Effects of language impairment and bilingualism across domains

Vocabulary, morphology and verbal memory

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Purpose: This study examined the effects of language impairment (LI) and bilingualism across vocabulary, morphology and verbal memory in a sample of children learning Dutch. Methods: Children (M_{AGE} = 71 months) were assigned to a monolingual group with typical development (TD) (n = 30), bilingual TD (n = 30), monolingual LI (n = 30) or bilingual LI group (n = 30). Vocabulary was measured with the Peabody Picture Vocabulary Test, morphology with the Taaltoets Alle Kinderen, verbal short-term (VSTM) and working memory (VWM) with forward and backward digit span tasks. Results: Language knowledge (vocabulary, morphology) was affected by LI and bilingualism. Language processing (VSTM, VWM) was influenced by LI only. When language knowledge was controlled, the bilinguals outperformed the monolinguals on VSTM and VWM when TD and LI were collapsed. Bilingualism aggravated the effects of LI for vocabulary. Conclusions: Bilingualism may create a risk for the vocabulary knowledge of children with LI, but might be beneficial for their verbal memory.

Keywords: language impairment, bilingualism, knowledge and processing

1. Introduction

About 5 to 7% of children have an inborn impairment that disproportionally and selectively affects their ability to learn language (Bishop, 2010; Tomblin et al., 1997). These children display a significant delay in learning language that cannot be attributed to hearing loss, low nonverbal intelligence or neurological damage (Leonard, 2014a), hence a language delay with no identifiable cause. Like children with a typical language development (TD), children with a language impairment (LI) can grow up in language environments where more than one

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language is spoken and, as a result, become bilingual. The main aim of this study was to investigate the separate and combined effects of LI and bilingualism across multiple domains.

Several studies have shown that bilingual children tend to receive less language input in one language compared with monolingual children learning the same language (Unsworth, 2013) and, as a result, show language delays (Hoff et al., 2012; MacLeod, Fabiano-Smith, Boegner-Pagé, & Fontolliet, 2013). Identifying overlap between the effects of LI and bilingualism is important for determining the risk of over-diagnosis of LI in bilingual settings and for locating those areas where bilingual children with LI may experience a double delay (Armon-Lotem, 2012; Kohnert, 2010; Paradis, 2010; Paradis, Rice, Crago, & Marquis, 2008). Other studies have shown that dual language management can accelerate children's cognitive development, but it is virtually unknown if bilingual children with LI show the same bilingual cognitive benefits as bilingual children with TD (Engel de Abreu, Cruz-Santos, & Puglisi, 2014). While most studies on bilingual children with LI focus on one language area (cf. Blom, De Jong, Orgassa, Baker, & Weerman, 2013; Clahsen, Rothweiler, Sterner, & Chilla, 2014; Gutiérrez-Clellen, Simon-Cereijido, & Wagner, 2008; Orgassa & Weerman, 2008; Paradis, 2007; Rothweiler, Chilla, & Clahsen, 2012; Verhoeven, Steenge, & Van Balkom, 2011), the present study was designed to provide a more balanced overview of the risks and benefits of bilingualism for children with LI. To this end, we compared four groups of children – monolingual with TD, monolingual with LI, bilingual with TD, bilingual with LI – on their performance on vocabulary, morphology and verbal memory tasks.

The domains investigated in this study vary along two dimensions. First, domains are distinguished based on whether they concern language knowledge (vocabulary, morphology) or language processing (verbal short-term and working memory). Investigating processing-based measures that tap into verbal memory is important, because in this domain bilingualism might equip children with protective mechanisms (Blom, Küntay, Messer, Verhagen, & Leseman, 2014). These variables thus allow us to distinguish between those domains where bilingualism may be a risk (language knowledge) or a strength (language processing) for children with LI. The secondary goal of the study was to gather more insight into the deficit that underlies LI. Therefore, a second distinction was made between language domains that rely on declarative (vocabulary, irregular morphology) or procedural memory (regular morphology). The distinction is relevant to evaluate approaches to LI that propose more selective delays in the domain of regular morphology (Ullman & Pierpont, 2005) or more general language delays (Gathercole & Baddeley, 1993).

1.1 Effects of language impairment

Children with LI demonstrate an array of language problems, but certain areas are more severely affected by the impairment than others (Leonard, 2014a). Vocabulary is one domain where children with LI show persistent delays (Rice & Hoffman, 2015), but more profound delays are generally found in the domain of functional morphology. English-speaking children with LI show severe delays for tense morphology (e.g., third person *-s*, past tense *-ed*) (Rice, 2003). In German and Dutch, agreement morphology can be delayed (German; Clahsen, Bartke, & Göllner, 1997; Eisenbeiss, Bartke, & Clahsen, 2005; Dutch: De Jong, 1999; Blom, Vasić, & De Jong, 2014) while in languages such as French (Jakubowicz, 2003), Greek (Tsimpli, 2001), or Italian (Bortolini et al., 2006) clitics are the locus of extreme difficulties of children with LI. Other studies report effects of LI on pluralization (English: Oetting & Rice, 1993; German: Kauschke, Kurth, & Domahs, 2011) or case marking (Wexler, 1998).

