implies more exposure.

The current study is the first study that examined the effect of language balance on EF in a longitudinal way. The finding that the effect on selective attention fluctuates over time is important, because it may explain some inconsistencies in the literature. Namely, if the
current study were cut into three separate cross-sectional studies, these three studies would have contradicted each other, as only one out of three would have found an effect. By following the same group of children for a longer period of time, we were able to show the instability of the cognitive effect of bilingualism. One possibility for the vanishing of the effect is that Dutch is the dominant language in school, which would lead to a reduction in the use of the minority language as the children grow older. However, as children’s language balance did not change over time, other explanations may be more likely.

One alternative explanation for the vanishing of the effect is that over time, the effect of bilingualism on visual selective attention got overruled by the effect of literacy. Several studies have shown that literacy enhances visual discrimination abilities (e.g. Pegado et al., 2014; Ventura et al., 2013). Pegado and colleagues (2014), for example, showed that learning to read has an impact on several stages of visual processing, including repetition suppression. This is the reduction in neural activity in response to a repeated stimulus. Since repetition suppression reflects the brain’s capacity to discriminate two items, this suggests that literacy facilitates the identification of identical visual stimuli, a skill that is useful for the Sky Search task. In the first year of our study, most children were in grade 2 and had not started formal literacy education yet. However, by the third year of our study, all children had received between 0.5 and 2.5 years of literacy instruction. It could be that the age at which formal literacy instruction begins influences when the cognitive effects of bilingualism are visible. Therefore, we suggest that future studies investigate the cognitive effects of bilingualism in combination with the cognitive effects of literacy.

Another potential reason why the effect disappears over time is given by Gathercole and colleagues (2014). They argue that links within a language are usually stronger than links across languages. However, in fluent bilinguals, the between-language links are quite strong and as their linguistic knowledge in both languages is automatized, they may require little cognitive control to monitor their two co-activated languages. On average, the language balance of the children in our study did not improve over time, but their proficiency in Dutch and Frisian did. Following Gathercole and colleagues’ (2014) line of reasoning, the children in our study with a high degree of language balance may have strengthened the links between their two languages as they grew older, which might have resulted in the leveling off of the cognitive effect. While this explanation seems to be at odds with the suggestion that the effect of bilingualism develops as a result of growing bilingual proficiency (Blom et al., 2014), it is not impossible that once a higher degree of proficiency in both languages has been attained, bilingual monitoring becomes more automatic and bilingual experience does not further
enhance EF. What this suggests is a limited window of development in which bilingualism enhances cognitive functioning.

Taken together, the current study shows that minority language exposure at home predicts aspects of EF and that this effect can be understood as being mediated by degree of bilingualism. However, the effect is temporary and only visible on one task in this study. As we only observed an effect on selective attention, this strengthens the view that attention to the target language is the central mechanism behind the bilingual EF advantage (Chung-Fat-Yim et al., 2016; Costa et al., 2006), rather than suppression of interference from the non-target language (Green, 1998). The observation that the effect disappeared as the children grew older shows that the cognitive effects of bilingualism are unstable. Although the reasons for this fluctuation over time remain as yet unclear, the instability of the effect may explain why some cross-sectional studies show cognitive enhancement in bilinguals, whereas other studies do not.
Chapter 7

Summary and general discussion
Chapter 7

The overall aim of this dissertation was to deepen our understanding of the factors that support bilingual language development and the ways in which bilingualism interacts with cognition. To this end, we conducted a longitudinal study with three annual measurements in which we tested and analysed the linguistic and cognitive development of a group of Frisian-Dutch bilingual children \((n = 120)\) who were 5 or 6 years old at the first time of testing. The separate chapters of this dissertation report the results of five individual studies, each approaching bilingual language acquisition and cognitive development from a different perspective. In this concluding chapter, we will give an overview of the main findings of each study and reflect on their implications in the broader context of what we know about bilingualism and cognition. Furthermore, we will provide some directions for future research and consider the practical implications that follow from this dissertation.

**Summary and main findings of each chapter**

In chapter 2 of this dissertation, we investigated the influence of age of onset (AoO) on the acquisition of Dutch vocabulary and inflectional morphology, and its relation with transfer and intensity of exposure. For this study, we selected the children who had been exposed to Frisian from birth and whose AoO of exposure to Dutch ranged between 0 and 4 years of age \((n = 110)\). We analysed two language tasks from the first measurement, when the children were 5 or 6 years old. The first task was the Peabody Picture Vocabulary Test-III-NL (PPVT-III-NL; Schlichting, 2005), the Dutch version of the PPVT-III (Dunn & Dunn, 1997). On this receptive vocabulary task, children with an older AoO performed better than children with a younger AoO, and the effect of AoO was bigger than the effect of exposure. This finding replicates previous research that showed that for vocabulary growth, an older AoO can be helpful (Golberg et al., 2008; Snedeker et al., 2007, 2012). The second task was the word formation subtest of the *Taaltoets Alle Kinderen* (TAK; ‘Language assessment for all children’; Verhoeven & Vermeer, 2002), a Dutch morphology task that tests plural formation with nouns and participle formation with verbs. On this task, a later AoO also had a positive effect, but the effect was only relevant to a small subset of the children, namely those children who were relatively proficient at inflection in Frisian and who had a relatively low intensity of exposure to Dutch. In an analysis with a smaller but more balanced subsample, AoO did not emerge as a significant predictor. In line with previous studies that reported either a positive effect (Blom & Paradis, 2015) or no effect of a later AoO (Snedeker et al., 2007), it can therefore be concluded that a later AoO had a very small, and possibly negligible, positive effect on inflectional morphology. Besides AoO, there were two other factors that had a
significant effect on Dutch inflectional morphology, namely intensity of exposure to Dutch and proficiency at Frisian inflection. A more detailed analysis at the level of lexical items showed that children were more accurate with overlapping items than with non-overlapping items, suggesting that the effect of proficiency at Frisian inflection may be due to lexical overlap between Frisian and Dutch. Furthermore, the results showed that for Dutch inflectional morphology, intensity of exposure to Dutch was a more important predictor than AoO, which is in line with previous research (Unsworth et al., 2014). Taken together, the main finding of this study is that it is not necessarily better to start learning a new language as soon as possible. For inflectional morphology, it does not matter whether children start at age 0 or 4, and for vocabulary, it may even be better to start a bit later. A possible explanation here is that older children know more concepts than younger children. In order to learn new words, a child has to map conceptual and phonological information, and knowledge of more concepts could therefore result in more rapid vocabulary growth. It can thus be concluded that it may be helpful to first build a substantial vocabulary in the first language before learning a new language.

