Past tense production in children with SLI and bilingual children

The influence of vocabulary and non-word repetition

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We investigated whether (1) 7–9-year-old children with SLI, bilingual children (BIL) and monolingual (TD) children differed on Dutch past tense production of real and pseudo-verbs and (2) whether non-word repetition (NWR), receptive vocabulary, and group status contributed to past tense production. Past tense patterned as SLI < BIL < TD, for NWR as SLI < BIL = TD and for vocabulary SLI = BIL < TD. Vocabulary and SLI group status were significant predictors of real-verb past tense inflection. SLI and bilingual group status were predictors of pseudo-verb past tense inflection. These findings confirm the association between vocabulary and past tense and the difficulty that children with SLI and bilingual children have with both skills.

Keywords: bilingualism, language development, past tense, specific language impairment

Introduction

Although language acquisition is a fast and seemingly effortless process, some patterns take more time to acquire than others (e.g. Keijzer, 2007). For instance, in some languages children need a substantial amount of time in order to accurately inflect verbs. Past tense acquisition has been found to take a while in monolingual typically developing (TD) language learners (e.g., Bleses, Basboll, & Vach, 2011; De Schryver, Neijt, Ghesquiere, & Ernestus, 2013; Ernestus & Baayen, 2001) and in bilingual children acquiring two languages (Nicoladis, Palmer, & Marentette, 2007; Paradis, Rice, Crago, & Marquis, 2008; Thordardottir, Rothenberg, Rivard, & Naves, 2006). Furthermore, past tense production is known to be notoriously difficult for children with language impairments (e.g., Blom & Paradis, 2013;

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Conti-Ramsden, Botting, & Faragher, 2001; Rispens & de Bree, 2014; Vang Christensen & Hansson, 2012).

Past tense production in English, the language studied most often, and in Dutch, the language of the current study, may be relatively difficult as the past tense surface form (allomorph) is morphophonologically determined (e.g. de Bree, van der Ven & van der Maas, 2017). Its acquisition depends on the integration of several domains of linguistic knowledge: syntax, i.e., acquisition of the past tense rule; morphology, i.e., acquisition of morphological forms of the past tense; phonology, i.e., phonological analysis required for correct selection of past tense allomorphs; and vocabulary, i.e., acquisition of verbs and their meaning. The purpose of the present study was to investigate production accuracy of the past tense in monolingual children with specific language impairment (SLI), bilingual children and monolingual TD children and to examine whether phonological processing and vocabulary contribute to past tense production in these three groups.

Past tense in children with SLI and bilingual children

Impaired past tense production has been proposed as a clinical marker of SLI (e.g., Conti-Ramsden et al., 2001). Children with SLI demonstrate impaired language abilities in the absence of cognitive, neurological, sensory and emotional impairments (Leonard, 2014). They generally have disproportionately more and persistent difficulty with grammar than other areas of language, part of which is past tense production. A recent meta-analysis of past tense production in Germanic languages in SLI underlined the reports of profound difficulties (Krok & Leonard, 2015). Persistent and evident difficulties were reported for regular past tense, measured through real and pseudo-verb elicitation, as well as difficulties with irregular verbs.

Past tense production in bilingual children has also been found to be less accurate relative to their monolingual peers (e.g., Nicoladis et al., 2007; Paradis, Rice, Crago, & Marquis, 2008; Paradis et al., 2008). However, results showing no differences between bilingual and monolingual children have also been reported (e.g., Rispens & de Bree, 2015), as well as results showing differences in only one of the languages (Paradis, Nicoladis, Crago, & Genesee, 2011). It seems that outcomes of bilingual children are related to the amount of exposure and experience they have with each of the languages, which is related to the onset of bilingualism and age of acquisition (Nicoladis et al., 2007; Paradis et al., 2011; Unsworth, Argyri, Cornips, Hulk, Sorace, & Tsimpli, 2014). Other factors, such as the morphosyntactic paradigm of the other language of bilingual children may also play a role in past tense performance (see Hulk & Unsworth, 2010).