Interestingly, many studies that investigated tense morphology in English children with LI found effects of LI for regular (*walk-walked*) but not for irregular tense marking (*teach-taught*) (Bedore & Leonard, 1998; Conti-Ramsden, 2003; Oetting & Horohov, 1997; Rice, Wexler, & Cleave, 1995). This discrepancy between regular and irregular morphology is not limited to tense morphology but extends to noun plurals (Oetting & Rice, 1993). A theoretical model that captures this observation is the Procedural Deficit Hypothesis (PDH; Ullman & Pierpont, 2005). The basic assumption that underlies the PDH is that learning predictable sequences is subserved by the procedural memory system, while the storage of facts, events and arbitrary relations is subserved by the declarative memory system (Ullman, 2001). Regular forms are predictable and can be generated on the fly using a rule (e.g., V_{stem}+ *-ed*) and are, as such, assumed to be stored within the procedural memory system, while irregular forms have to be memorized. The PDH holds that abnormalities of brain structures underlying procedural memory cause the language deficits in children with LI. Consequently, regular morphological patterns – regardless of whether these are morphosyntactic (e.g., agreement) or morphophonological (e.g., past tense) in nature – may be severely affected by LI, while irregular morphology and, more in general, vocabulary is relatively spared (Ullman & Pierpont, 2005; Van der Lely & Ullman, 2001).

The procedural and declarative memory systems are part of the long-term memory system and can be considered a learner's language knowledge, but children with LI are also often outperformed by their TD peers on language processing tasks (Gathercole & Alloway, 2006; Montgomery, Magimairaj, & Finney, 2010). Children with LI have difficulties with the temporary storage of verbal information and display verbal short-term memory (VSTM) deficits in simple span tasks (Ellis

Weismer et al., 2000; Gathercole & Baddeley, 1990; Marton & Schwartz, 2003), as well as verbal working memory (VWM) deficits in more complex tasks that also require manipulation of the information stored (Archibald & Gathercole, 2006; Henry, Messer, & Nash, 2012; Marton & Schwartz, 2003), even when differences in language knowledge between TD and LI are controlled (Lum, Conti-Ramsden, Page, & Ullman, 2012).

These observations have led researchers to the hypothesis that verbal processing limitations are the main cause of the language problems of children with LI (see for an overview: Marinis, 2011). Children with LI may suffer from less efficient processing and reduced intake due to imprecise segmental analysis and faster decay of phonological traces. This will affect their lexical representations and, as a result, also their morphological and syntactic analysis (Gathercole, 2006; Gathercole & Baddeley, 1990, 1993). This explanation is supported by studies that find relationships between children's performance on processing tasks and their language outcomes (Ellis Weismer, 1996; Leonard et al., 2007; but see Lum et al., 2012). Leonard (2007) points out that specifically morphemes with low perceptual salience or complex form-function mappings may be prone to the effects of less efficient verbal processing. Cross-linguistic variation in the morphophonological and morphosyntactic properties of functional morphemes may in turn explain the cross-linguistic profile of LI (Leonard & Bortolini, 1998; Leonard, 2014b).

In sum, both language knowledge and language processing are affected by LI. Some researchers emphasize that long-term, procedural memory deficits are the main cause of the language problems observed in LI. According to this view, verbal processing limitations exist in children with LI but are not necessary for the presence of LI, unlike procedural memory deficits (Lum et al., 2012; Ullman & Pierpont, 2005). Other researchers argue that processing limitations such as less VSTM and VWM capacity and slower speed of processing are the main cause of the language profile of children with LI. In the present study, we examined a range of variables allowing us to investigate if the symptoms of LI in Dutch are more broadly manifested, as predicted by the processing hypotheses, or show a more selective pattern affecting specifically regular morphology, as predicted by the PDH.

1.2 Effects of bilingualism

Bilingual children generally have less time on task for each language compared with their monolingual peers (MacLeod et al., 2013; Unsworth, 2013). Research has shown that strong relationships exist between exposure to a language and abilities in that language (Thordardottir, 2011, 2015). As a result of dual language exposure and thus less exposure in one language, bilingual children's vocabulary and grammar development can indeed be slower than the development of monolingual children (Scheele, Leseman, & Mayo, 2010; Hoff et al., 2012). The consequence is that the effects of less exposure due to the distributed nature of the input add up to the effects of LI and lead to double delays; however, not all domains are equally influenced by exposure or dual language management. In this section, we review these effects of bilingualism across domains and discuss the implications for bilingual children with LI.

Delays due to bilingualism may be especially persistent for vocabulary because it is a moving target (Cummins, 2000). For instance, while the vocabulary size of monolinguals keeps increasing throughout the life span, performance on morphological rules is at ceiling during childhood (Golberg, Paradis, & Crago, 2008). Marinis and Chondrogianni (2010) indeed observed that child second language learners of English converge sooner to monolingual English norms for grammar than for vocabulary comprehension. Bilingualism may furthermore affect regular and irregular morphology differently. According to the PDH, exposure to multiple instances strengthens associations in declarative memory and because of this, learning irregular forms can be more time-consuming than learning regular forms, which is more instantaneous and less dependent on exposure (Van der Lely & Ullman, 2001). Also, regular forms have a high type frequency, allowing fast generalization and acquisition based on a small amount of exposure. Irregular forms, in contrast, have a low type frequency and can only be learned based on repeated exposure to the same form (Bybee, 2007).

Verhoeven, Steenge, Van Weerdenburg and Van Balkom (2011) indeed observed a double delay in the domain of vocabulary, because the bilingual group with LI was outperformed by the monolingual group with LI as well as the bilingual group with TD. In the domain of morphology they also found a double delay, an observation that contrasts with other studies (Blom, De Jong, Orgassa, Baker, & Weerman, 2013; Clahsen et al., 2014; Gutiérrez-Clellen et al., 2008; Paradis, 2007; Rothweiler, Chilla, & Clahsen, 2012). Orgassa and Weerman (2008) observed a double delay for Dutch adjective-noun agreement. However, accurate use of adjectival inflection in Dutch requires knowledge of the gender of nouns, which is an opaque property that is learned word-by-word (Blom, Polišenská, & Weerman, 2008) and sensitive to the amount of exposure. Clahsen et al. (2014) compared German regular and irregular participles across monolingual children with LI, bilingual children with LI and bilingual children with TD. Neither for regular nor for irregular participles double delays emerged, nor did they observe an effect of LI for regular participles, contra the PDH. A previous study with the same sample did point to more selective deficits with respect to subject-verb agreement (Rothweiler et al., 2012).

