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Research Article

Production and Processing of Subject–Verb Agreement in Monolingual Dutch Children With Specific Language Impairment

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Purpose: In this study, the authors investigated whether errors with subject–verb agreement in monolingual Dutch children with specific language impairment (SLI) are influenced by verb phonology. In addition, the productive and receptive abilities of Dutch acquiring children with SLI regarding agreement inflection were compared.
Method: An SLI group (6–8 years old), an age-matched group with typical development, and a language-matched, younger, typically developing (TD) group participated in the study. Using an elicitation task, the authors tested use of third person singular inflection after verbs that ended in obstruents (plosive, fricative) or nonobstruents (sonorant). The authors used a self-paced listening task to test sensitivity to subject–verb agreement violations.
Results: Omission was more frequent after obstruents than nonobstruents; the younger TD group used inflection less often after plosives than fricatives, unlike the SLI group. The SLI group did not detect subject–verb agreement violations if the ungrammatical structure contained a frequent error (omission), but if the ungrammatical structure contained an infrequent error (substitution), subject–verb agreement violations were noticed.
Conclusions: The use of agreement inflection by children with TD or SLI is affected by verb phonology. Differential effects in the 2 groups are consistent with a delayed development in Dutch SLI. Parallels between productive and receptive abilities point to weak lexical agreement inflection representations in Dutch SLI.

Key Words: specific language impairment, agreement inflection, production, processing

Specific language impairment (SLI) is a language disorder that affects approximately 7% of kindergarten children (Tomblin et al., 1997). It is generally assumed that affected children have difficulties acquiring language without any known causes such as hearing loss, neurological disorder, or general developmental delay (Leonard, 1998), although several studies have noted genetic and neurological correlates (see, for a review: Schwartz, 2009). One area of language typically affected by the impairment is morphosyntax, with cross-linguistic differences regarding which morphosyntactic properties show developmental delays in SLI (Leonard, 2009). In Dutch, SLI manifests itself in errors with verb inflection (Blom, de Jong, Orgassa, Baker, & Weerman, 2013; de Jong, 1999; Orgassa, 2009; Verhoeven, Steenge, & van Balkom, 2011; Wexler, Schaeffer, & Bol, 2004). The present study aimed at enhancing our insight into the factors that codetermine verb inflection errors in Dutch SLI by investigating, first, the role of phonology and, second, parallels between production and reception.

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Agreement Inflection in Dutch SLI

Studies on Dutch SLI consistently show that the production of subject–verb agreement is affected by SLI (Blom et al., 2013; de Jong, 1999; Orgassa, 2009; Verhoeven et al., 2011). Verbal agreement inflection in Dutch is highly regular; in the present tense indicative, speakers distinguish between three different forms: stem, stem + *t* and stem + *en*. There are few exceptions to these rules (e.g., suppletive *zijn* [be], some modal verbs lack the –*t* ending). The present study focused on regular agreement forms and in particular on the third person singular –*t* suffix, which shares phonological properties with the regular past tense form in English. In (1), the Dutch regular agreement paradigm is illustrated for the verb *zoeken* [search].

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(1)	1SG	*Ik*	*zoek*	stem	[I search]
	2SG	*Jij*	*zoek-t*	stem + *t*	[You search]
	3SG	*Hij/zij*	*zoek-t*	stem + *t*	[He/she searches]
	1PL	*Wij*	*zoek-en*	stem + *en*	[We search]
	2PL	*Jullie*	*zoek-en*	stem + *en*	[You search]
	3PL	*Zij*	*zoek-en*	stem + *en*	[They search]

In Dutch main clauses, finite verbs (i.e., verbs that express tense or agreement) are in left-peripheral second position, a property referred to as *verb second* or V2. In embedded clauses, finite verbs are sentence-final. Infinitives are homophonous with finite plural verb forms (stem + *en*, e.g., *zoeken*) but are in sentence-final position regardless of sentence type. Examples of placement of the finite verb versus the infinitive can be found in the Method section, example (3) versus example (7).

De Jong (1999) demonstrated in a group of children with SLI who were, on average, 7 years old that the third person singular suffix *–t* was accurately used in 61% of the obligatory contexts, much lower than the TD language-matched group—consisting of children who were on average 2 years younger—and the TD age-matched groups, who had an accuracy of 87% and 89%, respectively. The same two TD groups had an accuracy of more than 95% with third person plural *–en* in contrast to only 69% in the SLI children. Experimental data from children between ages 6 and 8 showed that despite a fairly high accuracy of 80%, children with SLI are outperformed by younger TD controls whose accuracy in the same task assessing all three forms of present-tense paradigm was 91% correct (Orgassa, 2009).[1] Children ages 6 and older with SLI show incorrect use of bare verb stems in V2 position (de Jong, 1999; Orgassa, 2009, Verhoeven et al., 2011). Use of incorrect inflection is less frequent than incorrect bare verbs, whereas unambiguous use of plural forms in singular contexts is rare in Dutch SLI (Blom et al., 2013; de Jong, 1999; Orgassa, 2009; Verhoeven et al., 2011; Wexler et al., 2004).[2]

Phonological Factors

It has been observed that phonological factors affect SLI children's use of verb inflection (Bishop, 1994). Inflecting a verb often leads to formation of a consonant cluster, and consonant clusters present a problem for children with SLI (in English: Bishop, North, & Donlan, 1996; Gathercole & Baddeley, 1990; Pharr, Bernstein Rattner, & Rescorla, 2000; in Dutch: Gerrits & de Bree, 2009). Marshall and van der Lely (2007) indeed found that English children with SLI tend to omit regular past tense inflection when the verb ends in a consonant cluster. Other studies on English past tense inflection show that the quality of the stem-final consonant to which the suffix attaches is also important. For instance, children with SLI inflect verbs ending in nonobstruents (e.g., *rolled*) more often than verbs ending in obstruents (e.g., *walked*; Eyer & Leonard, 1994; Johnson & Morris, 2007; Marchman, Wulfeck, & Weismer, 1999; Oetting & Horohov, 1997). In other relevant studies, researchers looked at phonotactic probability. Phonotactic probability refers to the likelihood that a sound or sound sequence occurs in a particular part of a word or syllable (Kenstowicz, 1994). English children with SLI failed to use past tense marking if the final cluster had low phonotactic probability such as /gd/ (as in *hugged*), whereas forms with high phonotactic probability raised no specific difficulties (Leonard, Davis, & Deevy, 2007; Marshall & van der Lely, 2006; but see Rispens & de Bree, 2014, who found effects of phonotactic probability on the level of past tense allomorphs but not on the word level).