Relation between phonology and past tense

In many languages, past tense inflection is dependent on different types of knowledge such as syntax, morphology, and phonology (e.g. Bishop, 2014; Blom & Paradis, 2013; de Bree et al., 2016; Marchman, Wulfeck & Ellis Weismer, 1999; Marshall & van der Lely, 2007; Matthews & Theakston, 2006; Owen, 2010; Rispens & de Bree, 2014). Phonology plays an important role, as phonological knowledge and phonological processing is needed for allomorph selection and analysis, and thus can be envisaged to affect acquisition of the past tense patterns. For instance, in English, the correct allomorph (/d/, /t/, or /Id/) is selected depending on the verb stem. Similarly, in Dutch, regular past tense inflections take either allomorph -te or -de, depending on the stem-final phonemes. Adequate speech perception is also required for detection of the suffix, which is often in a non-salient position. Additionally, phonological processing, i.e., speech perception, storage, retrieval and reproduction, is required for segmenting the verb and deciding on the correct allomorph which is particularly important for past tense inflection of novel verbs that are not stored (yet).

Monolingual children with SLI generally show phonological processing difficulties, often demonstrated by significant less accurate nonword repetition (NWR) relative to their typically developing peers (e.g. de Bree, Rispens, & Gerrits, 2007; Gathercole, 2006; Estes, Evans, & Else-Quest, 2007; Rispens & Baker, 2012). NWR has even been proposed to be a marker of SLI (Conti-Ramsden et al., 2001). Limitations in phonological processing, in turn, have been related to grammatical difficulties (Leonard, 2014) including impaired past tense acquisition (Joanisse & Seidenberg, 1998). A study by Archibald, Joanisse and Shepherd (2008) found that NWR significantly correlated with regular past tense production (both existing and novel verbs) in a sample of monolingual TD children. Note that Norbury, Bishop, and Briscoe (2001) did not find an association between past tense and NWR in children with SLI (see also Bishop, Norbury, & Adams, 2006),

Studies on NWR in bilingualism often report that bilingual children perform less accurately than monolingual children (e.g. Engel de Abreu, 2011; Kohnert, Windsor, & Yim, 2006). Amount of language exposure has been suggested to play a role in NWR performance, due to the role of lexical knowledge in NWR ability (see Thordardottir & Brandeker, 2013). Indeed, studies on second language learning children have shown that nonword repetition is best in the language children speak best. This indicates that there is a relationship between nonword repetition and language knowledge (Masoura & Gathercole, 2005; Messer, Leseman, Boom, & Mayo, 2010). The association between grammar learning and phonological processing has also been subject of study in bilingualism. NWR has been found to

significantly correlate with grammar skills, including past tense morphology, in bilingual children or child L2 learners (Paradis, 2011; Verhagen, Leseman, & Messer, 2015; Verhagen & Leseman, 2016), indicating that phonological processing influences long-term learning of grammatical patterns. Other studies have found that the relationship between NWR and grammar scores was mediated by vocabulary (Engel de Abreu & Gathercole, 2012, Service & Kohonen, 1995). The inconsistent findings might stem from differences between the grammar tasks used; some addressing more broad linguistic skills and other tasks tapping more specific grammatical constructions, which rely less on vocabulary comprehension (Verhagen & Leseman, 2016).

So far, comparisons between children with SLI and bilingual children on the same NWR task are scarce (e.g. Paradis, Schneider, & Duncan, 2013), and no study as yet examined the association between NWR and past tense production in these groups of children.

Relation between vocabulary and past tense

Past tense production of monolingual TD children has been found to correlate with vocabulary (Marchman & Bates, 1994; Kidd & Kirjavainen, 2011). This influence stems from lexical frequency effects: higher accuracy scores are found for the past tense forms of high frequency verbs (Ernestus & Baayen, 2001; Rispens & de Bree, 2014). Influences of vocabulary on past tense production have also been reported in bilingual children and child L2 learners (Blom & Paradis, 2013; Verhagen et al., 2015). Bilingual children generally have a smaller vocabulary in one language than monolingual TD children have, as they have to divide their time between two languages (Hoff, Core, Place, Rumiche, Señor, & Parra, 2012). As discussed, vocabulary also influences the association between NWR and grammar (including past tense) in some studies with bilingual children, indicating a strong role for vocabulary in grammatical development. For monolingual children with SLI the association between vocabulary and past tense production is less clear: in the majority of studies there are no significant correlations between vocabulary and verbal morphology, which is often a composite score of past tense and agreement (e.g. Norbury, et al., 2001; Rice, Tomblin, Hoffman, Richman, & Marquis, 2004; Oetting & Horohov, 1997; Pruitt & Oetting, 2009).