Research with cultural minorities (Ellis Weismer et al., 2000) suggests that VSTM is minimally influenced by environmental factors, although exposure may indirectly influence VSTM via language knowledge. Engel de Abreu (2011) observed that bilingual children performed lower on a non-word repetition task than monolinguals, but when vocabulary was covaried, the difference was not significant anymore. Regarding VWM, Engel de Abreu, Baldassi, Puglisi and Befi-Lopes (2013) found that bilingual and monolingual children showed equal performance. In this study, VWM was tested through a backward digit recall task in which children had to manipulate the information stored in VSTM by reversing the order of this information. Using the same task, but covarying SES and vocabulary, Blom et al. (2014) found that bilingual children outperformed monolingual children. This bilingual advantage may be caused by children's experience with dual language management resulting in enhanced executive functions (Adesope, Lavin, Thompson, & Ungerleider, 2010; Barac, Bialystok, Castro, & Sanchez, 2014). Engel de Abreu et al. (2014) suggest that the effects of bilingualism compensate the effects of LI with respect to executive functioning, but they did not directly compare bilingual and monolingual children with LI.

Taken together, studies with bilingual children with LI suggest that there is some evidence for double delays in the domain of vocabulary. At first sight, most studies do not confirm double delays for regular morphology. There is furthermore some indirect evidence for the hypothesis that positive effects of bilingualism may counteract negative effects of LI. Further research is needed into the combined effects of bilingualism and LI. In this respect it is relevant to note that few studies have compared the size of the effect of LI in monolingual and bilingual contexts. Possibly, the delay in bilingual children with LI goes *beyond* a simple addition of the effects LI and bilingualism. The reason is that the effect of processing limitations on the intake of input information may be more pronounced if exposure is reduced, as is the case for many bilinguals. For instance, research has shown that effects of LI are more pronounced for low frequency phenomena compared to higher frequency phenomena (Leonard, Davis, & Deevy, 2007). In this case, bilingualism may aggravate the effects of LI. Such aggravating effects can be identified if the size of the LI effect is larger in a bilingual than in monolingual context (Paradis, 2010).

1.3 Research questions and predictions

For this study, three research questions were formulated. The first research question addressed the overlap between LI and bilingualism: *Do LI and bilingualism have the same or different effects on vocabulary, morphology, verbal short-term memory and verbal working memory?* We expected similar effects of LI and bilingualism with respect to language knowledge (vocabulary, morphology), thus lower performance for LI than TD and lower performance for bilinguals than monolinguals.

Regarding verbal processing (VSTM, VWM), differential effects of LI and bilingualism were expected. More specifically, LI may affect VSTM and VWM negatively, while no or positive effects of bilingualism were expected. The PDH furthermore predicts that the effect of LI may be stronger for regular morphology than for vocabulary and irregular morphology. On the other hand, negative effects of bilingualism may be stronger for irregular than for highly regular morphology.

The second research question concerned the combined effect of LI and bilingualism: *Do bilingual children with LI show additive effects of LI and bilingualism, and is this different across domains?* Because it was expected that both LI and bilingualism influence the knowledge-based measures (vocabulary, morphology), we predicted additive effects of LI and bilingualism in those domains. We did not predict differential effects for vocabulary, irregular morphology and regular morphology for the following reason: vocabulary and irregular morphology could be relatively more influenced by bilingualism than regular morphology, whereas regular morphology could be more affected by LI than vocabulary and irregular morphology. The processing-based measures (VSTM, VWM) were not expected to display additive effects of bilingualism and LI, and it could even be possible that the bilingual group with LI would outperform the monolingual group with LI on these tasks.

The third research question addressed the issue of how the bilingual context affects the severity of LI: *Is the effect of LI different in bilingual and monolingual contexts?* If children with LI indeed experience difficulties processing the input, a bilingual learning context may aggravate the effects of LI, hence the difference between TD and LI would be larger in the bilingual sample than in the monolingual sample. This may be most relevant for language properties that rely strongly on exposure (vocabulary, irregular morphology). The effects of LI may be weaker in a bilingual than in a monolingual context for those domains that are positively influenced by bilingualism (VWM); in this case the difference between LI and TD may be smaller in a bilingual than in a monolingual context.