The above observations suggest that more atypical clusters raise problems, in particular for children with SLI. For instance, across languages, sonority in the coda decreases from peak to margin following the sonority scale (Blevins, 1995; Selkirk, 1984), a constraint known as the *sonority sequencing principle (*Clements, 1990). More specific constraints disallow sonority reversals and plateaus, (i.e., coda clusters consisting of consonants with the same position on the sonority scale; Morelli, 1999). The plosive-plosive cluster /kt/ in *walked* creates a sonority plateau and is thus highly marked. Verbs ending in nonobstruents such as vowels or semivowels, in contrast, are not expected to present problems for suffixation of regular past tense inflection because the sonority sequencing principle is obeyed in such cases.

In the present study, we investigated whether phonological constraints on consonant clusters may explain why Dutch children with SLI have problems using the third person singular suffix *–t*. This *present* tense suffix is functionally different but shares phonological properties with English *past* tense. Hence, it would be expected that sonority affects the Dutch third person singular form in similar ways that it affects English past tense inflection, which is an expectation further investigated in this study.

Receptive Ability

Most studies that identified verb inflection as the locus of errors in SLI have done so on the basis of production data. Investigating parallels between production and reception can be important for understanding children's errors. Asymmetries between reception and production could reveal whether problems in SLI have to do with articulatory planning of complex syllables (Orsolini, Sechi, Maronato, Bonvino, & Corcelli, 2001). Consonant clusters increase syllable complexity, placing great demands on speech output processes due to the need to coordinate and plan a variety of articulatory gestures within a syllable (Bishop et al., 1996). This is relevant to the third person singular suffix investigated in this study, as explained above.

Studies on English SLI have reported parallels between reception and production of verb inflection (Paradis, Rice,

[1]Differences in accuracy between the study by de Jong (1999) and the study by Orgassa (2009) could have to do with differences in the tasks used (story retelling vs. elicited production).

[2]Because infinitives are homophonous with plural forms, it is difficult to discern incorrect use of infinitives ("root infinitives") from incorrect plurals. In order to do so, it should be decided whether the verb is in V2 or in sentence-final position; to verify verb position, a sentence needs to contain negation/adverbials or (direct/indirect) objects.

Crago, & Marquis, 2008; Redmond & Rice, 2001; Rice, Wexler, & Redmond, 1999). Investigators of one study looked at the receptive ability of Dutch children with SLI regarding agreement inflection (Rispens & Been, 2007). Rispens and Been (2007) reported data from an offline grammaticality judgment task with 11 children with SLI who were on average 8 years old. In their study, awareness of three different subject–verb agreement errors was tested: bare verb form instead of third person singular, plural form instead of third person singular, and third person singular instead of plural. The children with SLI were worse at detecting violations compared with TD age-matched children. The SLI group showed chance performance for all error types; only two children with SLI were able to detect the violations (exhibiting A' scores above .80). The children performed well on the control condition with subcategorization errors, but subject–verb agreement errors are subtle compared with subcategorization errors. Therefore, chance performance for subject–verb agreement could indicate that the children failed to understand the judgment task when it tested subject–verb agreement. Thus, on the basis of these results, it cannot be decided with sufficient confidence whether the results indicate a lack of grammatical competence or point to task effects.

In the present study, we used a self-paced listening task to assess children's receptive ability. *Self-paced listening* is a relatively new online method (Ferreira, Henderson, Anes, Weeks, & McFarlane, 1996) that can tap children's implicit grammatical knowledge (Marinis, 2010). It is less demanding than other online tasks used for similar purposes, such as the word monitoring task (Montgomery & Leonard, 1998), or offline judgment tasks (Rispens & Been, 2007). Self-paced listening has been successfully used with children with SLI (for an overview, see Marinis, 2010) and to assess sensitivity to the omission of verb inflection in English children with TD (Chondrogianni & Marinis, 2012). To our knowledge, the current study was the first where the self-paced listening task was used to examine sensitivity to subject–verb agreement errors in children with SLI. Furthermore, no study on Dutch SLI has compared children's production and reception of subject–verb agreement in the same group of children.

Goals and Research Questions for the Study

The first goal of this study was to examine effects of phonological form on use of subject-verb agreement—particularly, suffixation of the third person singular suffix *–t,* in Dutch children with SLI.

Research question 1. The following research question was formulated: Are errors with subject–verb agreement affected by sonority of the stem-final segment, and is this different for TD and SLI? Fewest errors would be expected for stems ending in a vowel or semivowel because suffixation of *–t* does not create a consonant cluster. For consonants, the sonority scale—from least to most sonorous—is: plosives < fricatives < nasals < liquids < glides (Blevins, 1995; Selkirk, 1984). Plosives and fricatives are obstruents, whereas nasals, liquids, and glides are nonobstruents or sonorants (like vowels and semivowels). We predicted that children with SLI would omit third person singular *–t* more often after obstruents than after nonobstruents, and among the obstruents, more omissions may be found after plosives than after fricatives.

Research question 2. Our second goal in this study was to compare production and reception. The guiding research question was as follows: Do parallels exist between the productive and receptive abilities of Dutch children with SLI regarding agreement inflection? The frequency of errors in production was inferred based on the production data for the children in the present study (and not on frequency distributions of the population in general). On the basis of previous research, we expected that the children with SLI in our study would use incorrect bare verbs in V2 position and that they would hardly ever use incorrect plural forms in singular contexts. Parallels between production and reception predicted that the children should be sensitive to infrequent errors and insensitive to frequent production errors (Paradis et al., 2008; Redmond & Rice, 2001; Rice et al., 1999). Assuming that incorrect bare verbs in V2 position are frequent, we expected no sensitivity to this error in the self-paced listening task. We expected the children to sense incorrect plural forms because this is an infrequent error in production.

Method

Participants

Sixty-three children between ages 5 and 8 participated in the study: 26 children with SLI between ages 6 and 8 (SLI group; 20 boys, 6 girls), 20 children with no history of language or learning problems age-matched to the SLI group (TD–AM group; 12 boys, 8 girls), and 17 younger children with no history of language and learning problems language-matched to the SLI group (TD–LM group; 7 boys, 10 girls). All 63 children participated in the production experiment. In the processing experiment, 55 children participated because eight children with SLI (6 boys, 2 girls) did not complete the processing experiment either because they lost interest or because they were too tired to finish it.

Language matching was based on receptive vocabulary, assessed through a subtest of the Taaltoets Alle Kinderen (TAK; Verhoeven & Vermeer, 2002).[3] The TAK is a language assessment test with standardized norms for native and non-native Dutch children. The test was chosen because this study was part of a larger study that also included child second-language learners of Dutch. Information on the children's ages and receptive vocabulary scores is given in Table 1. On the

[3]Due to limited resources, we were unable to collect and transcribe speech samples that allowed reliable calculations of children's mean length of utterances (MLU), which is commonly used for matching SLI and TD on language abilities. Because children with SLI often show delayed vocabulary development (Schwartz, 2009), we matched on the raw vocabulary scores. In so doing, we used the same method as de Jong (1999) in his study on subject–verb agreement in Dutch SLI. De Jong matched on vocabulary in order to avoid circularity because MLU is affected by omission of verb inflection.