In the second study, described in chapter 3, we investigated to what extent the acquisition of cognates among bilingual children depends on degree of cross-language similarity and intensity of exposure to the tested language, and whether children’s sensitivity to cognates with different degrees of cross-language similarity changes over time. In order to answer these questions, we designed a Frisian receptive vocabulary task that was based on the PPVT-III-NL (Dunn & Dunn, 1997; Schlichting, 2005). In this task, cross-language similarity was systematically manipulated through four cognate categories, differing in their degree of overlap between Frisian and Dutch: (1) identical cognates, (2) non-identical cognates that either do or (3) do not exhibit a simple phonological regularity between Frisian and Dutch, and (4) non-cognates. An example of a cross-linguistic phonological regularity (category 2) is Frisian -âld [ɔ:t] and Dutch -oud [aut], as in the cognate pairs kâld [kɔ:t] - koud [kaut] ‘cold’ and wâld [wɔ:t] - woud [waut] ‘forest’. The four cognate categories were equally represented across the different sets of the test and did not differ with respect to word frequency. For three consecutive years, the task was administered to 120 Frisian-Dutch bilingual children. To investigate the influence of intensity of exposure, this sample was split into three groups that differed with respect to intensity of exposure to Frisian at home. The results showed a gradual cognate facilitation effect for children with a low intensity of exposure to Frisian, but not for children with a middle or a high intensity of exposure to Frisian. The higher the degree of cross-language similarity, the better the performance of the children in the low exposure
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group. Furthermore, as they grew older, the performance of this group of children improved the most on non-identical cognates with a simple cross-linguistic phonological regularity between Frisian and Dutch. This suggests that over time, children become better at recognizing regularities between the Frisian and Dutch phonological systems.

In chapter 4 of this dissertation, we followed up on this last result by investigating whether there is a relationship between the acquisition of cross-linguistic phonological regularities and verbal working memory. To explain how cross-linguistic phonological regularities could be represented in the brain, we used Bybee’s (1995, 2001, 2008, 2010) usage-based network model. Based on the observation that words in the input activate phonologically and semantically similar words (e.g. Gonnerman et al., 2007), this model proposes that related words are stored together. As a result, so-called schemas emerge that capture semantic and phonological generalizations. In contrast to what is traditionally thought of as grammar, these generalizations do not necessarily have a cognitive representation that is independent of the individual linguistic items that together build up the schema. Within Bybee’s network model, grammar is not seen as rules that are stored separately from the lexicon (as in Pinker’s (1991) dual-processing model or Ullman’s (2004) declarative/procedural model), but rather as the structure that emerges from the complex network of phonological and semantic relations within the lexicon.

As similarity-based activation of lexical items occurs both within (Gonnerman et al., 2007) and across languages (Bosma et al., 2016; Dijkstra et al., 2010), it can be assumed that phonologically and semantically similar words are stored closely together, regardless of whether they belong to the same or to a different language. This means that the network model is not only able to account for regularities within a language, but also for regularities across languages. What this suggests is that phonological regularities across languages resemble grammatical rules within a language, as they can both be thought of as generalizations that arise from schemas of phonologically and semantically related words. Previous research has shown that the acquisition of grammar, but not vocabulary, is supported by verbal working memory (Engel de Abreu & Gathercole, 2012; Gottardo, Stanovich, & Siegel, 1996; McDonald, 2008; Verhagen & Leseman, 2016). This suggests that verbal working memory plays a role in the acquisition of linguistic regularities. In order to test this hypothesis, we investigated whether the acquisition of cross-linguistic phonological regularities is also related to verbal working memory. To this end, we used the cognate data from chapter 3 (Bosma et al., 2016) and examined associations with verbal working memory, controlling for verbal short-term memory (Engel de Abreu & Gathercole, 2012), SES (Rice &
Hoffman, 2015), exposure (Pearson et al., 1997), non-verbal IQ (Rice & Hoffman, 2015) and age, which have previously been shown to be related to vocabulary learning. The results showed that verbal working memory had a significantly stronger effect on the acquisition of cognates with a cross-linguistic regularity than on other types of cognates and non-cognates. This confirms the hypothesis that verbal working memory is related to the acquisition of cross-linguistic phonological regularities and, more generally, it suggests that verbal working memory plays a role in the acquisition of linguistic regularities.

The fourth study, which is described in chapter 5, investigated the cognitive effects of bilingualism and the role of language balance in this domain. Previous research has shown that bilingual children outperform monolingual children on executive function tasks that test attention (e.g. Engel de Abreu et al., 2012) and working memory (e.g. Blom et al., 2014). Bilingualism can even enhance executive functioning in the context of two closely related languages, such as Cypriot Greek and Standard Modern Greek (Antoniou, Grohmann, Kambanaros, & Katsos, 2016). The mechanism that is argued to result in EF enhancement in bilinguals is the monitoring of two co-activated languages in the brain. Some researchers argue that the central process of this mechanism is inhibition of interference from the non-target language (Green, 1998), while others suggest that it is attention to the target language (Chung-Fat-Yim et al., 2016; Costa et al., 2006). In any case, it is argued that this linguistic practice of inhibition/attention generalizes to other, non-linguistic, domains, resulting in the bilingual EF advantage (Bialystok et al., 2004; Chung-Fat-Yim et al., 2016; Costa et al., 2009; Green, 1998). However, not all studies have found a cognitive advantage for bilinguals (e.g. Duñabeitia et al., 2014), which raises the question under which conditions the cognitive effects of bilingualism are visible.

One factor that moderates bilingual EF effects is degree of bilingualism (e.g. Bialystok & Barac, 2012). As bilinguals with equal proficiency in both languages need to deal with a more active second language than bilinguals with unequal proficiency, it is believed that bilinguals with equal proficiency have to exert more effort to maintain attention to the appropriate language system (Yow & Li, 2015). However, as most studies do not provide a detailed description of participants’ language proficiency in both languages, it is difficult to draw clear conclusions about the role of language proficiency on the bilingual cognitive effect (Treffers-Daller, 2015). Therefore, in chapter 5, we compared two carefully matched groups of 5- and 6-year-old Frisian-Dutch bilingual children, who differed in bilingual language balance. While the balanced bilingual children performed similarly on the Frisian and Dutch versions of four different language tasks, the Dutch-dominant bilingual children performed
significantly better on the Dutch versions of these tasks. Furthermore, the two groups differed minimally with respect to SES, culture and education, thus minimizing the risk of confounding variables. The results turned out to be mixed for both attention and working memory. The balanced bilingual children outperformed the Dutch-dominant bilingual children on selective attention (Sky Search) and verbal working memory (Backward Digit Span), but not on interference suppression (Flanker) and visuospatial working memory (Backward Dot Matrix). These results partially confirm that bilingualism enhances children’s EF development (e.g. Bialystok, 2009), although the differences between the two groups were moderate and inconsistent.