2. Method

2.1 Participants

This study used the same participant sample as Boerma and colleagues (2015), including 120 children. More than 90% of the children were 5 or 6 years old at time of testing. Each group (monolingual TD (MOTD), monolingual LI (MOLI), bilingual TD (BITD), bilingual LI (BILI)) contained 30 children. Children were considered monolingual if both parents always spoke Dutch to them. They were regarded as bilingual if one or both parents were native speakers of a language other than Dutch and spoke their native tongue with the child for an extensive period of the child's life. In this respect, we followed Kohnert's (2010) definition of bilingualism according to which individuals who receive regular input in two or more languages during the most dynamic period of communication development, are bilingual (p. 456). All bilingual children in our sample received some exposure to Dutch before the age of 4 and much exposure to Dutch from the age of 4 onwards, when they went to full day kindergarten. Between the ages of 0 and 4, the relative amounts of exposure to the two languages varied greatly across children. Importantly, the two bilingual groups were matched on amount of exposure to Dutch before the age of 4 and current exposure to Dutch at home (Table 1) based on the Questionnaire for Parents of Bilingual Children (PaBiQ; Tuller, 2015). A univariate ANOVA showed no significant differences between the bilingual groups (TD, LI) in exposure to Dutch before the age of 4 ($F(1, 58) = .06$, $p = .81$, $\eta_p^2 = .00$) nor in current exposure to Dutch at home ($F(1, 58) = 1.9$, $p = .18$, $\eta_p^2 = .03$). The first languages of the bilingual TD children included Turkish ($n = 13$), Tarifit-Berber ($n = 11$) and Moroccan Arabic ($n = 6$). The first languages of the bilingual children with LI were Turkish ($n = 8$), Moroccan Arabic ($n = 7$), Egyptian Arabic ($n = 3$), Tarifit-Berber ($n = 2$), Dari ($n = 2$), Pashto ($n = 1$), Suryoyo ($n = 1$), Kirundi ($n = 1$), Russian ($n = 1$), Chinese ($n = 1$), Portuguese ($n = 1$), Danish ($n = 1$) and Frisian ($n = 1$).

Children with TD were recruited via regular elementary schools. Children with LI were recruited through two national organizations in the Netherlands (Royal Dutch Kentalis and Royal Auris Group) that provide diagnostic, care and educational services for children with language difficulties. All children with LI had been diagnosed by independent, licensed professionals on the basis of a standardized protocol before participating in the present study. A score of at least 2 standard deviations (*SD*) below the mean on an overall score of a standardized language assessment test battery or a score of at least 1.5 *SD* below the mean on two out of four subscales of this standardized language assessment were the inclusion criteria for LI in this study. The most common test batteries used include the Dutch version of the Clinical Evaluation of Language Fundamentals (CELF-4-NL; Kort, Schittekatte, & Compaan, 2008) and the Schlichting Test for Language Production and Comprehension (Schlichting & Lutje Spelberg, 2010a, b). Exclusion criteria were the presence of a hearing impairment, intellectual disability and severe articulatory difficulties as determined by a certified professional.

The four groups of children were matched on age in months, nonverbal IQ and, to the extent that this was possible, SES. Nonverbal IQ was measured with the short version of the Wechsler Nonverbal-NL (Wechsler & Naglieri, 2008) and SES was based on the education level of both parents. In cases where precise matching on child level was not possible, a child was matched on group level. Group

Table 1. Characteristics of the participants (from Boerma et al., 2015)

	Age in months		Nonverbal IQ		Socio-Economic Status[a]		Sex	Exposure to Dutch before the age of 4 in %		Current exposure to Dutch at home in %	
	M	R	M	R	M	R	B/G	M	R	M	R
MOTD	71.7 (6.7)	59–84	102.5 (14.4)	81–128	6.6 (2.1)	2–9	20/10 (67%)	n/a	n/a	n/a	n/a
MOLI	71.9 (7.3)	59–87	97.8 (12.8)	72–118	5.7 (2.0)	2–9	22/8 (73%)	n/a	n/a	n/a	n/a
BITD	71.4 (7.5)	54–83	96.7 (14.1)	70–126	4.8 (2.4)	1–9	12/18 (40%)	42.3 (8.1)	25–57	50.7 (13.9)	23–83
BILI	72.6 (8.8)	58–86	96.0 (14.8)	71–124	5.7 (2.3)	2–9	21/9 (70%)	41.7 (10.8)	20–67	45.2 (17.1)	14–100[b]

Note. MOTD = monolingual typically developing; MOLI = monolingual language impaired; BITD = bilingual typically developing; BILI = bilingual language impaired; M = mean; SD = standard deviation; R = range; B/G = boys/girls; n/a = not applicable (this information was only collected for the bilinguals).

a. The Socio-Economic Status index can range from 1 to 9, with 1 indicating 'no education' and 9 indicating 'university degree'.

b. Due to severe difficulties learning their native tongue, parents of one child with LI decided to consistently speak Dutch to the child when he entered elementary school (explaining the 100% current exposure to Dutch at home). Before this, he was exposed to Dutch 50% of the time.

characteristics are presented in Table 1. There were no significant age differences as shown by a univariate ANOVA with group (MOTD, MOLI, BITD, BILI) as the independent variable ($F(3, 116) = .14$, $p = .94$, $\eta_p^2 = .00$) nor were there any differences in nonverbal IQ ($F(3, 116) = 1.3$, $p = .28$, $\eta_p^2 = .03$). SES did differ significantly across the four groups, reflecting lower SES in the bilingual TD group compared to the monolingual TD group ($H(3) = 8.06$, $p = .045$).

2.2 Tasks and procedures

This research was screened by the Standing Ethical Assessment Committee of the Faculty of Social and Behavioral Sciences at Utrecht University. Criteria were met and further verification was not deemed necessary. Parents of participants signed an informed consent. All children were individually tested in a quiet room at their school. They completed a battery of tests tapping into language, memory and attention. All children were tested by a native speaker of Dutch in two separate sessions, each lasting approximately one hour. Verbal memory was assessed in the first session and receptive vocabulary and morphology were tested in the second session.

Receptive vocabulary

Dutch receptive vocabulary was measured with the Peabody Picture Vocabulary Test (PPVT-III-NL; Schlichting, 2005). The PPVT is a standardized receptive vocabulary test in which a child hears a stimulus word and has to choose the correct referent out of four pictures. The PPVT contains 204 items divided over 17 sets. The sets are ordered according to difficulty and each set consists of twelve items. The PPVT-III-NL was administered and scored according to the official guidelines. This means that the starting set was determined by a child's age and the task was terminated after a child produced nine or more errors within one set. Raw scores were converted to standardized scores based on age-corrected normative scores.