Table 1. Properties of the groups.

Group	*n*	M_{age} in months (*SD*)	Raw receptive vocabulary score (*SD*)
SLI (production task)	26	90.6 (10.5)	71.7 (10.2)
SLI (processing task)	18	91.3 (10.6)	69.8 (11.1)
TD–AM	20	86.1 (6)	79.4 (5.7)
TD–LM	17	65.5 (3.38)	69.6 (9.8)

Note. SLI = specific language impairment; TD-AM = typically developing, age-matched to SLI group; TD-LM = typically developing, language-matched to SLI group.

basis of the the TAK norm data, children were assigned to five levels corresponding to the 1st-10th percentile (E), 11th–25th percentile (D), 26th–50th percentile (C), 51st–75th percentile (B), and 76th–100th percentile (A). Most TD children fell in TAK levels A/B (n = 27; 73%) and thus scored above the median, whereas most children with SLI fell in TAK levels C/D/E (n = 20; 80%)[4] and thus scored below the median.

For the full sample, a one-way analysis of variance (ANOVA) with age as the dependent variable indicated an effect of Group, $F(2, 60) = 57$, $p < .001$, $\eta^2 = .66$; Bonferroni post hoc tests revealed no age differences between the SLI and TD–AM groups ($p = .17$), whereas both the SLI and the TD–AM groups were older than the TD–LM group ($p < .001$). A comparison of raw vocabulary scores indicated an effect of Group, $F(2, 59) = 6.72$, $p = .002$, $\eta^2 = .19$; SLI scored lower than TD–AM ($p = .012$) and matched TD–LM ($p = 1.00$); TD–AM scored higher than TD–LM ($p = .004$). Dropouts of children with SLI in the processing experiment did not affect matching. Ages were different across groups, $F(2, 52) = 61.52$, $p < .001$, $\eta^2 = .70$, with SLI and TD–AM having a similar age ($p = .08$), and both SLI and TD–AM were older than TD–LM ($p < .001$). Receptive vocabulary scores differed across the groups, $F(2, 52) = 7.32$, $p = .002$, $\eta^2 = .22$, showing that SLI scored lower than TD–AM ($p = .006$) and matched TD–LM ($p = 1.00$), and TD–AM scored higher than TD–LM ($p = .006$).

Children with SLI were recruited through special schools for children with speech and language problems. They were referred to these schools by certified clinicians on the basis of a standardized protocol for speech and language disorders in the Netherlands (the so-called Cluster 2 protocol). For a child to be referred to special education for speech and language problems, her/his score on the tests measuring expressive language proficiency—TAK (Verhoeven & Vermeer, 2002) or Taaltests voor Kinderen (TvK; van Bon & Hoekstra, 1982)—was at least 1.5 *SD*s below the mean for her/his age. Selected children with SLI had a nonverbal IQ score of 96 on average (*SD* = 10) as measured by the revised Snijders-Oomen Non-Verbal Intelligence Test (SON–R; Tellegen, Winkel, & Laros, 1989), with the exception of one child who was tested with the Dutch version of the Wechsler Intelligence Scale for Children (WISC–III NL; Kort et al., 2002).[5] None of the children had severe articulatory difficulties or dyspraxia, nor did they have hearing deficits. The standardized language assessment, nonverbal IQ test, and hearing screening were carried out at the special schools; children were selected for our study based on information in the children's school files.

Production Experiment: Materials and Procedures

For testing children's use of third person singular *–t,* a cloze procedure was used in which children had to describe a contrast between two pictures by completing a sentence prompted by the research assistant. Two adjacent pictures were shown that depicted the same activity but with a different object manipulated. The agents on the pictures (who manipulated the object) corresponded to third person singular subjects. An introductory sentence primed the target verb. The prime was followed by the prompt. In (2), the target response is in bold.

(2) *Hier wordt gelezen. De man … **leest een krant** en de vrouw … **leest een boek**.*
[Here is read-PASS-PTCP. The man … read-3SG a newspaper and the woman …
read-3SG a book.]
[Here reading is being done. The man … **is reading a newspaper** and the woman … **is reading a book**.]

The verb inflection test was part of a larger test battery administered to the groups in the present study and, in addition, to a group of sequentially bilingual children. This limited both the number of items and the type of items we could include. First, only verbs were selected that could be assumed to be known by children in all groups (based on information from Damhuis, de Glopper, Boers & Kienstra, 1992; Schlichting & lutje Spelberg, 2002). Second, the actions the verbs referred to had to be able to be represented with a photograph. Third, only transitive verbs were included to classify responses based on the verb's position relative to the direct object. Based on placement of the verb

[4]The TAK score of one child with SLI is missing due to the child's unwillingness to complete the test battery. For the smaller sample that participated in the processing experiment, the majority of the children also scored below the median (n = 14; 80%).

[5]The most recent nonverbal IQ scores of the children were made available to us by the special schools, and schools vary in which test is administered.

relative to the object, an incorrect response with a verb ending in *–en* could be classified as having incorrect number (*–en* suffix in V2 position preceding the object) or containing an infinitive (*–en* suffix in sentence-final position following the object). Fourth, only verbs with monosyllabic stems were included. Fifth, equal numbers of verbs had to end in a sonorant, fricative, or plosive. Lexical frequencies of the items were checked in the SUBTLEX-NL corpus (Keuleers, Brysbaert, & New, 2010), a 44 million-word corpus with film and television subtitles. The three different sonority classes did not differ in lexical frequency, $F(2) = 0.862$, $p = .468$, and it would not be expected that frequency creates a confounding effect in the present study. Because our criteria restricted the set of verbs to choose from, we were unable to control for more specific phonological properties such as length in phonemes or complexity of the consonant cluster. In this respect, it is relevant to note that the verb *drinken* [drink] in the plosive class also yields a more complex coda cluster (/ŋkt/); we return to this in the Discussion section. The task contained nine experimental items (three per phonological condition) and 15 filler items (determiner-noun agreement). Experimental items appear in Appendix A. Materials from all tasks used for the present study are available in full at www.iris-database.org.

Production Experiment: Coding and Data Analysis

Each item primed a different verb, and for each verb, two responses were elicited, as illustrated in (2) for the verb form *leest* [reads]. Responses were assigned one of the following codes: Target (third person singular *–t,* see response in [3]), Omission (incorrect bare verb stem, see response in [4]), Substitution (plural *–en,* see response in [5]); note that in this example, the child also inverts the order of subject and verb), Periphrasis (auxiliary + infinitive, see [6]), or Infinitive (infinitival *–en* in sentence-final position, see [7]).