In chapter 6 of this dissertation, we conducted a longitudinal study that followed up on the cross-sectional study described in chapter 5. In chapter 5, we excluded potentially confounding variables by selecting matched groups, but in doing so we reduced the sample size and lost the precision of graduality. Therefore, in chapter 6, we included the full longitudinal sample. Whereas most previous studies on the cognitive effects of bilingualism compared monolinguals to bilinguals (e.g. Engel de Abreu et al., 2012), the study presented in chapter 6 adds to the few studies in which children’s bilingualism is defined as a gradient (Bialystok & Barac, 2012; Blom et al., 2014; Crivello et al., 2016; Thomas-Sunesson et al., 2016; Tse & Altarriba, 2014), doing justice to the graduality of bilingualism (Luk & Bialystok, 2013). We defined degree of bilingualism as language balance based on receptive vocabulary and inflectional morphology scores in both languages. By following the children for three consecutive years, we were able to investigate whether the cognitive effects of bilingualism were sustained over a three-year period. Furthermore, we investigated the relationship between exposure and EF. In a context with a minority and a majority language, such as the Frisian-Dutch context, chances for becoming proficient in both languages are best for children who speak the minority language at home (Dijkstra, 2013; Gathercole & Thomas, 2009; Hammer et al., 2009). Therefore, we examined whether minority language exposure predicted language balance and whether there was a relationship between minority language exposure and EF, mediated by language balance.

Our results partly confirmed previous research showing that bilingualism enhances EF (e.g. Adesope et al., 2010) and that the effects are moderated by language balance (Bosma et al., 2017; Prior et al., in press; Thomas-Sunesson et al., 2016). However, the effect was limited to selective attention (Sky Search) and disappeared over time, thus supporting previous scepticism about the robustness of the bilingual advantage (Ross & Melinger, 2016). The absence of an effect on verbal working memory is in contrast with the results from
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chapter 5, which suggests that the effect of bilingualism on verbal working memory is less robust than the effect on selective attention. The results furthermore showed that intensity of exposure to Frisian at home predicted degree of bilingualism to a large extent, an observation that lines up with previous evidence that in the province of Fryslân, chances for becoming proficient in both Frisian and Dutch are best for children with Frisian as their home language (Dijkstra, 2013; Van Ruijven, 2006; Ytsma, 1995; 1999). Moreover, intensity of exposure to Frisian at home predicted EF in the same way as degree of bilingualism did, that is, there was only an effect on selective attention (Sky Search) and this effect disappeared over time.

**General discussion and directions for future research**

The results from the individual chapters of this dissertation show that bilingual language acquisition interacts with a range of environmental, cognitive and linguistic factors, such as exposure, verbal working memory and degree of cross-language similarity. In what follows, we will put the different strands of this dissertation together, reflect on the main findings and provide some directions for future research.

The results from this dissertation demonstrate that the two languages of a bilingual are intertwined depending on similarities in form and meaning. In line with previous evidence from bilingual adults (Duyck et al., 2007; Dijkstra et al., 2010), we showed that bilingual children are sensitive to different degrees of cross-language similarity. This demonstrates that the two languages of a bilingual child are constantly co-activated and that the spreading of activation in the child’s bilingual lexicon depends on the degree of phonological and semantic similarity across words. As even the youngest children in our study were sensitive to different degrees of cross-language similarity, this suggests that children become sensitive to non-identical cognates at a very young age. However, a study with Spanish-Catalan bilingual children suggests that this sensitivity does not develop before the age of 18 months (Bosch & Ramon-Casas, 2014). For future studies, it would therefore be useful to investigate children between 18 months and 5 years of age to see at what age children develop sensitivity to non-identical cognates.

Such a follow-up study would be useful, because sensitivity to similarities between languages is beneficial for bilingual language acquisition. As we have shown in this dissertation, it facilitates positive transfer from one language to the other, both at the lexical and at the grammatical level. An important new insight in this respect is the finding that as they grow older, children discover the regular correspondences between the Frisian and Dutch phonological systems. This shows that children are not only sensitive to similarities between
their two languages, but also capable of detecting patterns in these similarities. The finding that the acquisition of cross-linguistic phonological regularities is related to verbal working memory shows that children learn these regularities on the basis of a general cognitive capacity of pattern recognition. Future studies should investigate whether others factors also have an effect on the acquisition of cross-linguistic phonological regularities, such as phonological awareness and type frequency. Furthermore, more research is needed to investigate whether regularities across languages are acquired through the same mechanisms as regularities within a language. One indication that this is the case is that verbal working memory, which was found to be related to cross-linguistic regularities in this dissertation, is also related to the acquisition of grammatical rules within a language (e.g. Engel de Abreu & Gathercole, 2012; Verhagen & Leseman, 2016).

Co-activation of two languages not only has an impact on bilingual language acquisition itself. The results from this dissertation partially confirm that bilingualism also has an effect on cognitive functioning and that this effect is moderated by language balance (e.g. Thomas-Sunesson et al., 2016). However, as the effect that we found was very small and disappeared over time, the results also support previous scepticism about the robustness of the bilingual advantage (Ross & Melinger, 2016). In fact, the results from this dissertation are both consistent with studies that do show cognitive effects of bilingualism (e.g. Blom et al., 2014; Engel de Abreu et al., 2012) and studies that do not (e.g. Duñabeitia et al., 2014). If our longitudinal study were cut into three separate cross-sectional studies, these three studies would have contradicted each other, as only one out of three would have found an effect. The finding that the effect of language balance on selective attention changes over time may thus explain some inconsistencies in the literature.

Still, the question remains why the cognitive effects of bilingualism are so unstable. First of all, we should not forget that the cognitive system is very complex and that its development is influenced by a range of factors and interactions that are constantly changing. This means that when studying the cognitive effects of bilingualism, it is very difficult to control for all other variables that might have an effect on children’s cognitive development. For example, one possible explanation for the vanishing of the effect is that the effect of bilingualism was overruled by the effect of literacy, which has been shown to improve visual discrimination abilities (Pegado et al., 2014; Ventura et al., 2013). To investigate whether this is indeed the case, future studies could investigate whether the age at which formal literacy instruction begins influences when the cognitive effects of bilingualism are visible. In any
case, we would recommend more longitudinal research, as this could shed more light on the relationship between the linguistic and cognitive development of bilingual children.