Overview of present study

In sum, past tense difficulties are consistently reported in children with SLI and have also been noted in bilingual children (e.g., Nicoladis et al., 2007; Paradis, Rice, Crago, & Marquis, 2008; Paradis et al., 2008). There are, however, also studies reporting TD-like performance of bilingual children (e.g. Rispens & de Bree, 2015). Differences between studies in the population of bilingual children (amount of exposure to the target language), or differences between the other languages of the bilingual children may account for the inconsistent findings. In a previous study carried out in Dutch, Rispens and de Bree (2015) compared past tense production of bilingual (Hebrew – Dutch) children with that of monolingual children. They found no differences between the groups. As the bilingual children were a specific group of children (all Hebrew speaking and from the same school), the results are difficult to generalize to other bilingual children speaking Dutch as one of their languages. A first aim of this study was to replicate Rispens and de Bree's study (2015) in a mixed group of bilingual children to get more insight into past tense acquisition in bilingual children in the Netherlands. Related, we compare past tense production of bilingual children to monolingual children with SLI. Both groups might show lower rates of correct past tense production; the bilingual group because of more limited exposure and experience in Dutch than monolingual TD children, the children with SLI because of their primary language difficulties.

A second aim of our study was to investigate associations between past tense on the one hand and NWR and receptive vocabulary on the other. Such relationships have been reported in monolingual TD children (Archibald et al., 2008), as well as in bilingual children (Verhagen & Leseman, 2016; Paradis, 2011). For children with SLI, the empirical data on the relationships between past tense on the one hand and NWR and vocabulary on the other, are less clear, even though causal relationships between deficits in phonological processing / vocabulary and past tense difficulties have been postulated (e.g. Joanisse & Seidenberg, 1998; Conti-Ramsden & Jones, 1997). It is difficult to compare the statistical outcomes of separate studies. In the current study we therefore investigated associations between past tense, NWR and vocabulary in children with SLI, bilingual and monolingual children all tested on the same tasks and in the same language. We assessed past tense production of both existing and novel verbs. Whereas real verbs can be inflected on the basis of lexical knowledge, this is not the case for novel/pseudo-verbs. We hypothesize that receptive vocabulary in all three groups is associated with past tense inflection of existing verbs, but not of novel verbs. In addition, since pseudo-verbs are nonwords, we hypothesize that manipulating such non words is related to NWR.

Methods

Participants

In total, 69 7-to-9-year-old children participated in this study. These children were divided in three groups: monolingual children with SLI (n = 31, mean age: 8;1, SD: 0.49, 22 boys), bilingual (BIL) children (n = 16, mean age: 8;45, SD: 0.49, 8 boys), and monolingual TD children (n = 22, mean age: 8;1, SD: 0.48, 10 boys). All children had normal hearing and normal or corrected-to-normal vision

The group of children with SLI is a subset of the children who participated in Rispens and de Bree (2014). Four children of that study were excluded here as they had not completed all tasks. The children with SLI were selected from three special-needs schools for children with developmental language disorders and had been diagnosed with SLI by the specialist teams of the schools. The diagnosis required either a cutoff of a performance at least 1.5 *SD* below the mean in at least two language domains measured on a selection of Dutch standardized language tests or more than 2 *SD* below the mean on one Dutch standardized general language test (see Rispens & de Bree (2014) for details). In addition, only children were included who scored at least on or above the 15th percentile on the Dutch version of the Raven Standard Progressive Matrices (Raven, 2006) which was taken as an estimate of nonverbal intelligence at the time of testing. Children who had a history of speech output problems, such as dyspraxia, or showed evidence of such problems at the moment of testing, were excluded. Only children who were raised in families where Dutch had been spoken from birth onward were included (see also Rispens & de Bree, 2014).