(3)	*De vrouw*	*geeft*	*een*	*appel*	Target
	[The woman	give-3SG	an	apple]	
(4)	*De man*	*was*	*een*	*pan*	Omission
	[The man	wash-Ø	a	pan]	
(5)	*Geven*	*de man*	*een*	*appel*	Substitution
	[Give-PL	the man	an	apple]	
(6)	*De vrouw*	*gaat*	*z'n*	*haar*	*knippen* Periphrasis
	[The woman	go-AUX	his	hair	cut-INF]
(7)	*Een appel*	*geven*			Infinitive
	[An apple	give-INF]			

For the purpose of this study, we did not analyze periphrasis or infinitive responses. The processing experiment did not contain these forms; were we to include them, the production and processing data would become less comparable. In addition, both periphrasis and infinitive responses are not well suited to assess correct use of finite inflection. The infinitival responses lack a finite verb, the finite verbs in periphrastic constructions often have irregular/suppletive agreement paradigms, and the criteria for lexical verbs do not apply. In addition, the finite forms used in periphrasis are high-frequency forms that cause fewer errors than lower-frequency forms, inflating the accuracies in production. Finally, it is straightforward how properties of the coda would cause omission of the suffix *–t,* but it is not clear how properties of the coda would lead to periphrasis or infinitives. Periphrasis in Dutch SLI is discussed in de Jong, Blom, and Orgassa (2013). Infinitival clauses in Dutch SLI are analyzed in detail in de Jong (1999) and Wexler et al. (2004). General all-purpose verbs (*de man doe met een bal* [the man do with a ball]), past tense verbs (*de man kocht een cadeau* [the man bought a present]), responses without a verb (*de vrouw een poes, de jongen een hond* [the woman a cat, the boy a dog]), and unintelligible responses were coded as "other" and also excluded. Unclear responses were checked by a second researcher and solved by consensus (for each group: 10–20 responses). Data from 21 participants were transcribed and coded by a research assistant as well as the first and second author. Codings agreed 94.6% of the time.

Due to the priming, children nearly always used the targeted verb. Sometimes, the prime led to elliptic responses with an omitted verb or elicited past tense responses. The latter situation in particular happened when the past participle prime resembled the past tense form (*gekocht* /ɣəkɔxt/ [bought]; *kocht* /kɔxt/ [bought]). Also, children sometimes used the nonexisting third person singular form *slaagt* /slaːɣt/ instead of the target form *slaat* /slaːt/ [beats]. The form *slaagt* /slaːɣt/ might also have been influenced by phonological overlap with the past participle prime *geslagen* /ɣəslaːɣən/. Such responses were coded as target-like, but the coda was recoded from sonorant into fricative.

Responses were also coded for sonority (plosive, fricative, sonorant) of the onset of the postverb syllable to control for resyllabification possibilities. Resyllabification is guided by the sonority scale and the principle that the onset of a syllable (i.e., the position preceding the vowel) should be filled with a consonant (Clements, 1990; Hooper, 1972). Consequently, when the postverb syllable has an onset not filled by a consonant or filled by a consonant with low sonority, this may create a context that favors resyllabification. Such a context might help a child to retain third person singular inflection (e.g., the $[CVCC]_\sigma[VC]_\sigma$ pattern in *koopt-een* /koːpt ən/ [buys a] becomes a $[CVC]_\sigma[CVC]_\sigma$ pattern as in *koop-teen* $[\text{koːp}]_\sigma[\text{tən}]_\sigma$ instead of the bare verb *koop* /koːp/). The onset of the postverb syllable was most often a vowel because the direct object started with the indefinite singular article *een* /ən/ [a]. The plosive verbs *knippen* /knɪpən/ [cut] and *drinken* /drɪŋkən/ [drink] were often followed by the mass nouns *papier* /papiːr/ [paper], *haar* /haːr/ [hair], and *thee* /teː/ [tea]/*sap* [juice], leading to relatively many postverb plosive and fricative onsets.[6] In the sonorant, fricative, and plosive conditions, the postverb syllable began, respectively, 62%, 78%, and 50% of the time with a sonorant (mainly a vowel, but also a consonant of low sonority); 4%, 4%, and 25% of the time, the onset of the postverb syllable was a fricative, and 34%, 18%, and 25% of the time, it was a plosive. The relatively high percentages of plosive and fricative onsets in the plosive

[6] Dutch mass nouns are bare nouns.

condition could create a confounding effect (that is, drop of *–t* due to a plosive-/t/ cluster or drop of *–t* because of few possibilities to resyllabify). Therefore, the onset of the postverb syllable was included as a covariate in the statistical analysis.

A logistic mixed-effects regression analysis was used to identify which variables predict children's omission errors. Logistic regression is a robust statistical procedure suited for a study where the dependent variable is binary, as in our study (omission vs. target responses). Mixed-effects modeling is a technique that allows one to assess the simultaneous effect of multiple random- and fixed-effect variables. Inclusion of Child and Verb as random-effect variables has the advantage that the predictions of the regression model can be generalized to the populations of children and verbs. Group, Coda (of the verb stem), and Onset (of the syllable following the verb) were included as fixed-effect variables.

Production Experiment: Nonword Repetition Task

In order to assess whether the children were able to produce the required consonant clusters, a nonword repetition (NWR) task was administered. Target words were seven monosyllabic words with the same coda as the inflected verbs in the verb inflection task. These items were mixed with an equal number of fillers where the sequence was word-medial and divided over two syllables (Appendix B).[7] Parallels between the verb inflection task and the NWR task could point to more general phonological or articulatory problems that could also contribute to children's errors with verb inflection (Gathercole & Baddeley, 1990; Bishop et al., 1996). The seven target words were scored on correct repetition of the coda. Any error in repeating the coda was coded as incorrect (e.g., omission or substitution of a segment). Errors in repeating the onset or the nucleus were not coded. All groups performed well on the NWR task: SLI scored on average 6.0 (SD = 0.71), TD–AM scored 6.8 (SD = 0.44), and TD–LM scored 6.7 (SD = 0.47) correct out of seven targets. A one-way ANOVA indicated a difference between the groups, $F(2, 51) = 10.38$, $p < .001$, $\eta^2 = .29$, with SLI performing lower compared to both TD–AM ($p < .001$) and TD–LM ($p = .001$).

Production Experiment: Results

Table 2 shows the percentages of correct responses (target), omission errors, and substitution errors on the verb inflection task. Substitution errors were rare overall, but appeared most frequently in the SLI group. Yet the SLI group made more omission errors than substitution errors, $t(25) = 3.93$, $p < .001$, as expected (de Jong, 1999; Orgassa, 2009; Verhoeven et al., 2011). In the SLI group, 17 different children made omission errors. One child omitted third person singular *–t* across the board. In the TD–AM and TD–LM groups respectively five and eight different children occasionally made omission errors.