Another important point that deserves more attention in the debate about the cognitive effects of bilingualism is the finding from other studies that cognitive effects of language are not limited to bilingual populations. Several studies have shown that language acquisition in monolingual children also has an effect on EF (Bohlmann et al., 2015; Fuhs & Day, 2011; Hughes & Ensor, 2007; Kuhn et al., 2016), something that has only rarely been taken into account in studies on the cognitive effects of bilingualism (but see Bohlmann et al., 2015). We think that this observation deserves more attention, as it begs the question whether cognitive enhancement as a result of monolingual language acquisition is different from cognitive enhancement as a result of bilingual language acquisition.

Although we do not have an answer to this question, there is some reason to believe that the underlying mechanisms may not be very different. One argument that supports this view is that the spreading of activation in the bilingual lexicon is very similar to the spreading of activation in the monolingual lexicon (Costa et al., 2005), which has also been shown to depend on the degree of phonological and semantic similarity between words (Gonnerman et al., 2007). This means that although monolingual children cannot be distracted by co-activated cognates, they do have to deal with co-activated words from the same language. As the bilingual cognitive effect is argued to stem from a continuous practice of managing co-activation (e.g. Green, 1998), the parallel between lexical activation within and across languages deserves some more consideration in future research.

Taken together, the five studies presented in this dissertation contribute to a better understanding of the relationship between the linguistic and cognitive development of bilingual children who grow up with two closely related languages. They demonstrate how bilingual children can benefit from the similarities and regularities that their two languages share and the ways in which cognition supports bilingual language acquisition. As a result of the extensive overlap between the Frisian and Dutch linguistic system, there is much co-activation between the two languages and thus many opportunities for cross-linguistic transfer. With respect to the debate about the cognitive effects of bilingualism, this dissertation provides a nuanced perspective.

**Practical implications**

The results from this dissertation have some practical implications for parents and teachers of bilingual children in general, and Frisian-Dutch bilingual children in specific. First of all, the
results show that bilingual language acquisition can to a large extent be stimulated by parents, teachers and other people who play a role in children’s lives. Two findings from this dissertation are important in this respect: first, the observation that children’s degree of bilingualism is largely determined by the amount of Frisian input they receive at home (chapter 6), and second, the finding that for the acquisition of Dutch vocabulary and grammar, it is not necessarily best to acquire Frisian and Dutch simultaneously from birth. For Dutch inflectional morphology, it does not matter whether children start acquiring Dutch from the age of 0 or from the age of 4, and for Dutch vocabulary, it may even be better to start a bit later and first acquire a substantial vocabulary in Frisian (chapter 2). These two findings confirm previous evidence that the acquisition of Frisian does not hinder the acquisition of Dutch, and that Frisian input at home is key to balanced Frisian-Dutch bilingualism (Dijkstra, 2013; Van Ruijven, 2006; Ytsma, 1995, 1999).

Second, the results of this dissertation show that knowledge of one language can support the acquisition of the other. Three findings from this dissertation are notable in this regard: first, the finding that a good command of Frisian inflectional morphology supports the acquisition of Dutch inflectional morphology, especially when lexical items overlap in form (chapter 2); second, the observation that the extent of cross-linguistic lexical transfer depends on the degree of similarity across cognate pairs: the more two words overlap in form and meaning, the more children can benefit from their knowledge of the other language (chapter 3); and third, the finding that over time, children learn the regularities between the Frisian and Dutch phonological systems (chapter 3 and 4). These three findings show that bilingual children who acquire two closely related languages can benefit from the lexical and grammatical similarities that the two languages share.

Finally, the results from this dissertation show that bilingual language acquisition is closely tied to cognitive development. On the one hand, we showed that verbal working memory supports the acquisition of regularities between the Frisian and Dutch phonological systems (chapter 4). On the other hand, we showed that a high degree of bilingualism boosts selective attention to a certain extent. However, the cognitive effect of bilingualism that we found was small, probably negligible in practice, and disappeared as the children grew older (chapter 5 and 6). On a more positive note, though, we also did not find any negative consequences of bilingualism. Therefore, we would advise teachers and policy makers to continue promoting bilingualism, but at the same time, we would recommend them to be very careful with the statement that bilingualism leads to cognitive advantages.
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English summary

Bilingualism and cognition: the acquisition of Frisian and Dutch
English summary

Bilingualism and cognition: the acquisition of Frisian and Dutch
This dissertation is the result of a project in which we examined the interplay between bilingualism and cognition. This was done by means of a longitudinal study with three consecutive annual measurements, in which we followed the linguistic and cognitive development of a group of 120 Frisian-Dutch bilingual children, who were 5 or 6 years old at the first time of testing. Frisian is a regional minority language that is spoken in the Dutch province of Fryslân, where it has official status next to the national majority language Dutch. Historically, Frisian is most closely related to English, but over time Frisian and English have diverged, while Frisian and Dutch have converged (Gooskens & Heeringa, 2004). As a result of this convergence, the Frisian and Dutch language that are spoken nowadays share a large part of their vocabularies and morphosyntactic structures. In this dissertation, we used the extensive overlap between the Frisian and Dutch linguistic system to investigate how cross-language similarity interacts with variables such as exposure, age of onset and cognitive functioning, and to examine whether growing up with two closely related languages has an effect on children’s cognitive capacities.

The measures that were used to assess Dutch language development include the PPVT-III-NL (Dunn & Dunn, 1997; Schlichting, 2005) for receptive vocabulary, the TAK (Verhoeven & Vermeer, 2002) for inflectional morphology and the MAIN (Blom & De Jong, 2013; Gagarina et al., 2012) for the comprehension and production of narratives. Frisian receptive vocabulary and Frisian inflectional morphology were measured with tasks developed for the purpose of this project and the comprehension and production of Frisian narratives were measured with a translation of the MAIN. In the Frisian receptive vocabulary task, cross-language similarity was systematically manipulated through four cognate categories. The measures that were used to assess cognitive development include the Sky Search task (Manly et al., 1998) for selective attention, the Flanker task (Engel de Abreu et al., 2012; Rueda et al., 2004) for interference suppression, the Digit Span task (Alloway, 2012) for verbal memory and the Dot Matrix task (Alloway, 2012) for visuospatial memory.