The group of bilingual children consisted of simultaneous and successive bilingual children (representing the mixed population of bilingual children in the Netherlands) who were raised in a family where a different language than Dutch was spoken by one parent or by both parents. A questionnaire was given to the children and their parents to assess the language(s) spoken by the child, mother, father and the language spoken at home during daily interaction. Four children were considered to be successive bilinguals: they learnt Somali (n = 1), Arabic (n = 2) and Turkish (n = 1) as their first language and were exposed to Dutch after entrance at primary school at 4 years of age. Twelve children were classified as simultaneously bilingual. They were raised in a family in which both Dutch and another language (Somali (n = 1), Arabic (n = 4), Berber (n = 2), Turkish (n = 4), and Dari (n = 1) was spoken with them. Teacher and parental reports confirmed that the bilingual children made normal progress at school and that they did not have emotional, physical or sensory problems. All children attended the same primary school in the middle of the country. This school included predominantly bilingual children from

an immigrant situation and few typically developing monolingual Dutch language learners.

The TD children were all raised in a monolingual setting. They were selected from two schools in the vicinity of the schools of the bilingual children and the children with SLI. The majority of TD children attended a school that was in the same street as the school where the bilingual children were tested. Both schools were located in the same postal code area, thus providing an indirect match of socio-economic status of the groups of children. Teacher and parental reports confirmed that the TD children made normal progress at school and that they did not have emotional, physical or sensory problems.

Tasks

Children completed three tasks: (1) production of the past tense (real and pseudo-verbs), (2) receptive vocabulary, and (3) NWR.

Past tense: Stimuli

Production accuracy of the past tense was assessed using the elicitation task as reported in Rispens and de Bree (2014; 2015). The past tense task consisted of two parts. One part assessed the production of the past tense of real words (PT Real), containing 12 items, the other assessed the past tense of pseudowords (PT Pseudo), containing 16 items. Both existing and pseudo-verbs were included to measure the ability to apply morphophonological rules (pseudo-verbs) rather than retrieve rote learned lexical information from memory (existing verbs). In Dutch, two past tense allomorphs exist depending on the phonological characteristics of the final phoneme of the stem. Underlying voiceless stems take the *-te* allomorph (bakken – bak**te** *bake – baked*); voiced stems the -de allomorph (kammen – kam**de** *comb combed*). Half of the items of both the PT Real and the PT Pseudo are inflected for the past tense with a *-te* allomorph (e.g. PT Real : pakken – pak**te**; *pack – packed*, PT Pseudo: moepen – moep**te**), the other half with a *-de* allomorph (e.g. PT Real : hollen – hol**de**; *jog – jogged*, PT Pseudo: daanen – daan**de**). All infinitive forms of the items of the PT Real and the PT Pseudo were two syllabic (no consonant clusters), the verb stems had a CVC structure and the target structure consisted of CVCCV.

The items of the PT Real were controlled for lexical frequency. The frequency counts of all verbs (inflected for the past tense as well as the infinitive form) were calculated based on the logged values of the CELEX database (Baayen, Piepenbrock, & van Rijn, 1993). Half of the past tense items were high in frequency (M = 1.9, SD = .45) the other half low in frequency (M = .59, SD = .29). There was no overlap

between frequencies in the high/low condition and there was a significant difference between the high and low-frequency verbs, $t(10) = 4.0$, $p = .006$), see Rispens and de Bree (2014) for an overview of the verbs and their lexical frequencies. For an overview of the PT Pseudo items (8 items taking *-de* and 8 items taking *-te*) see also Rispens and de Bree (2014). For the items in the task eliciting existing verbs, photographs were presented. For items eliciting pseudo-verbs, drawings were presented. The latter pictures represented monsters or other fictional characters, or were created by the authors using software to draw characters.

Past tense: Task

The past tense elicitation task was conducted with a laptop using PowerPoint: children saw a picture depicting an action on the screen. Upon seeing the picture, the experimenter would click on a sound button and the child would once hear a digitalized presentation of the infinitive form of the verb before the story was being told. The sound file was played to the children from the laptop computer using loudspeakers. There was a three-line narrative to accompany the verb: it first described what was going on in the picture, then indicated that the character performed this action often or every day. Then, the children were asked to complete the final sentence in which they were prompted to give a past tense form (yesterday ….?). An example is: this is a kind grandmother. She often bakes pancakes. Yesterday also. Yesterday…? The experimenter waited for the child to complete the sentence.