Table 3 summarizes omission across phonological conditions and groups. A simple regression model revealed that both Group and Coda predicted children's omission errors. Regarding Group, it was found that the SLI group omitted inflections more frequently than the TD–AM group ($\beta = 3.7$, $SE = 0.84$, $z = 4.38$, $p < .001$) and the TD–LM group ($\beta = 2.14$, $SE = 0.71$, $z = 3.0$, $p = .003$), whereas TD–AM and TD–LM groups did not differ in the frequency of omissions ($p = .10$). Regarding Coda, it turned out that omission was less frequent after sonorants compared with fricatives ($\beta = -2.83$, $SE = 0.64$, $z = -4.45$, $p < .001$) and plosives ($\beta = -3.51$, $SE = 0.65$, $z = -5.41$, $p < .001$). A trend toward less omission after fricatives than plosives emerged ($\beta = 0.67$, $SE = 0.37$, $z = 1.85$, $p = .065$). All significant effects were retained when a Bonferroni-adjusted α level of .017 (.05/3) was applied. A more complex regression model indicated an interaction between Group and Coda showing that the TD–LM group omitted third person singular *–t* more often after plosives compared with fricatives, whereas this pattern did not emerge for the SLI group ($\beta = -2.42$, $SE = 0.96$, $z = -2.52$, $p = .011$). A likelihood-ratio test indicated that the more complex, nested model was preferred over the simple model, $\chi^2(4) = 16.0$, $p = .003$. Onset of the postverb syllable yielded no significant effects (plosive vs. fricative: $p = .44$; sonorant vs. fricative: $p = .77$; plosive vs. sonorant: $p = .20$).[8]

Inspection of individual data indicated no clear relationships between children's performance in the NWR task and verb inflection task. Almost all children were able to use sonorant-/t/, fricative-/t/, and plosive-/t/ codas. One child with SLI who omitted third person singular *–t* after a fricative in the verb inflection task did the same in the NWR task. Three other children with SLI simplified /kt/ or /pt/ clusters in the NWR task, producing [mout] and [bɪnt] instead of [moupt] and [bɪŋkt], but the same children used [knɪpt] or [drɪŋkt] in the verb inflection task. Children's scores in the NWR task ranged between 5 and 7, and the variation was not sufficient for using correlational analyses to assess the relationships between children's performance on the NWR task and the verb inflection task.

Processing Experiment: Materials and Procedure

A self-paced listening task was used in which children listened to grammatical and ungrammatical sentences. Ungrammatical sentences with third person singular subjects either contained an incorrect bare verb (third person omission condition; i.e., Ø instead of *–t* suffix) or plural number instead of singular (third person substitution condition, i.e., *–en* instead of *–t* suffix). A control condition tested a context in which bare verbs are grammatical and the third

[7] Children with SLI notoriously have difficulties with nonwords, in particular if the nonwords contain consonant clusters (Bishop et al., 1996). However, we used this task because no existing and familiar Dutch words with the same clusters as in the inflected verbs were available.

[8] The task led to a short break between verb and object because the child had to look for a difference in the object manipulated (e.g., the woman gives … an apple and the man gives … a rose), and this may have diminished any effects of the onset of the word following the verb.

Table 2. Production data: percentage of responses per response class with the raw number of the responses in parentheses (*n*).

Group	Included responses			Excluded responses		
	% target (*n*)	% omission (*n*)	% substitution (*n*)	% periphrasis (*n*)	% infinitive (*n*)	% other (*n*)
SLI	58.3% (273)	15.4% (72)	2.1% (10)	12.4% (58)	3.2% (15)	8.5% (40)
TD–AM	96.4% (347)	2.2% (8)	—	0.3% (1)	—	1.1% (4)
TD–LM	79.1% (242)	4.6% (14)	0.3% (1)	3% (9)	2.3% (7)	10.8% (33)

person singular –*t* is ungrammatical (first person substitution condition, i.e., –*t* suffix instead of Ø). This condition was included to disentangle effects of processing of a particular verb form and effects of (un)grammaticality.

Sentences were divided into segments, and each time the child pressed a button, (s)he heard the following segment of a particular sentence. Children are expected to take longer to press the button (i.e., exhibit longer reaction times [RTs]) for segments that are in conflict with their internal grammatical representation (Marinis, 2010). The experiment was programmed and administered using the E-prime software (Schneider, Eschman, & Zuccolotto, 2002).

(8) Third person omission condition (3SG omission; incorrect bare verb):
Louise houdt van knutselen met papier. Louise / pakt / een stuk papier / en / ze ***knipt (*knip)*** */ hartjes / in haar kamer.*
[Louise like-3SG to play with paper. Louise / pick-3SG / a piece paper / and / she cut-3SG / hearts-DIM / in her room.]
[Louise likes to play with paper. Louise picks a piece of paper and she cuts small hearts in her room.]

(9) Third person substitution condition (3SG substitution; wrong number):
*Joris doet de afwas. Joris / maakt / een sopje / en / hij wast (*wassen) / bordjes / in de keuken.*
[Joris do-3SG the dishes. Joris / make-3SG / a soap-DIM / and / he wash-3SG / plates-DIM / in the kitchen.]
[Joris is doing the dishes. Joris is making soapy water and he is washing some small plates in the kitchen.]

(10) First person substitution condition (1SG substitution; wrong person):
Ik maak een cadeau voor moederdag. Ik / verf / een boot / en / ik ***knip (*knipt)*** */ vissen / uit papier.*
[I make-1SG a present for mother's day. I / paint / a boat / and / I cut-1SG / fish / out paper.]
[I am making a mother's day present. I paint a boat and cut fish out of paper.]

Table 3. Percentage of omission errors across phonological coda conditions with the number of omissions in parentheses (*n*).

Coda group	Sonorant% omission (*n*)	Fricative% omission (*n*)	Plosive% omission (*n*)
SLI	6% (7)	30% (35)	27% (30)
TD–AM	0% (0)	0% (0)	7% (8)
TD–LM	0% (0)	2% (2)	15% (12)

All sentences contained a direct object to ensure that the verbs were unambiguously in V2 position and prevent the children from interpreting the incorrect version of (9) as an infinitival clause. The verbs in the third person omission condition and in first person substitution condition were the same as those selected for the production experiment. For the third person substitution condition, different verbs were chosen—the same criteria were applied—to avoid occurrence of a grammatical and ungrammatical version of the same verb in the same session. All verbs are listed in Appendix A.

Each participant heard a grammatical and ungrammatical version of each sentence (single-case design). The two versions were presented in separate sessions with an interval of 1 week between sessions. Each condition was tested with nine experimental sentences giving rise to 54 experimental sentences in total. Items on determiner-noun agreement were fillers ($n = 30$). Each second or third experimental item was followed by a comprehension question (see [11]) to avoid automatic button pressing without paying attention.

(11) *Marga houdt van allerlei soorten dieren. Marga / kijkt / naar vogels / en / ze aait / honden / in het park. Vindt Marga honden eng?*
[Marga love-3SG of all sorts animals. Marga / watch-3SG / to birds / and / she stroke-3SG / dogs / in the park. Finds Marga dogs scary?]
[Marga loves all sorts of animals. Marga watches birds and she strokes dogs in the park. Does Marga find dogs scary?]