Individual topics that were examined concern the influence of age of onset on the acquisition of Dutch vocabulary and grammar (chapter 2), the role of cognates in receptive vocabulary acquisition (chapter 3), the role of verbal working memory in the acquisition of cross-linguistic phonological regularities (chapter 4), and, finally, the effect of language balance (chapter 5 and 6) and minority language exposure (chapter 6) on cognitive functioning. These individual studies will be summarized below.
In the first study of this dissertation, described in chapter 2, we investigated the influence of age of onset on the acquisition of Dutch receptive vocabulary and inflectional morphology. The results showed that for inflectional morphology, it does not really matter whether children start learning Dutch at age 0 or at age 4, while for vocabulary, it may be better to start a bit later. Furthermore, for both vocabulary and inflectional morphology, intensity of exposure to Dutch turned out to be a significant predictor. In addition, proficiency at using Frisian inflection significantly predicted proficiency at using Dutch inflection. As the children were more accurate with overlapping items than with non-overlapping items, this was probably due to lexical overlap between Frisian and Dutch.

In chapter 3 of this dissertation, we investigated to what extent the acquisition of cognates among bilingual children depends on degree of cross-language similarity and intensity of exposure to the tested language, and whether children’s sensitivity to cognates with different degrees of cross-language similarity changes over time. In order to answer these questions, we analysed children’s performance on the four cognate categories of the Frisian receptive vocabulary task. The results showed a gradual cognate facilitation effect for children with a low intensity of exposure to Frisian: the higher the degree of cross-language similarity, the better their performance. Furthermore, as they grew older, these children improved the most on non-identical cognates with a simple cross-linguistic phonological regularity between Frisian and Dutch. An example of such a regularity is Frisian -âld [ɔ:t] and Dutch -oud [aut], as in the cognate pairs kâld [kɔ:t] - koud [kaut] ‘cold’ and wâld [wɔ:t] - woud [waut] ‘forest’. This finding suggests that over time, children become better at recognizing regularities between the Frisian and Dutch phonological systems.

In the third study of this dissertation, reported on in chapter 4, we followed up on this last result by examining whether there is a relationship between the acquisition of cross-linguistic phonological regularities and verbal working memory. The results showed that this is indeed the case: verbal working memory had a significantly stronger effect on the acquisition of cognates with a cross-linguistic regularity than on other types of cognates and non-cognates. In line with previous studies that have shown that verbal working memory is related to the acquisition of grammar, but not vocabulary (e.g. Engel de Abreu & Gathercole, 2012; Verhagen & Leseman, 2016), this suggests that verbal working memory plays a role in the acquisition of linguistic regularities.

In chapter 5 of this dissertation, we investigated the cognitive effects of bilingualism and the role of language balance in this domain, comparing the cognitive performance of balanced bilingual children and Dutch-dominant bilingual children. The results showed that
the balanced bilingual children outperformed the Dutch-dominant bilingual children on selective attention and verbal working memory, but not on interference suppression and visuospatial working memory. In line with previous research (e.g. Prior et al., in press; Thomas-Sunesson et al., 2016), this suggests that bilingual cognitive effects are influenced by language balance, although the differences between the two groups were moderate and inconsistent.

In the fifth and last study of this dissertation, described in chapter 6, we conducted a longitudinal study that followed up on the cross-sectional study described in chapter 5. First, we investigated whether language balance, based on vocabulary and morphology scores in both languages, influenced cognitive performance and whether this effect was sustained over a three-year period. Second, we investigated whether intensity of exposure to Frisian at home predicted language balance and whether there was a relationship between intensity of exposure to Frisian at home and cognitive performance. The results showed that intensity of exposure to Frisian at home, mediated by language balance, had an impact on selective attention, but not on interference suppression, verbal working memory and visuospatial working memory. However, the effect on selective attention was only visible at time 1. These results show that substantial minority language exposure at home indirectly affects bilingual children’s cognitive development, but at the same time support previous scepticism about the robustness of the bilingual advantage (Ross & Melinger, 2016).

Taken together, the results from this dissertation deepen our understanding of the relationship between the linguistic and cognitive development of bilingual children growing up with two closely related languages. Due to extensive overlap between the Frisian and Dutch linguistic system, there is much co-activation between the two languages and thus many opportunities for cross-linguistic transfer. The results from this dissertation show how bilingual children can benefit from these cross-linguistic similarities and regularities and the ways in which cognition supports bilingual language acquisition. With regard to the debate about the cognitive effects of bilingualism, this dissertation provides a nuanced perspective.
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Taken together, the results from this dissertation deepen our understanding of the relationship between the linguistic and cognitive development of bilingual children growing up with two closely related languages. Due to extensive overlap between the Frisian and Dutch linguistic system, there is much cross-activation between the two languages and thus many opportunities for cross-linguistic transfer. The results from this dissertation show how bilingual children can benefit from these cross-linguistic similarities and regularities and the ways in which cognition supports bilingual language acquisition. With regard to the debate about the cognitive effects of bilingualism, this dissertation provides a nuanced perspective.

Nederlandse samenvatting

Tweetaligheid en cognitie: de verwerving van het Fries en het Nederlands
Nederlandse samenvatting

Deze dissertatie is het resultaat van een project waarin we de wisselwerking tussen tweetaligheid en cognitie hebben onderzocht. Dit hebben we gedaan door middel van een longitudinale studie met drie opeenvolgende jaarlijkse metingen. Hierin volgden we de taal- en cognitieve ontwikkeling van een groep van 120 Fries-Nederlandse tweetalige kinderen die 5 of 6 jaar oud waren op het eerste meetmoment. Het Fries is een regionale minderheidstaal die wordt gesproken in de Nederlandse provincie Friesland, waar het officiële status heeft naast de nationale meerderheidstaal Nederlands. Historisch gezien is het Fries het meest verwant aan het Engels, maar in de loop der tijd is het Fries steeds minder op het Engels gaan lijken en juist meer op het Nederlands (Gooskens & Heeringa, 2004). Het resultaat hiervan is dat de Friese en de Nederlandse taal die tegenwoordig gesproken worden grote overlap vertonen op het gebied van woordenschat en morfosyntactische structuur. In deze dissertatie hebben we de uitgebreide overlap tussen de twee taalsystemen gebruikt om te onderzoeken hoe gelijkenissen tussen talen interactie vertonen met variabelen zoals taalinput, de leeftijd van eerste blootstelling aan een tweede taal en cognitief functioneren. Verder hebben we onderzocht of het opgroeien met twee nauw verwante talen een effect heeft op de cognitieve capaciteiten van kinderen.