Morphology

Grammatical morphology was tested with the TAK Word Formation, a subtest of the Dutch Language Proficiency Test for All Children (Taaltoets Alle Kinderen (TAK); Verhoeven & Vermeer, 2001). Children were presented with a picture and were asked to finish an incomplete sentence, hereby eliciting the plural of a noun, as illustrated in (1), or the past participle of a verb, as illustrated in (2).

(1) Dit is één lepel, dit zijn twee…? Lepels.
this is one spoon, these are two…? Spoons-plural

(2) Hier zie je Paul op de bank zitten. Gisteren heeft hij ook al op de
here see you Paul on the couch sit. Yesterday has he also already on the
bank…? Gezeten.
couch…? Sat-participle
'Here you see Paul sitting on the couch. Yesterday he also … on the couch? Sat.'

The task included 24 items of which the first half targeted plurals and the second half targeted past participles. Each half was preceded by three practice items that familiarized the children with the procedure. Items in this task fall into three classes. The noun classes included plural forms ending with *-en* (e.g., *bril-brillen* brɪl – brɪlən 'glass-glasses'), plural forms ending with *-s* (e.g., *emmer-emmers* ɛmər – ɛmərs 'bucket-buckets'), plural forms with stem vowel lengthening, ending with *-en* (e.g., *gat-gaten* ɣat – ɣatən 'hole-holes'). The verb classes included past participles with the circumfix *ge_t/d* (e.g., *koken-gekookt* kokən – ɣəkokt 'cook-cooked'), past participles with the circumfix *ge_en* and the alternation of the stem vowel (e.g., *vliegen-gevlogen* vliɣən – ɣəvloɣən 'fly-flown'), and past participles with the circumfix *ge_t* or *ge_en* (except for one item that had no participial prefix) and a significant stem change, beyond the stem vowel (e.g., *brengen-gebracht* brɛŋən – ɣəbraxt 'bring-brought'). For the sake of power, nouns and verbs were collapsed. To address the issue of regularity, specific analyses focused on the most regular and irregular classes within the nouns and past participles. Regular morphology included *-en* plurals and *ge_t/d* past participles (8 items) while irregular morphology included *-en* plurals with vowel lengthening and part participles ending on either *-t* or *-en* and a significant stem change, beyond the stem vowel (8 items).

A correct answer was awarded one point, with a maximum of 24 points for all items, and a maximum of eight points for both regular and irregular items. Incorrect formations of the plural noun were omissions of the plural suffix, use of an incorrect suffix or, if applicable, no lengthening of the stem vowel. Phonological errors in the stem of the noun were not considered incorrect. Final *-n* deletions were also not considered incorrect because the final *-n* in syllabic suffixes is most often not pronounced in Dutch, resulting in a suffix *-e* instead of *-en*. Incorrect formations of the past participle included omissions of the prefix or suffix, use of an incorrect prefix or suffix, and, if applicable, absent or incorrect changes to the stem.

Verbal short-term and working memory

VSTM and VWM memory were measured with a forward digit span task and backward digit span task, respectively. These tasks were adapted from the Automated Working Memory Assessment (AWMA; Alloway, 2007) and translated into Dutch. A native speaker of Dutch prerecorded the instructions and stimuli.

The tasks were administered on a laptop using the experimental software E-Prime 2.0 (Schneider, Eschman, & Zuccolotto, 2002). In the forward digit span task, children were asked to repeat a sequence of digits in the correct order, assessing the temporary storage of verbal information. The task started with a block of trials with one digit and continued with digit sequences of increasing length, up to seven digits. In the backward digit span task, a similar procedure was followed, with the exception that children were asked to repeat the sequences in backward order and were thus required to both store and manipulate the incoming stimuli. Prior to each task, two practice items familiarized the child with the procedure. A child proceeded to the next block if four out of six trials were repeated correctly. The task was terminated if three trials within one block were incorrectly repeated. This entailed a wrong ordering of the sequence, an omission of one or more digits or a repetition of one or more incorrect digits. Following the AWMA, a child received one point for each correctly repeated sequence and was awarded six points if the first four trials within a block were correct. Scores could thus range from 0 to 42.

3. Results

3.1 Effects of LI and bilingualism across domains

The first question addressed was: *Do LI and bilingualism have the same or different effects on vocabulary, morphology, verbal short-term memory and verbal working memory?* Table 2 illustrates the means and standard deviations for TD versus LI and for monolinguals versus bilinguals across the domains tested. Note that for the regular and irregular morphology we decided to focus on the most regular and irregular classes within the nouns and past participles. Therefore, the regular

Table 2. Mean (standard deviations) in the TD versus LI and MO versus BI group for receptive vocabulary, morphology, VSTM, and VWM

	TD	LI	MO	BI
Receptive vocabulary[a]	102.76 (15.30)	86.33 (14.41)	102.95 (15.41)	85.86 (13.87)
Morphology (max. 24)	14.20 (5.49)	8.69 (4.40)	13.62 (5.07)	9.29 (5.46)
Regular (max. 8)	5.97 (2.15)	4.39 (2.11)	5.93 (1.65)	4.42 (2.55)
Irregular (max. 8)	2.05 (2.13)	.47 (.90)	1.78 (2.19)	.75 (1.12)
VSTM (max. 42)	20.13 (4.20)	15.43 (3.72)	18.45 (5.03)	17.12 (4.07)
VWM (max. 42)	12.17 (3.63)	8.62 (3.21)	10.73 (4.02)	10.05 (3.68)

Note. TD = typical development; LI = language impairment; MO = monolingual; BI = bilingual; VSTM = verbal short-term memory; VWM = verbal working memory

a. For receptive vocabulary normed quotient scores were used with mean = 100.

and irregular items do not add up to 24, which is the total number of items on the morphology task.