Children with a comprehension score below –2 *SD*s from the mean were excluded, but in this sample this applied to no child. All participants were tested in a quiet room at their school. Each experimental session was preceded by a practice session, which could be repeated twice if necessary. None of the children failed to complete the practice session. All children received the different tasks in the same order. During the first session, the elicitation task, NWR task, and first part of the self-paced listening task were administered. The second part of the self-paced listening task was administered during the second session.

Processing Experiment: Data Analysis

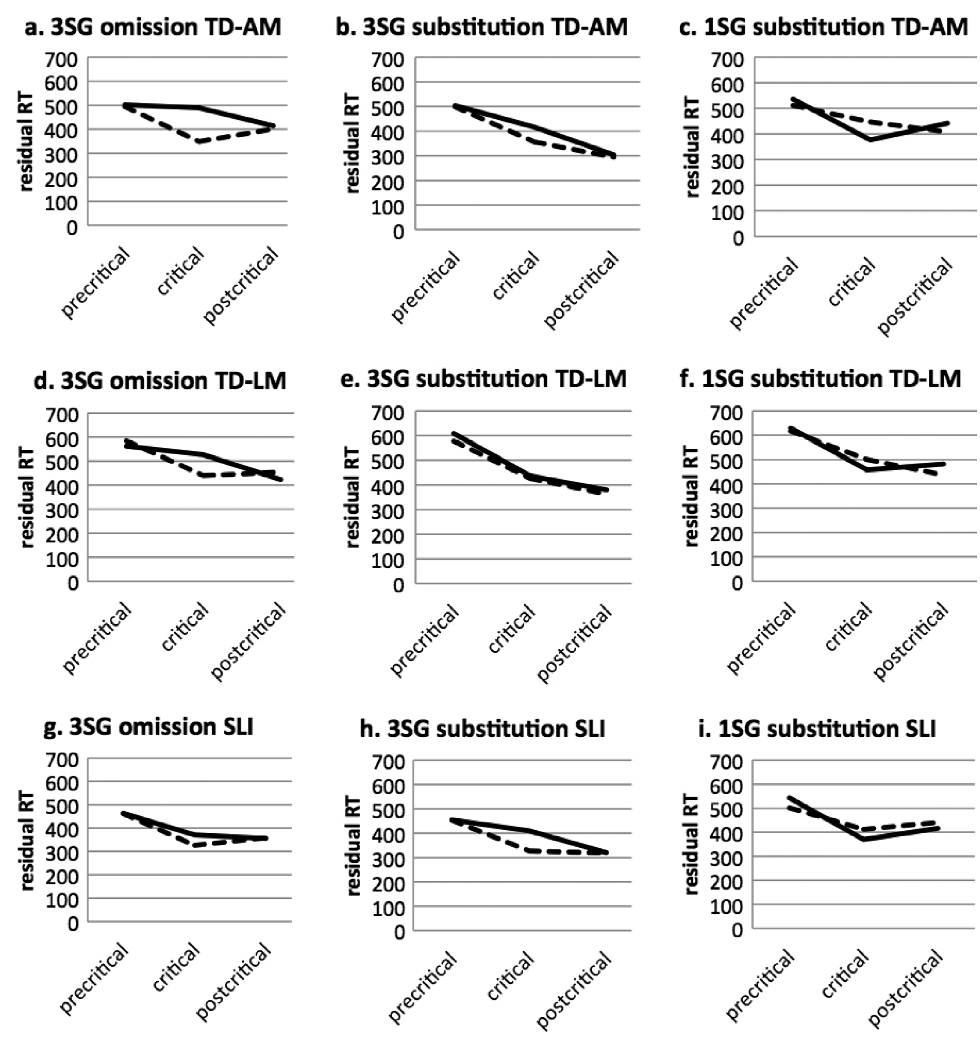
Raw RTs were transformed into residual RTs by subtracting from the RTs on each segment the duration of the audio file for this segment. Extreme values (> 3,000 ms), outliers (2 *SD*s above/below the mean RT per condition), and negative residual RTs were excluded. Negative residual RTs indicated that the participant did not listen to the entire segment. Less than 10% of the data was excluded. For the statistical analysis, repeated measures (RM) ANOVA was used because the dependent variable is continuous; after trimming, the data were normally distributed. Group (SLI, TD–AM, TD–LM) was a between-participants variable, Condition (third person omission, third person substitution, first person omission) and Grammaticality (grammatical, ungrammatical) were within-participants variables. Only statistically significant results are reported.

Processing Experiment: Results

Main analysis. The results are displayed in Figure 1. The dotted lines represent RTs to the grammatical condition; the continuous lines represent RTs to the ungrammatical condition. Visual inspection of the graphs at the critical segment suggests that the TD–AM group has longer RTs to ungrammatical than to grammatical sentences in both third person conditions. In the first person condition, RTs to the grammatical sentences appear to be longer. The TD–LM group shows largely the same pattern but less pronounced. In the third person omission condition, the SLI group has a smaller difference between grammatical and ungrammatical sentences compared with the TD groups, whereas in the third person substitution condition, the difference appears to be larger for the SLI group.

We first checked whether any grammaticality effects emerged at the precritical and postcritical segments—that is, the segments preceding and following the critical segment (which contained the correct or incorrect verb form). This was not the case, and further analyses focused on the critical segment. An RM ANOVA indicated a main effect of Condition, $F(1, 53) = 8.88$, $p = .004$, partial $\eta^2 = .14$. The first person substitution condition (mean RTs: 425 ms) and the

Figure 1. Residual reaction times at the precritical, critical, and postcritical segments in all three conditions, all groups. Dotted lines represent grammatical structures; continuous lines represent ungrammatical structures.



third person omission condition (mean RTs: 420 ms) elicited longer RTs than the third person substitution condition (mean RTs: 397 ms; $p = .004$; $p = .010$). A main effect of Group, $F(2, 53) = 5.79$, $p = .005$, partial $\eta^2 = .18$, emerged because the TD–LM group (mean RTs: 465 ms) had longer RTs than the TD–AM (mean RTs: 407 ms) and the SLI groups (mean RTs: 370 ms; $p = .017$; $p < .001$). A main effect of Grammaticality $F(1, 53) = 17.68$, $p < .001$, partial $\eta^2 = .25$, showed that RTs to ungrammatical sentences (mean RTs: 429 ms) were longer than to grammatical sentences (mean RTs: 399 ms).

Significant interaction effects emerged between Condition and Group, $F(2, 53) = 6.77$, $p = .002$, partial $\eta^2 = .20$; Grammaticality and Group, $F(1, 53) = 32.47$, $p < .001$, partial $\eta^2 = .38$; and Condition, Group, and Grammaticality, $F(3, 53) = 4.77$, $p = .012$, partial $\eta^2 = .15$. The three-way interaction is most informative. We unpacked this interaction by applying RM ANOVAs for each group separately.