De maten die gebruikt zijn om de Nederlandse taalontwikkeling in kaart te brengen zijn de PPVT-III-NL (Dunn & Dunn, 1997; Schlichting, 2005) voor receptieve woordenschat, de TAK (Verhoeven & Vermeer, 2002) voor inflectionele morfologie en de MAIN (Blom & De Jong, 2013; Gagarina et al., 2012) voor het begrip en de productie van narratieve. Friese receptieve woordenschat en Friese inflectionele morfologie zijn gemeten met taken die speciaal ontwikkeld zijn voor dit project en het begrip en de productie van Friese narratieve zijn gemeten met een vertaling van de MAIN. In de Friese receptieve woordenschattaak is de gelijkenis tussen de talen systematisch gemanipuleerd door middel van vier cognaatcategorieën. De maten die gebruikt zijn om de cognitieve ontwikkeling in kaart te brengen zijn de Sky Search taak (Manly et al., 1998) voor selectieve aandacht, de Flanker taak (Engel de Abreu et al., 2012; Rueda et al., 2004) voor interferentieonderdrukking, de Digit Span taak (Alloway, 2012) voor verbaal geheugen en de Dot Matrix taak (Alloway, 2012) voor visuospatieel geheugen.

Individuele onderwerpen die onderzocht zijn, betreffen de invloed van de leeftijd van eerste blootstelling op de verwerving van Nederlandse woordenschat en grammatica (hoofdstuk 2), de rol van cognaten in de verwerving van receptieve woordenschat (hoofdstuk 3), de rol van verbaal werkgeheugen in de verwerving van cross-linguïstische fonologische regelmatigheden (hoofdstuk 4), en, tot slot, het effect van taalbalans (hoofdstuk 5 en 6) en
taalinput in de minderheidstaal (hoofdstuk 6) op het cognitief functioneren. Deze individuele studies worden hieronder samengevat.

In de eerste studie van deze dissertatie, beschreven in hoofdstuk 2, hebben we onderzoek gedaan naar de invloed van de beginleeftijd van blootstelling op de verwerving van Nederlandse receptieve woordenschat en inflectionele morfologie. De resultaten lieten zien dat het voor inflectionele morfologie niet echt uitmaakt of kinderen vanaf hun geboorte of op hun 4e beginnen met het leren van de Nederlandse taal, terwijl het voor woordenschat beter kan zijn om een beetje later te beginnen. Verder bleek de intensiteit van blootstelling aan het Nederlands een significante voorspeller te zijn van zowel woordenschat als inflectionele morfologie. Daarnaast was de vaardigheid in het gebruik van Friese inflectie een significante voorspeller van de vaardigheid in het gebruiken van Nederlandse inflectie. Omdat de kinderen nauwkeuriger waren met overlappende items dan met niet-overlappende items, werd dit effect waarschijnlijk veroorzaakt door de lexicale overlap tussen het Fries en het Nederlands.

In hoofdstuk 3 van deze dissertatie hebben we onderzocht in hoeverre de verwerving van cognaten bij tweetalige kinderen afhankt van de mate van gelijkenis tussen de talen en de intensiteit van blootstelling aan de geteste taal, en of de gevoeligheid van kinderen voor verschillende soorten cognaten door de tijd heen verandert. Om deze vragen te beantwoorden hebben we de scores op de verschillende cognaatcategorieën van de Friese receptieve woordenschattaak geanalyseerd. De resultaten lieten een gradueel cognaatfacilitatie-effect zien voor kinderen die thuis weinig Fries horen: hoe hoger de mate van gelijkenis tussen de talen, hoe beter hun scores. Verder gingen deze kinderen toen ze ouder werden het meest vooruit op cognaten met een cross-linguïstische fonologische regelmatigheid tussen het Fries en het Nederlands. Een voorbeeld van zo’n regelmatigheid is het Friese -âld [ɔːt] en het Nederlandse -oud [aut], zoals in de cognaatparen kâld [kɔːt] - koud [kaut] en wâld [wɔːt] - woud [waut]. Deze bevinding suggereert dat kinderen door de tijd heen beter worden in het herkennen van de regelmatige correspondenties tussen het Friese en het Nederlandse fonologische systeem.

In de derde studie van dit proefschrift, gerapporteerd in hoofdstuk 4, hebben we verder onderzoek gedaan naar dit laatste resultaat door te kijken of er een relatie is tussen de verwerving van cross-linguïstische fonologische regelmatigheden en verbaal werkgeheugen. De resultaten lieten zien dat dit inderdaad het geval is: verbaal werkgeheugen had een significant sterker effect op de verwerving van cognaten met een cross-linguïstische fonologische regelmatigheid dan op andere typen cognaten en niet-cognaten. In het verlengde
van eerdere studies die hebben aangetoond dat verbaal werkgeheugen gerelateerd is aan de verwerving van grammatica, maar niet aan de verwerving van woordenschat (e.g. Engel de Abreu & Gathercole, 2012; Verhagen & Leseman, 2016), suggereert dit dat verbaal werkgeheugen een rol speelt bij het verwerven van regelmatigheden in taal.

In hoofdstuk 5 van deze dissertatie hebben we onderzoek gedaan naar de cognitieve effecten van tweetaligheid en de rol van taalbalans in dit domein. Dit hebben we gedaan door de cognitieve prestaties van gebalanceerde tweetalige kinderen te vergelijken met die van Nederlands-dominante tweetalige kinderen. De resultaten lieten zien dat gebalanceerde tweetalige kinderen beter presteerden dan Nederlands-dominante tweetalige kinderen op selectieve aandacht en verbaal werkgeheugen, maar niet op interferentieonderdrukking en visuospatieel werkgeheugen. Voortbouwend op eerder onderzoek (e.g. Prior et al., in press; Thomas-Sunesson et al., 2016) suggereert dit dat tweetalige cognitieve effecten beïnvloed worden door taalbalans, alhoewel de verschillen tussen de twee groepen matig en inconsistent waren.