The novel verb elicitation task was introduced by telling the children that funny figures doing strange things would be shown. The children were told that the experimenter would tell them a little story in which the name of the action would be told and that the children had to finish the story. The narrative contained the similar set-up as for the real verbs. Afterwards, the child was prompted to complete the sentence; the experimenter waited for the child to finish the sentence.

The verb responses of the children were transcribed on-line and scored afterwards. In case of doubt, recordings were listened to again. Transcription was only made of the verb production. The production was evaluated only on its accuracy of tense and was marked as correct or incorrect (subject verb agreement mistakes for example did not count as errors). A percentage of correctly inflected past tenses was calculated for real and novel verbs. Children were encouraged to give an answer and there were no non-responses (see Rispens & de Bree, 2014 and 2015 for an overview of errors produced).

The order of the presentation of the two tasks was pseudo-randomized: half of the children were first presented with task 2 (novel verbs) followed by task 1 (lexical verbs), the other half the other way around.

Receptive vocabulary

The Dutch standardized version of the Peabody Picture Vocabulary Task (Schlichting, 2005) was administered to the children to measure their receptive vocabulary ability. A child was presented with a sheet with four pictures and was asked to point to the picture that matched an auditorily given target by the examiner. The task was presented according to the instruction; the test was abandoned when the child answered nine or more items of one set (consisting of twelve items) incorrectly. Both raw scores as well as the word comprehension quotient (normed score with a mean of 100) was calculated.

Non-word repetition

NWR skills were measured using the task designed for the Dutch language (Rispens & Baker, 2012; Rispens, Baker, & Duinmeijer, 2015). It comprised 40 items divided equally into two-, three-, four-, and five-syllable items. To control for the influence of phonotactic probability, half of the items were low and half were high in phonotactic probability (see Rispens et al., 2015 for an overview of the stimuli and the PP counts), based on the Dutch Phonotactic Frequency database (Adriaans, 2006) derived from the corpus of spoken Dutch (Oostdijk, 2000). The items did not contain consonant clusters and followed the Dutch rules of prosody. The items, prerecorded by a female native speaker of Dutch, were played using a laptop computer. The items were divided into two blocks of 20 items each that were presented to the children with a pause between the blocks. The order of the two blocks was pseudo-randomized. All responses of the children were recorded and transcribed offline. For each item, the percentage of phonemes correctly (PPC) repeated per word was calculated.

Procedure

Children were assessed individually in a quiet room at school by the authors or by a trained research assistant. The test battery was administered in a single session or in two sessions with one or two days in between. Children received a small present (sticker or pen) after completion of all tasks. Consent was provided by the parents of the participating children.

Data analysis

As a first step, normality of the data was inspected by performing Shapiro-Wilk tests of the separate groups of children on the results of the two past tense tasks, the PPVT and the NWR. The data of the PPVT and the NWR were distributed normally for all groups (PPVT: TD: $W(22) = .982$, $p = .986$, BIL: $W(16) = .955$, $p = .759$, SLI $W(31) = .827$, $p = .089$; NWR: TD: $W(22) = .945$, $p = .443$, BIL: $W(16) = .958$, $p = .620$, SLI: $W(31) = .978$, $p = .75$). Parametric statistics (ANOVA) were performed on these results. However, the data of the PT Real and PT Pseudo were not distributed normally for some of the groups (PT Real : TD: $W(22) = .716$, $p < .001$, BIL: $W(16) = .916$, $p = .143$, SLI: $W(31) = .733$, $p < .001$; PT Pseudo: TD: $W(22) = .937$, $p = .089$, BIL: $W(16) = .903$, $p = .089$, SLI: $W(31) = .704$, $p < .001$).

The second step in our data analysis was to compare the performances of the three groups before investing the associations between the results. Non-parametric statistical analyses were carried out on these data.

To analyze associations between the tasks, correlation analyses were performed. To investigate relative contributions of receptive vocabulary and NWR ability to past tense production, hierarchical regressions were used for existing and pseudo-verbs. The analyses for existing and pseudoverbs were separated, as receptive vocabulary may be related more strongly to existing verbs, whereas nonword repetition may be more related to pseudoverbs due to the use of pseudo-words. The contribution of group status to past tense ability was investigated by inserting two dummy variables, reflecting (1) the presence of SLI (relative to no SLI), and (2) the presence of bilingualism (relative to monolingualism).