The TD–AM group showed a main effect of Grammaticality, $F(1, 19) = 14.25$, $p = .001$, partial $\eta^2 = .41$, and an interaction effect between Condition and Grammaticality, $F(1, 19) = 23.81$, $p < .001$, partial $\eta^2 = .56$. Subsequent paired-samples t tests revealed in all conditions a significant grammaticality effect (third person omission: $t(19) = -6.33$, $p < .001$; third person substitution: $t(19) = -3.57$, $p < .01$; first person substitution: $t(19) = 3.83$, $p = .001$. Statistical significance was retained after a Bonferroni correction was applied to the α level (.017) to correct for multiple comparisons. The effect in the first person substitution condition was in an unexpected direction because the grammatical condition elicited longer RTs than the ungrammatical condition. The two third person conditions yielded longer RTs for the ungrammatical sentences compared with the grammatical sentences.

The TD–LM group showed a main effect of Condition, $F(1, 17) = 4.48$, $p = .049$, partial $\eta^2 = .21$, and an interaction effect between Condition and Grammaticality, $F(1, 17) = 8.04$, $p = .01$, partial $\eta^2 = .32$. A subsequent paired-samples t test indicated a significant effect of grammaticality in the third person omission condition only, $t(17) = -3.45$, $p = .003$; also significant for $\alpha = .017$, in the expected direction.

Finally, for the SLI group, main effects of Condition, $F(1, 17) = 9.37$, $p < .01$, partial $\eta^2 = .36$, and Grammaticality, $F(1, 17) = 7.05$, $p < .05$, partial $\eta^2 = .29$, and an interaction between Condition and Grammaticality, $F(1, 17) = 15.77$, $p = .001$, partial $\eta^2 = .48$, emerged. Subsequent paired-samples t tests revealed a significant effect of grammaticality in the third person substitution condition only, $t(17) = -3.90$, $p = .001$, in the expected direction. The other effects were marginally significant when α was set at .05 but not if α is adjusted to .017.

Follow-up analyses: Grammaticality effects by verb form. In the TD–AM group, a reversed grammaticality effect was found in the first person substitution condition, which was due to longer listening to the bare form compared with the form on *–t*. This raises the question whether the grammaticality effect in the third person omission condition found for TD–AM and TD–LM could also be due to listening longer to bare verbs compared with verbs ending with *–t*. We compared children's RTs for grammatical bare verbs in the first person substitution condition to their RTs for ungrammatical bare verbs in the third person omission condition. If the ungrammatical bare verbs elicited longer RTs compared with the grammatical bare verbs, we can be confident that the grammaticality effect in the third person omission condition points to children's sensitivity to subject–verb agreement errors. An RM ANOVA with Grammaticality (first person substitution, third person omission) as the within-participants variable and Group (TD–AM, TD–LM) as the between-participants variable revealed that RTs for ungrammatical bare verbs in the third person condition (M RT = 508 ms) were longer than for grammatical bare verbs in the first person condition (M RT = 474 ms), $F(1, 36) = 5.21$, $p = .03$, partial $\eta^2 = .13$. No other effects emerged, indicating that the longer RTs to ungrammatical bare verbs hold for both groups. A similar analysis on grammatical and ungrammatical *–t* suffixation in the TD–AM group (who showed the significant reversed grammaticality effect) did not yield a difference, $F(1, 19) = .99$, $p = .33$. We turn to this observation in the Discussion section.

Follow-up analysis: Sequencing effects. Due to sequencing, children may have become used to hearing ungrammatical sentences, and this could have obscured grammaticality effects. This is relevant for the TD–LM and SLI groups because these groups showed limited grammaticality effects. Familiarization to ungrammatical sentences would show in a negative correlation between RTs and item number for ungrammatical sentences. In the TD–LM group, RTs to the ungrammatical sentences became indeed shorter after hearing more items, but the relationship between RTs and item number was nonsignificant, $r(473) = -.033$; for grammatical sentences, a significant relation emerged, $r(472) = -.116$, $p = .01$. In the SLI group, RTs to both ungrammatical and grammatical sentences became shorter; these effects were nonsignificant. Also, the effect for grammatical sentences, $r(486) = -.072$, was larger than for ungrammatical sentences, $r(486) = -.029$. Thus, both TD–LM and SLI became faster during the experiment. Because these effects were stronger for grammatical sentences compared with ungrammatical sentences, it is unlikely that familiarization obscured grammaticality effects.[9]

Discussion

In Dutch, SLI manifests itself in errors with verb inflection (Blom et al., 2013; de Jong, 1999; Orgassa, 2009; Verhoeven et al., 2011; Wexler et al., 2004), similar to SLI in other West Germanic languages (Leonard, 2009). In order to identify the cause of verb inflection errors in Dutch SLI,

[9]Note that also in the TD–AM group, RTs to both ungrammatical sentences, $r(540) = -.139$, $p = .001$, and grammatical sentences, $r(540) = -.163$, $p < .001$, became shorter during the experiment, with a stronger effect for grammatical sentences, similar to the other groups.

we investigated in this study the role of phonology. In addition, children's production of subject–verb agreement was compared to their processing of agreement.

Production: Phonological Factors

To address the role of phonology, the following question was formulated: Are errors with subject–verb agreement affected by sonority of the stem-final segment, and is this different for TD and SLI? The simple regression model revealed a two-way pattern with more omission after obstruents than nonobstruents similar to findings for English (Johnson & Morris, 2007; Oetting & Horohov, 1997). The second regression model indicated that whereas the TD–LM group failed to use third person singular *–t* more often after plosives than fricatives, no such difference emerged for the SLI group. The more complex, second model was the preferred model.

Closer examination of the data indicates that the same pattern found for TD–LM also emerged for TD–AM on the basis of percentages. Children in the TD–AM group rarely made errors (and thus no significant effects emerged), but if they omitted verb inflection, this happened after a plosive. In the TD groups, omission is thus found for the most marked coda that contained a sonority plateau, whereas the SLI group also displayed difficulties with the less marked fricative-/t/ cluster. The observation that children with SLI have particular difficulties with consonant clusters converges with previous findings based on NWR tasks and might suggest that articulation and planning of complex articulatory gestures contribute to SLI children's errors in speech production (Bishop et al., 1996), including verb inflection errors. However, consonant clusters in the context of verb inflection are particularly challenging because the same children who omitted the final /*t*/ in third person singular verb forms were able to produce nonwords with the same sequence of sounds.