In de vijfde en laatste studie van dit proefschrift, beschreven in hoofdstuk 6, hebben we een longitudinale studie uitgevoerd die de cross-sectionele studie in hoofdstuk 5 opvolgt. Ten eerste hebben we onderzocht of taalbalans, gebaseerd op woordenschat- en morfologiescores in beide talen, invloed had op de cognitieve prestaties en of dit effect zichtbaar bleef gedurende drie jaar. Ten tweede hebben we onderzocht of de hoeveelheid Fries die de kinderen thuis hoorden de taalbalans voorspelde en of er een relatie was tussen de hoeveelheid Fries die de kinderen thuis hoorden en hun cognitieve prestaties. De resultaten lieten zien dat de hoeveelheid Fries die de kinderen thuis hoorden een effect had op hun selectieve aandacht en dat dit effect gemedieerd werd door taalbalans. Er was geen effect op interferentieonderdrukking, verbaal werkgeheugen en visuospatieel werkgeheugen. Het effect op selectieve aandacht was echter alleen zichtbaar tijdens het eerste meetmoment. Deze resultaten laten zien dat een substantiële blootstelling aan de minderheidstaal thuis een indirecte invloed heeft op de cognitieve ontwikkeling van tweetalige kinderen. Tegelijkertijd ondersteunen ze ook eerdere scepsis over de robuustheid van het tweetalige voordeel (Ross & Melinger, 2016).

Samenvattend verdiepen de resultaten van dit proefschrift ons begrip van de relatie tussen de taal- en cognitieve ontwikkeling van tweetalige kinderen die opgroeien met twee nauw verwante talen. Door de uitgebreide overlap tussen het Friese en het Nederlandse taalsysteem is er veel co-activatie tussen de twee talen en zijn er dus veel mogelijkheden voor transfer van de ene naar de andere taal. De resultaten van dit proefschrift laten zien hoe
tweetalige kinderen kunnen profiteren van de gelijkenissen en regelmatigheden tussen hun twee talen en de manieren waarop cognitie de tweetalige taalverwerving ondersteunt. Met betrekking tot het debat over de cognitieve effecten van tweetalige biedt deze dissertatie een genuanceerd perspectief.
Fryske gearfetting

Twataligens en kognysje: de taalwinning fan it Frysk en it Nederlânsk
Fryske gearfetting

Twataligens en kognysje: de taalwinning fan it Fryske en it Nederlânsk
Dizze dissertaasje is it resultaat fan in projekt dêr’t wy de wiikelwurking tusken twataligens en kognysje yn ûndersocht ha. Dat ha wy dien troch middel fan in longitudinale stúdzje mei trije opienfolgende jierlikse mjittingen. Dêryn folgen wy de taal- en kognitive üntjouwing fan in groep fan 120 Frysk-Nederlânske twatalige bern dy’t 5 of 6 jier âld wienen op it earste mijtmomt. It Frysk is in regionale minderheidstaal dy’t sprutsen wurdt yn de Nederlânske provinsje Fryslân, dêr’t it offisjele status hat njonken de nasjonale mearderheidstaal Nederlânsk. Histoarysk besjoen is it Frysk it meast besibbe oan it Ingelsk, mar yn ‘e rin fan ‘e tiid is it Frysk hieltyd minder op it Ingelsk begûn te lykjen en krekt mear op it Nederlânsk (Gooskens & Heeringa, 2004). It resultaat dêrfan is dat de Fryseke en Nederlânske talen dy’t tsjintwurdich sprutsen wurde grutte oerlaap fertoane op it mèd fan wurdskat en morfosyntaktyske struktuur. Yn dizze dissertaasje ha wy de wiidweide oerlaap tusken de twa taalsystemen brûkt om te ûndersykjen hoe’t likenissen tusken talen ynteraksje fertoane mei fariaabelen lykas taalynput, de leeftiid fan earste bleatstelling oan in twadde taal en kognityf funksjonearjen. Hierder ha wy ûndersocht oft it grut wurden mei twa nau besibbe talen in effekt hat op de kognitive kapasiteiten fan bern.

De maten dy’t brûkt binne om de Nederlânske taalûntjouwing yn kaart te bringen binne de PPVT-III-NL (Dunn & Dunn, 1997; Schlichting, 2005) foar reseptive wurdskat, de TAK (Verhoeven & Vermeer, 2002) foar ynfleksjonele morfology en de MAIN (Blom & De Jong, 2013; Gagarina et al., 2012) foar it begryp en de produksje fan narrativen. Fryseke reseptive wurdskat en ynfleksjonele morfology binne metten mei taken dy’t spesjaal ûntwikkele binne foar dit projekt en it begryp en de produksje fan Fryseke narrativen binne metten mei in oersetting fan de MAIN. Yn de Fryseke reseptive wurdskattaak is de likenis tusken de talen systematysk manipulatearre troch middel fan fjouwer kognaatkategoryen. De maten dy’t brûkt binne om de kognitive üntjouwing yn kaart te bringen binne de Sky Search taak (Manly et al., 1998) foar selektive oandacht, de Flanker taak (Engel de Abreu et al., 2012; Rueda et al., 2004) foar ynterferinsjeûnderdrukking, de Digit Span taak (Alloway, 2012) foar ferbaal ûnthâld en de Dot Matrix taak (Alloway, 2012) foar fisuospasjeel ûnthâld.

Yndividuele ûnderwerpen dy’t ûndersocht binne betreffte de ynfloed fan de leeftiid fan earste bleatstelling op it oanlearen fan Nederlânske wurdskat en grammatika (haadstik 2), de rol fan kognaten yn it learen fan reseptive wurdskat (haadstik 3), de rol fan ferbaal wurkûnthâld by it üntdekken fan kross-linguïstyske fonologyske regelmjittichheden (haadstik 4), en, ta beslût, it effekt fan taalbalâns (haadstik 5 en 6) en taalynput yn de minderheidstaal (haadstik 6) op it kognityf funksjonearjen. Dizze yndividuele stúdzjes wurde hjirûnder gearfette.
Yn de earste stúdzje fan dizze dissertaasje, beskreun yn haadstik 2, ha wy ûndersyk dien nei de ynfloed fan de begjinleeftiid fan bleatstelling op it learen fan Nederlânske resaptive wurdskat en ynkleksjonele morfology. De resultaten lieten sjen dat it foar ynkleksjonele morfology net rjocht útmakket oft bern sûnt de berte of op har 4° beginne mei it learen fan de Nederlânske taal, wylst it foar wurdskat better wêze kin om in bytsje letter te beginnen. Fierder dien die bliken dat de yntensiteit fan bleatstelling oan it Nederlânsk in signifikante foarsizzer is fan sawol wurdskat as ynkleksjonele morfology. Dërnjonken wie de feardichheid yn it brûken fan Fryske ynkleksje in signifikante foarspeller fan de feardichheid yn it brûken fan Nederlânske ynkleksje. Om’t de bern sekerder wienen mei oerlaapjende items as mei net-oerlaapjende items, waard dit effekt wierskynlik teweibrocht troch de leksikale oerlaap tusken it Frysk en it Nederlânsk.