Effect of LI
A univariate ANOVA with Language Impairment (TD, LI) as the independent variable revealed that the children with LI were outperformed by the children with TD on receptive vocabulary, $F(1, 116) = 36.06$, $p < .001$, $\eta_p^2 = .24$, and morphology, $F(1, 117) = 36.40$, $p < .001$, $\eta_p^2 = .24$. The magnitude of the difference was the same for vocabulary and morphology. Neither the regular nor the irregular items that were part of the morphology test were normally distributed. Mann-Whitney tests revealed that the TD group performed more accurately than the LI group on regular ($p < .001$, $r = .35$) and irregular items ($p < .001$, $r = .43$); the magnitude of the difference between TD and LI was larger for irregulars than for regulars, as indicated by a comparison of the effect sizes. Significant differences between TD and LI also emerged for the two verbal memory tasks, as indicated by a MANOVA, $F(2, 117) = 24.79$, $p < .001$, $\eta_p^2 = .30$. Post-hoc tests revealed that the children with TD obtained higher scores than the children with LI on VSTM, $F(1, 118) = 42.10$, $p < .001$, $\eta_p^2 = .26$, and on VWM, $F(1, 118) = 32.18$, $p < .001$, $\eta_p^2 = .21$.

Effect of bilingualism
The monolingual children outperformed the bilingual children on receptive vocabulary as shown by the outcomes of a univariate ANOVA, $F(1, 116) = 40.05$, $p < .001$, $\eta_p^2 = .26$. The monolingual children were also more accurate than the bilinguals on morphology, $F(1, 117) = 22.11$, $p < .001$, $\eta_p^2 = .15$. Two Mann-Whitney tests yielded a significant result for all regulars ($p = .002$, $r = .33$) and irregulars ($p = .010$, $r = .29$), also with a Bonferroni-corrected $\alpha = .025$. A comparison of the effect sizes suggests that the monolinguals differed slightly more from bilinguals in their performance on regulars than irregulars. No significant effects emerged for the two verbal memory tasks, as indicated by a MANOVA, $F(2, 117) = 1.27$, $p = .286$.

As a follow-up analysis, we analyzed the two verbal memory tasks using a MANCOVA with receptive vocabulary and morphology as covariates, because previous research has indicated that performance on VSTM and VWM tasks is influenced by language representations in long-term memory (Engel de Abreu, 2011; Blom et al., 2014). Both receptive vocabulary and morphology were added because they tap different language representations and their combined effect is more powerful. The bilinguals outperformed the monolinguals on verbal memory, $F(2, 112) = 5.67$, $p = .005$, $\eta_p^2 = .09$. Post-hoc tests revealed that this difference was found for VSTM, $F(1, 113) = 9.83$, $p = .002$, $\eta_2^2 = .08$, and for VWM, $F(1, 113) = 4.61$, $p = .034$, $\eta_p^2 = .04$. Statistically significant relationships emerged between receptive vocabulary and VSTM ($F(1, 113) = 6.54, p = .012, \eta_p^2 = .06$), between morphology and VSTM ($F(1, 113) = 75.47, p < .001, \eta_p^2 = .40$) and between morphology and VWM ($F(1, 113) = 41.40, p < .001, \eta_p^2 = .27$), but not between receptive vocabulary and VWM. Separate MANCOVA's in the TD and LI groups to investigate the effect of bilingualism on the two verbal memory tasks showed that in both groups the bilinguals scored higher than the monolinguals, but these effects were not statistically significant (TD: $F(2, 53) = .62, p = .543, \eta_p^2 = .02$; LI: $F(2, 54) = 2.47, p = .09, \eta_p^2 = .08$), which could be due to low statistical power given that in the larger aggregated samples similar effect sizes were associated with significant differences.

3.2 Four-group comparisons across domains

The second question addressed was: *Do bilingual children with LI show additive effects of LI and bilingualism, and is this different across domains?* Table 3 displays the descriptive information for receptive vocabulary, regular and irregular morphology, VSTM, and VWM in the four groups of children.

Table 3. Mean (standard deviations) in the MOTD, MOLI, BITD and BILI for receptive vocabulary, morphology, VSTM, and VWM

	MOTD	MOLI	BITD	BILI
Receptive vocabulary	111.41 (13.09)	94.77 (12.99)	94.10 (12.24)	77.90 (10.34)
Morphology (max. 24)	16.77 (4.54)	10.47 (3.32)	11.63 (5.20)	6.86 (4.67)
Regular (max. 8)	6.70 (1.60)	5.17 (1.32)	5.23 (2.39)	3.59 (2.47)
Irregular (max. 8)	2.93 (2.45)	.63 (1.03)	1.17 (1.29)	.31 (.71)
VSTM (max. 42)	21.27 (4.69)	15.63 (3.61)	19.00 (3.35)	15.23 (3.88)
VWM (max. 42)	12.77 (3.83)	8.70 (3.11)	11.57 (3.38)	8.53 (3.36)

Note. MOTD = monolingual typically developing; MOLI = monolingual language impaired; BITD = bilingual typically developing; BILI = bilingual language impaired; VSTM = verbal short-term memory; VWM = verbal working memory