Results

Descriptive statistics are provided in Table 1. To investigate whether there were age differences between the groups, a one-way ANOVA, was carried out with age in months as the dependent variable. A significant main effect of Group was revealed, $F(2, 68) = 3.33$, $p = .042$. A post hoc test (Bonferroni) showed that the bilingual children were significantly older than the children with SLI ($p = .046$, Cohen's $d = -0.75$). There were no significant differences between the TD children and the children with SLI ($p = 1.0$, Cohen's $d = -0.09$) and between the TD children and the BIL group ($p = .12$, Cohen's $d = 0.06$). As there was a main effect of age, it was entered in our regression model as a variable and age was entered as a covariate in our ANOVA's carried out with the normally distributed data to investigate group differences.

With respect to past tense production, the Kruskal-Wallis test showed between group differences for the results on the real and pseudo-verb past tense tasks (PT Real : $X^2 = 38.44$, $p < .001$, PT Pseudo $X^2 = 39.69$, $p < .001$). Mann Whitney U

Table 1. Means (Standard Deviations) of age, PT Real, PT Pseudo, PPVT (raw and WBQ Scores) and NWR (PPC) per group

Group	SLI (n = 31)	BIL (n = 16)	TH (n = 22)
Age in months	96.94 (5.77)	101.38 (5.97)	97.50 (5.73)
PT Real (% correct)	22.03 (29.29)	72.40 (22.30)	88.97 (13.48)
PT Pseudo (% correct)	15.54 (23.75)	53.13 (15.81)	71.15 (18.50)
PPVT (raw score)	90.94 (9.97)	95.31 (9.42)	104.90 (8.18)
PPVT (WBQ)	84.32 (18.63)	88.63 (11.47)	105.24 (8.71)
NWR (PPC)	75.38 (7.11)	84.04 (5.57)	87.91 (4.51)

tests were carried out to follow up the significant group effects. On PT Real and the PT Pseudo the children with SLI were significantly outperformed by the TD (PT Real $U = 41$, $p < .001$, $r = -.752$; PT Pseudo $U = 40.5$, $p < .001$, $r = -.754$) and the BIL groups (PT Real $U = 54$, $p < .001$, $r = -.643$; PT Pseudo $U = 52$, $p < .001$, $r = -.654$). The bilingual children performed significantly lower than the TD children on both tasks (PT Real $U = 96$, $p = .016$, $r = -.391$; PT Pseudo $U = 78.5$, $p = .004$, $r = -.472$). As the BIL group was significantly older than the SLI group we performed an additional ANCOVA with age entered as a covariate to check whether the lower performance of the SLI group was also detected when controlling for age. Both ANCOVA analyses showed main effects of group (PT real: $F(2, 69) = 55.63$, $p < .001$, $\eta^2_p = .631$, and PT pseudo: $F(2, 69) = 48.55$, $p < .001$, $\eta^2_p = .599$). Pairwise comparisons (Bonferroni corrected and based on covariate estimates) showed for both task performances that the children with SLI scored more poorly than the BIL group (both comparisons $p < .001$). We thus conclude on the basis on these analyses with age covariates that the outcomes of the Mann Whitney U tests are not caused by an age difference.

An ANCOVA with PPVT (raw scores) as the dependent variable, Group as a between-subjects factor, and age as a covariate yielded a significant main effect of Group, $F(2, 69) = 16.875$, $p < .001$, $\eta^2_p = .342$, and of Age, $F(1, 69) = 9.451$, $p = .003$, $\eta^2_p = .127$. Pairwise comparisons (Bonferroni corrected and based on covariate estimates), showed that the children with SLI performed significantly more poorly than the TD children ($p < .001$, Cohen's $d = -1.55$), but that they did not differ significantly from the bilingual children ($p = 1$, Cohen's $d = -0.47$). The bilingual children scored significantly more poorly than the TD children ($p = .001$, Cohen's $d = -1.09$).

The results of the NWR task also showed a main effect of Group, $F(2, 70) = 28.976$, $p < .001$, $\eta^2_p = .471$, but there was no main effect of age ($F < 1$). Pairwise comparisons (Bonferroni corrected) revealed that the children with SLI performed significantly more poorly than both the TD ($p < .001$, Cohen's $d = -2.08$) and the BIL group ($p < .001$, Cohen's $d = -1.33$). The bilingual children did not differ significantly from the TD children ($p = .194$, Cohen's $d = -0.76$).