Yn haadstik 3 fan dizze dissertaasje ha wy ûndersocht yn hoefier’t it learen fan kognaten by twatalige bern ûninget fan de mjitte fan likenis tusken de talen en de yntensiteit fan bleatstelling oan de teste taal, en oft de gefoeligens fan bern foar ûnderskate soarten kognaten troch de tiid hinne feroaret. Om dizze vrogan te beëntwurjdzen ha wy de skoares op de ferskillende kognaatkategoryen fan de Fryske resaptive wurdskattakaan analysearre. De resultaten lieten in gradeel kognaatfasilitaasje-effekt sjen foar bern dy’t thús net in soad Frysk hearre: wat heger de mjitte fan likenis tusken de wurden yn de twa talen, wat better oft se skoarden. Fierder gongen de bern doe’t se âlder waarden it meast foarút op kognaten mei in kross-linguïstyske fonologyske regelmjittichheid tusken it Frysk en it Nederlânsk. In foarbyld fan sa’n regeljmittichheid is it Fryske -âld [ɔ:lt] en it Nederlânske -oud [aut], lykas yn de kognaatpearen kâld [kɔ:lt] - koud [kaut] en wâld [wɔ:lt] - woud [waut]. Dizze útkomst suggerearret dat bern troch de tiid hinne better wurde yn it werkennen fan de regeljmittichheden tusken it Frysk en it Nederlânsk fonologyske systeem.

Yn de tredde stûdzje fan dizze proefskrift, rapportearre yn haadstik 4, ha wy fierder ûndersyk dien nei dat lêste resultaat troch te sjen oft der in relaasje is tusken it learen fan kross-linguïstyske regeljmittichheden en ferbaal wurkûnthâld. De resultaten lieten sjen dat dit yndie it gefal is: ferbaal wurkûnthâld hie in signifikant sterk er effekt op it learen fan kognaten mei in kross-linguïstyske fonologyske regeljmittichheid as op oare typen kognaten en net-kognaten. Yn it ferlingde fan eardere stûdzjes dy’t oantoand ha dat ferbaal wurkûnthâld relatearre is oan de winning fan grammatika, mar net oan de winning fan wurdskat (e.g. Engel de Abreu & Gathercole, 2012; Verhagen & Leseman, 2016), suggerearret dit dat ferbaal wurkûnthâld in rol spilet by it learen fan regeljmittichheden yn taal.
Yn *haadstik 5* fan dizzze dissertaasje ha wy ūndersyk dien nei de kognitive effekten fan twataligens en de rol fan taalbalâns yn dat domein. Dat ha wy dien troch de kognitive prestaasjes fan balansearre twatalige bern te ferlykjen mei dy fan Nederlânsk-dominante twatalige bern. De resultaten lieten sjen dat balansearre twatalige bern better prestearje as Nederlânsk-dominante twatalige bern op selektive oandacht en ferbaal wurkûnthâld, mar net op ynterferinsjeûnderdrukking en fisuospasjeel wurkûnthâld. Trochbouwend op earder ūndersyk (e.g. Prior et al., in press; Thomas-Sunesson et al., 2016) suggerearret dit dat twatalige kognitive effekten beynfloede wurde troch taalbalâns, alhoewolt de ferskillen tusken de groepen beheind en ynkonsistint wienen.

Yn de fiifde en lêste stúdzje fan dit proefskrift, beskreauyn yn *haadstik 6*, ha wy in longitudinale stúdzje útfierd dy’t de kross-seksjonele stúdzje yn haadstik 5 opfolget. Earst ha wy ūndersocht oft taalbalâns, basearre op wurdskat- en morfologyskoares yn beide talen, ynfloed hie op de kognitive prestaasjes en oft dit effekt trije jier lang sichtber bleau. Twads ha wy ūndersocht oft de hoemannichte Frysk dy’t de bern thús hearden de taalbalâns foarsizze koe en oft der in relaasje wie tussen de hoemannichte Frysk dy’t de bern thús hearden en har kognitive prestaasjes. De resultaten lieten sjen dat de hoemannichte Frysk dy’t de bern thús hearden in effekt hie op har selektive oandacht en dat dit effekt mediearre waard troch taalbalâns. Der wie gijn effekt op ynterferinsjeûnderdrukking, ferbaal wurkûnthâld en fisuospasjeel wurkûnthâld. It effekt op selektive oandacht wie lykwols allinnich sichtber op it earste mjitmomint. Dizze resultaten litte sjen dat in substansjele bleatstelling oan de minderheidstaal in yndirekte ynfloed hat op de kognitive Żntjouwing fan twatalige bern. Tagelyk stypje se ek eardere skepsis oer de robustens fan it twatalige foardiel (Ross & Melinger, 2016).

Gearfetsjend ferdjipje de resultaten fan dit proefskrift ús begryp fan de relaasje tusken de taal- en kognitive Żntjouwing fan twatalige bern dy’t opgroeiie mei twa ing besibbe talen. Troch de wiidweidige oerlaap tusken it Frysk en it Nederlânske taalsysteem is der in soad ko-aktivaausjes tusken de twa talen en binne der dus in soad mooglikheden foar transfer fan de iene nei de oare taal. De resultaten fan dit proefskrift litte sjen hoe’t twatalige bern profitearje kinne fan de oerienkomsten en regelmjittichheden tusken har twa talen en hoe’t kognysje de twatalige taalwinning stipet. Oangeande it debat oer de kognitive effekten fan twataligens biedt dizze dissertaasje in nuansearre perspektyf.
This dissertation investigates the interplay between bilingualism and cognition. This is done by examining the linguistic and cognitive development of 5- to 8-year-old children who grow up in Fryslân, a bilingual province in the north of the Netherlands where both Frisian and Dutch are spoken. The Frisian and Dutch language that are spoken nowadays share a large part of their vocabularies and morphosyntactic structures. This extensive overlap between the two linguistic systems offers a rich opportunity to investigate how cross-language similarity interacts with variables such as exposure, age of onset and cognitive functioning, and to investigate whether growing up with two closely related languages has an effect on children's cognitive capacities. By following 120 Frisian-Dutch bilingual children over the course of three years, this dissertation seeks to deepen our understanding of the ways in which language and cognition interact.