A univariate ANOVA with Group (MOTD, MOLI, BITD, BILI) as the independent variable and receptive vocabulary as the dependent variable revealed a significant effect, $F(3, 114) = 37.08, p < .001, \eta_p^2 = .49$. The MOTD group outperformed all groups ($p < .001$). The BILI group was outperformed by all groups ($p < .001$). No significant difference was found between the BITD group and the MOLI group. The same pattern was found for morphology, $F(3, 115) = 57.40, p < .001, \eta_p^2 = .39$. Kruskall Wallis tests indicated a significant effect for both regulars, $H(3) = 28.15$, $p < .001$, and irregulars, $H(3) = 32.35, p < .001$. Posthoc pairwise comparisons – with the α decision level corrected for six comparisons and set at .0083 – showed that for regulars the MOTD group outperformed the MOLI group (p = .001) and the BILI group (p < .001). The BITD outperformed the BILI group, (p = .008). The other groups comparisons (BILI-MOLI, MOLI-BITD, BITD-MOTD) did not reach statistical significance. On irregulars, the MOTD group outperformed the MOLI group (p < .001), the BILI group (p < .001), and the BITD group (p = .006). The other comparisons (BILI-MOLI, BILI-BITD, MOLI-BITD) did not reach statistical significance.

Regarding the verbal memory tasks, the overall MANOVA was statistically significant ($F(2, 232) = 7.62, p < .001, \eta_p^2 = .17$). The VSTM showed a significant effect of Group, $F(3, 116) = 16.14$, $p < .001$, $\eta_p^2 = .29$. The MOTD group outperformed the MOLI and BILI groups (p < .001), the BITD group outperformed the MOLI group (p = .007) and BILI group (p < .002). No statistically significant difference emerged between MOTD and BITD or between MOLI and BILI. The VWM task also showed a significant effect of Group, $F(3, 116) = 11.34, p < .001, \eta_p^2 = .23$, with exactly the same pattern: MOTD outperformed MOLI and BILI (p < .001), BITD outperformed MOLI (p = .009) and BILI (p = .005), and no statistically significant difference emerged between MOTD and BITD or between MOLI and BILI.

3.3 Comparing effects in mono- and bilingual contexts

Finally, we wanted to know whether or not a bilingual context aggravates the symptoms of LI. The following question was formulated to address this issue: *Is the effect of LI different in bilingual and monolingual contexts?* If the effect of LI is stronger in a bilingual context, we expect the magnitude of the difference between TD and LI groups to be larger in the bilingual than in the monolingual group, and

Table 4. Bonferroni-adjusted p values (to be tested against α = .05) and effect sizes for MOTD versus MOLI and BITD versus BILI comparisons regarding receptive vocabulary, morphology, VSTM, and VWM

Measure	MOTD versus MOLI	BITD versus BILI
Receptive vocabulary	$p < .001, \eta_p^2 = .30$	$p < .001, \eta_p^2 = .35$
Morphology	$p < .001, \eta_p^2 = .39$	$p < .001, \eta_p^2 = .19$
Regular	$p = .005, r = .46$	$p = .046, r = .32$
Irregular	$p < .001, r = .52$	$p = .054, r = .38$
VSTM	$p < .001, \eta_p^2 = .32$	$p = .001, \eta_p^2 = .22$
VWM	$p < .001, \eta_p^2 = .26$	$p = .007, \eta_p^2 = .17$

Note. MOTD = monolingual typically developing; MOLI = monolingual language impaired; BITD = bilingual typically developing; BILI = bilingual language impaired; VSTM = verbal short-term memory; VWM = verbal working memory thus larger effect sizes for the BITD versus BILI comparison than in the MOTD versus MOLI comparison. The data in Table 4 show the outcomes; the value of η_p^2 indicates the effect size for those variables that are normally distributed, *r* is used for data that are not normally distributed. All values show that for nearly all variables, except for receptive vocabulary, the effect size of LI is smaller in the bilingual context than in the monolingual context.

4. Discussion and conclusion

The main aim of this study is to investigate the separate and combined effects of LI and bilingualism in order to determine when bilingualism may be a risk or a benefit for children with LI. A secondary goal is to further our insight into the deficit that underlies LI. The effects of LI and bilingualism are investigated across multiple domains: vocabulary, morphology, and verbal memory. More specific analyses distinguish between regular and irregular morphology and between verbal short-term memory (VSTM) and verbal working memory (VWM). LI and bilingualism are predicted to influence these domains differently due to variation in their reliance on language knowledge (vocabulary, morphology) versus language processing (VSTM, VWM) and procedural (regular morphology) versus declarative (vocabulary, irregular morphology) memory systems. Monolingual and bilingual children with and without LI are compared, allowing us to systematically examine whether effects of LI and bilingualism vary across domains as expected, whether double delays are present in the bilingual group with LI and whether LI is aggravated or perhaps alleviated in a bilingual context.

The first question asks whether effects of LI and bilingualism are the same across the four domains, even though one factor is child-internal and the other child-external. The results correspond with our predictions, showing comparable effects of LI and bilingualism on the knowledge-based tasks testing vocabulary and morphology but different effects on processing-based tasks tapping VSTM and VWM. Children with LI have smaller receptive vocabularies and weaker morphology skills than their TD peers. Similarly, bilingual children are outperfomed on these measures by their monolingual peers. The children with LI performed below their TD peers on VSTM and VWM, confirming that children with LI fall behind on more than just word or rule learning (Leonard et al., 2007; Montgomery et al., 2010). However, no verbal memory differences emerge between monolinguals and bilinguals. When language knowledge is covaried, the bilingual children show enhanced verbal memory skills. In line with previous work (e.g., Engel de Abreu et al., 2013), these findings indicate that language knowledge is more affected by external factors than language processing. Moreover, a bilingual advantage on VWM appears to hold (Blom et al., 2014), even when a group of bilingual children with LI is included.