Correlations and regression analysis

Pearson's correlations between past tense, PPVT and NWR, controlling for age, rendered significant and positive correlations (see Table 2). Past tense inflection of real and pseudoverbs correlated strongly. The correlations between past tense and PPVT and NWR were moderate, as was the correlation between PPVT and NWR.

Table 2. Pearson's r coefficients controlled for age

	PT Pseudo	PPVT	NWR
PT Real	.834*	.535*	.602*
PT Pseudo		.487*	.506*
PPVT			.507*

* *indicates* p < *.001.*

Two hierarchical regression models (one for PT Real, and one for PT Pseudo) were constructed to determine the amount of unique and shared variance contributed to past tense production ability by receptive vocabulary, NWR and group status (SLI; bilingualism relative to TD) controlling for chronological age. In both models, variables were entered in the same order: chronological age in months was entered as a first block, followed by the raw scores on the PPVT and percentages phonemes correct on NWR. The third block included the dummy factors, representing the group status of SLI or bilingualism. The fourth and final block contained interactions between the dummies and the PPVT and the NWR. Table 3 reports the results of the regression model with PT Real as the dependent variable and Table 4 those of the regression model with PT Pseudo as the dependent.

Table 3. Standardized beta coefficients, t and p values and R^2 and R^2 change values of the three regression models predicting PT Real

Model	Variable	Beta	t-value	p-value	R^2	R^2 change
1	Age	.082	.675	.502	.007	.007
2	Age	.043	−.437	.663	.437	.431
	PPVT	.323	2.865	.006		
	NWR	.444	4.106	< .001		
3	Age	−.087	−1.065	.291	.666	.229
	PPVT	.216	2.220	.030		
	NWR	.048	.457	.650		
	Dummy SLI	−.701	−5.821	< .001		
	Dummy BIL	−.069	−.711	.480		

Table 4. Standardized beta coefficients, t and p values and R^2 and R^2 change values of the three regression models predicting PT Pseudo

Model	Variable	Beta	t-value	p-value	R^2	R^2 change
1	Age	.147	1.215	.229	.022	.022
2	Age	.030	.284	.777	.342	.320
	PPVT	.320	2.630	.011		
	NWR	.346	2.955	.004		
3	Age	.022	.248	.805	.622	.280
	PPVT	.153	1.483	.143		
	NWR	−.090	−.811	.421		
	Dummy SLI	−.537	−6.538	< .001		
	Dummy BIL	−.156	−1.994	.050		

The full regression model with PT Real as the dependent variable and all four blocks entered showed no significant *F* change, $F(4, 59) = .123$, $p = .973$, compared to the other models excluding the fourth block. The *F* change of the third model with three blocks entered (block 1: age; block 2 PPVT and NWR; block 3 two dummies), was significant, $F(2, 63) = 21.57$, $p < .001$, and the ANOVA of this model was also significant, $F(5, 68) = 25.13$, $p < .001$. The total variance explained by this model was 66.6% (R^2). In the third model, vocabulary contributed significantly to past tense inflection of existing verbs, and so did the group status of the presence of SLI relative to the TD and the bilingual children. NWR performance and being bilingual did not significantly contribute to inflecting existing verbs for the past tense. The regression model with PT Pseudo as the dependent variable yielded other results. Similar to PT Real, the full model containing all predictor variables entered in four blocks did not show significant *F* change, $F(4, 59) = .485$, $p = .747$, compared to the other models. The third model with three blocks entered (block 1: age; block 2 PPVT and NWR; block 3 two dummies), contributed significant *F* change, $F(2, 63) = 23.33$, $p < .001$, and the ANOVA of this model was significant, $F(5, 68) = 20.73$, $p < .001$. This model explained 62.2% (R^2) total variance. Vocabulary and NWR were not significant predictors in this model. Both of the dummy variables were significantly negatively related to past tense inflection of pseudo-verbs. Note that for both regression models, the second models with two levels showed that NWR significantly contributed to both PT Real and Pseudo, but that after entering the group status this significant effect disappeared.