With respect to the different morphological categories, we expected that effects of LI would be more pronounced in the domain of regular than irregular morphology. This asymmetry is predicted by the Procedural Deficit Hypothesis (Ullman & Pierpont, 2005) which assumes, first, that regular morphology is subserved by the procedural memory system and, second, that procedural memory is impaired in children with LI while declarative memory (subserving irregular morphology) is relatively spared. Children with LI are outperformed by their TD peers on both regular and irregular nouns and past participles. The effect of LI is larger for irregulars than for regulars, which is opposite to the predicted effect. Bilinguals were hypothesized to show particularly delays in irregular morphology because these forms may rely stronger on exposure than regular forms. It turns out that the bilinguals are outperformed by the monolinguals on regular and irregular forms and that the effect of bilingualism is slightly larger for regular than for irregular forms.

Taken together, these findings do not support the hypothesis that children with LI have a procedural memory deficit that affects grammar only, but suggest more overall delays that affect vocabulary, regular and irregular morphology. Such overall delays seem more in line with a limited processing view of LI (Gathercole & Baddeley, 1990, 1993; Gathercole, 2006; Leonard et al., 2007; Miller et al., 2001). Previous research with bilingual children has produced mixed outcomes regarding selective effects of LI on regular past tense. Similar to our study, Jacobson and Schwartz (2005) observe that bilingual children with LI are outperformed by their TD peers on both regular and irregular forms. However, Blom and Paradis (2013) find a statistically significant difference for regular past tense only. Some of this variation may be due to properties of the items that influence the comparability of regular and irregular forms. Moreover, in the present study, all groups, except for the monolingual TD children, perform at floor level on the irregular items, affecting the validity of the comparison between regular and irregular forms.

The second research question aims at investigating the additive effects of LI and bilingualism on the four domains. As expected, the bilingual children with LI are outperformed by both their bilingual TD peers and their monolingual peers with LI on vocabulary and morphology, showing a double delay in these domains. In contrast, no additive effects of LI and bilingualism are found on VSTM and VWM: the monolingual and bilingual children with TD show similar performance and outperform the monolingual and bilingual children with LI, who also show the same performance. More granular analyses focusing on regular and irregular morphology indicate no double delays for either category. Comparisons of the raw data suggest that this may be an effect of insufficient power.

If the language problems of children with LI are, to some extent, caused by verbal processing limitations, the delay in bilingual children with LI may go beyond a double delay in the domains that rely most strongly on language exposure (vocabulary, irregular morphology). The third research question addresses this issue. It is first relevant to note that relationships are found between language knowledge and processing, conform the hypothesis that (verbal) processing limitations may be underlying the reduced language outcomes (Ellis Weismer, 1996; Leonard et al., 2007; but see Lum et al., 2012). Vocabulary performance indeed shows aggravated symptoms of LI in a bilingual context, indicated by the larger effect size of LI in the bilingual than in the monolingual group. For the processing-based measures we tentatively predicted that the symptoms of LI may be weaker in a bilingual context, because this is a domain where positive effects of bilingualism may counteract the negative effects of LI (Blom et al., 2014). This prediction is supported by the observation that for VSTM and VWM the effect size of LI is smaller in a bilingual context than in a monolingual context.

Finally, we expected aggravating effects of bilingualism for irregular morphology because irregular morphology is generally strongly dependent on amount of exposure. However, the results show the opposite, not only for irregular but also for regular morphology. Many of the bilingual children in our sample have home languages with rich inflectional systems. Cross-linguistic research has demonstrated that in languages with rich inflection, such as many Romance languages, inflectional morphology is less affected by LI than in languages with poorer inflectional systems, such as many Germanic languages (Leonard, 2014b). Furthermore, transfer in the domain of morphology covers both regular and irregular forms (Blom & Paradis, 2013). Possibly, positive transfer weakens the effects of LI in a bilingual context in the domain of morphology. This would be in line with previous research that suggests transfer effects in bilingual children with LI (Armon-Lotem et al., 2012; Verhoeven et al., 2012), though other research found that children with LI may not benefit from transfer to the same extent as their TD peers (Blom & Paradis, 2014).

To conclude, this study is the first to compare the effects of LI and bilingualism across vocabulary, regular and irregular morphology, and verbal short term and working memory. Language knowledge is negatively affected by both LI, a child-internal factor, and bilingualism, a child-external factor, leading to double delays in bilingual children with LI in the domains of vocabulary and morphology. However, only in the domain of vocabulary, bilingualism actually aggravates the effects of LI. Therefore, vocabulary may be the domain where bilingual children with LI are most at risk. Processing-based measures of verbal memory are negatively impacted by LI, but positively influenced by bilingualism. Verbal memory measures may be promising for distinguishing between language delay and language impairment in bilingual children whose language development raises worries. In this study, the bilingual group is a heterogeneous group of children with varying degrees of exposure to Dutch. It is important to compare in future research different bilingual groups because simultaneous bilingual children with LI may be less likely to show double delays than sequential bilinguals, and this effect of exposure may vary across domains. The LI group is furthermore heterogeneous in terms of severity of the impairment as well as the domains that may be more or less affected. An interesting venue for future research is, therefore, to identify different LI profiles and investigate how these profiles interact with bilingualism. Finally, we recommend that future research further investigates relationships between verbal memory capacities and language abilities. Their relatively well-developed verbal memory may equip bilinguals with mechanisms to support language learning. The findings of this study suggest that this may hold for bilingual children with TD and bilingual children with LI alike.

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