Discussion

The aim of this research was twofold. We first wanted to replicate our study on past tense production in bilingual children. Different from our earlier study, we included a mixed sample of bilingual children, both in terms of onset of Dutch and in terms of other language spoken. The results showed that the bilingual group performed significantly lower than the monolingual TD group on past tense production and on receptive vocabulary. This group difference with the monolingual TD group aligns with previous findings that show lower past tense performance for bilingual children (e.g. Nicoladis et al., 2007; Paradis, Rice, Crago, & Marquis, 2008; Paradis et al., 2008). It does not match earlier findings on the very same task with a different group of bilingual children (Rispens & de Bree, 2015). As discussed, in the study by Rispens and de Bree (2015), a group of Hebrew-Dutch bilingual children participated. The current group of bilingual children is a more mixed group of children with different linguistic backgrounds and different onsets of learning Dutch. The results come from two different studies and can therefore not be compared directly, but we nevertheless consider some differences between the studies. One explanation to account for the different findings is a difference in overall language proficiency, with the Dutch-Hebrew group being more proficient and therefore being better at past tense production. However, this is unlikely as that group performed significantly lower on a receptive vocabulary task in comparison to their TD monolingual peers (Rispens & de Bree, 2015). An alternative explanation may be that the morphosyntactic properties of Hebrew had a positive transfer effect on Dutch past tense acquisition as the two languages overlap in the use of voiceless suffixes to mark the past tense (see Rispens & de Bree (2015) for a more detailed explanation). The results of the children with SLI were in line with previous literature; confirming severe difficulties with past tense production, also when compared to the bilingual children.

Our second aim was examining whether receptive vocabulary and NWR significantly predicted past tense productions in children with SLI, bilinguals and TD children and whether group status interacted with those contributions. A hierarchical regression analysis showed that receptive vocabulary and SLI group status were significant predictors of past tense inflection of regular existing verbs. For the production of pseudo past tenses, the results were different. SLI group status and bilingual group status contributed significantly to pseudo past tense production and vocabulary and NWR did not play a significant role when these group variables were entered. Our hypotheses on the associations between vocabulary and NWR and the past tense were thus partially fulfilled: receptive vocabulary significantly contributed to existing past tense production, which is in line with

what we expected based on previous findings on associations between vocabulary and past tense (Marchman & Bates, 1994; Kidd & Kirjavainen, 2011). As hypothesized, receptive vocabulary did not contribute significantly to the past tense of pseudo-verbs. Contrary to our expectations, NWR did not significantly predict past tense productions of either existing or pseudo-verbs. This is in line however with previous studies who did not report significant correlations between NWR and past tense in children with SLI (e.g. Bishop et al., 2006).

We conclude that the past tense difficulties that children with SLI experience may partly stem from problems with their receptive vocabulary, but impairments in (an)other domain(s) might also be responsible for their profound difficulties with past tense inflections, since group status of SLI predicted past tense performance in addition to vocabulary. One possible source of difficulties in children with SLI with respect to past tense morphology acquisition is impaired rule learning (see also Bishop, 2014). Recently, attention has been drawn to the difficulties that children with SLI demonstrate with implicitly learning rules from input (Ullman & Pierpont, 2005; Lum & Conti-Ramsden, 2013; Hsu, Tomblin, & Christiansen, 2014) and hypotheses have been postulated about the link between impaired implicit rule learning and deficient grammar learning, including past tense morphology. Note that being bilingual also significantly predicted past tense productions of pseudo-verbs (but not existing verbs). It is not likely that the past tense difficulties of this group stem from an impairment with implicit rule learning as proposed for the children with SLI. Instead we hypothesize that our results reflect a delay in past tense development due to reduced input of Dutch compared with monolingual children and possibly due to interactions with the other language of the child, which can work negatively or positively (see Paradis et al., 2011). This reduced input might affect the ability to generalize the morphophonological rules needed for past tense production. Longitudinal data are needed to determine the trajectory of the past tense acquisition patterns of these children.

The results from our research can be strengthened in several ways. First of all, increasing the sample sizes would improve statistical power. SLI is a heterogeneous impairment representing children with several profiles in terms of linguistic / cognitive strengths and weaknesses. Secondly, the group of bilingual children was heterogeneous both in terms of onset of Dutch and nature of second language. More homogenous and larger groups would offer a more controlled experiment.

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