Due to the criteria that the stimuli in our study had to meet, the number of verbs per sonority class and the choice of the verbs within each class were limited. Future research should take a closer look at phonological effects by exerting more control over the types of verbs. For instance, in our study, all verbs were monosyllabic, but they differed in number of phonemes. Also, the plosive class included one verb with a more complex coda cluster. It is relevant to note that this verb (*drinken* [drink]) yielded more omission (35%) than the other verbs in the plosive class (10%–13%), suggesting that in our study, coda complexity influenced the outcomes for plosives. In the fricative class, all codas were equally complex. In the SLI group, suffixation of *–t* after fricatives and plosives raised similar difficulties, and both caused more difficulties compared with sonorants. Thus, although complexity should be taken into account, sonority of the coda (independent of complexity) does affect successful use of the *–t* suffix in children with SLI. In future research, a different task, inclusion of fewer groups, and a smaller age range could enable more control of the phonological properties of the stimuli.

Receptive Ability: Self-Paced Listening

Our study was the first to use the self-paced listening task with subject–verb agreement in Dutch children with TD and SLI. The TD–AM group showed grammaticality effects in the expected direction in both third person conditions. The children sensed omission and substitution of third person singular *–t*. This is consistent with few omissions and no substitution of third person singular *–t* in production. In the first person substitution condition, a grammaticality effect emerged but in an unexpected direction. It took the children longer to process ungrammatical bare verbs in the third person omission condition than grammatical bare verbs in the first person substitution condition. Processing ungrammatical *–t* in the first person substitution condition and processing grammatical *–t* in the third person omission condition took equally long. These two observations indicate (a) that the grammaticality effect in the third person omission condition is a genuine grammaticality effect, and (b) the TD–AM group did not perceive a *–t* in first person singular contexts as ungrammatical.

Possibly, the children are used to hearing a *–t* at the end of a verb in first person singular contexts because some (frequent) Dutch verb stems end in an alveolar stop (*word* [become][10]; *zit* [sit]), some irregular past tense verbs end in a /t/ (*had* [had], *dacht* [thought]), and when the direct object begins with a definite article (*het* [the]) the finite verb is often followed by /t/ because *het* is commonly reduced to /t/ in spoken Dutch (Ernestus, 2000). These factors may have contributed to the absence of the expected grammaticality effect in the first person substitution condition in the TD–AM group.

The TD–LM group noticed omission of the third person singular *–t* but did not notice that this suffix was substituted by plural *–en*. In production, the TD–LM group did not substitute. Furthermore, in a grammaticality judgment task, Dutch 8-year-olds detected the same violation (Rispens & Been, 2007). Hence children's failure to notice number mismatches does not point to knowledge gaps. It is possible that the self-paced listening task is not suited to measure young children's sensitivity to number mismatches in Dutch.

Let us now turn to the SLI group and to the second question of the study: Do parallels exist between the productive and receptive ability of Dutch acquiring children with SLI regarding agreement inflection? The SLI group did not notice omission of third person singular *–t* and they also did not sense incorrect use of the *–t* suffix. Sequencing effects did not explain the absence of grammaticality effects in the self-paced listening task. Insensitivity to the *–t* suffix in the self-paced listening task was consistent with production, where the SLI group tended to omit the *–t* suffix in obligatory third person singular contexts. An incorrect plural *–en* suffix in third person singular contexts was noticed by the SLI group, and they also did not make this error themselves in the production task. The two modalities thus show parallels: Frequent production errors are not noticed, whereas infrequent

[10]Because Dutch has final devoicing, *word* is pronounced with the final sound devoiced.

errors are noticed. These parallels confirm findings on SLI in English (Montgomery & Leonard, 1998; Paradis et al., 2008; Rice et al., 1999; Redmond & Rice, 2001).

The SLI group had equally long processing times at the critical segment as the TD–AM group and shorter processing times than the TD–LM group. Other studies with SLI found significantly longer RTs for SLI groups compared with TD–AM groups in online tasks looking at verb inflection (Leonard, Miller, & Finneran, 2009; Montgomery & Leonard, 1998, 2006). These studies used a word-monitoring task in which children keep a target word in mind while processing a sentence they hear. This dual task puts considerable demands on children's working memory. Numerous studies have found that children with SLI have working memory limitations (Leonard et al., 2007; Miller, Kail, Leonard, & Tomblin, 2001; Windsor & Huang, 1999); hence, it is not surprising the word-monitoring task affects TD and SLI differently. Interestingly, not only did the SLI group show a grammaticality effect in the third person substitution condition whereas the TD–LM group did not, but the effect was also stronger compared with the TD–AM group. This stronger SLI effect parallels findings of other studies that investigated SLI children's processing of correct and incorrect sentences (Marinis & Saddy, 2013; Neville, Coffey, Holcomb, & Tallal, 1993; Sabisch, Hahne, Glass, von Suchodoletz, & Friederici, 2006), and it could be caused by slower recovery from the mismatch in children with SLI due to their processing limitations.

Causes of Verb Inflection Errors in Dutch SLI

In this study, we found that SLI children's errors with subject–verb agreement in production are affected by verb phonology. In addition, parallels emerged between the productive and receptive abilities of Dutch children with SLI regarding agreement inflection. The data on both production and processing suggest that factors relevant to spell out, such as articulatory planning and the coordination of articulatory gestures, are not the sole explanation for variable production of verb inflection in Dutch SLI. This conclusion is based on two observations. First, the consonant clusters that caused difficulties in the verb inflection task did not cause problems in the majority of children with SLI in the NWR task. Second, in the self-paced listening task, the children with SLI failed to notice omission of the suffix *–t*. We conclude that errors with subject–verb agreement in Dutch SLI may also be affected by impaired verb inflection representations, in particular of the *–t* suffix. The variability observed in our study is in line with Clahsen's (2008) claim that "agreement is not completely absent in SLI, but … the adult agreement paradigm seems to be incomplete with problems focusing on particular forms or verb classes" (p. 177).

The observed variation would be compatible with the view that the impairment of agreement is present at the level of lexical knowledge (Clahsen, 2008). More specifically, verb inflection paradigms are incomplete in SLI (Leonard, 2007). The observation that children are insensitive to the omission of *–t* but sensitive to the substitution of *–t* by *–en* indicates that perceptual salience could be a mitigating factor (Leonard, 1998): Children with SLI may have developed stronger representations for the syllabic and perceptually salient form *–en* than for nonsyllabic *–t*. Apart from articulatory complexity (Bishop et al., 1996) and salience (Leonard, 1998), functional complexity could play a role. Whereas *–en* (in V2 position) is associated with plurality only, *–t* is associated with singularity and person features (third, second). Because of their aforementioned and well-documented processing and working memory limitations, children with SLI may fail to keep the different functions in mind; thus, it may take them longer and may require much exposure to map these functions onto the correct form, in particular if the form lacks perceptual salience, as does the *–t* suffix.

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References

Bishop, D. V. M. (1994). Grammatical errors in specific language impairment: Competence or performance limitations? *Applied Psycholinguistics, 15,* 507–550.

Bishop, D. V. M., North, T., & Donlan, C. (1996). Nonword repetition as a behavioural marker for inherited language impairment: Evidence from a twin study. *Journal of Child Psychology and Psychiatry, 37,* 391–403.

Blevins, J. (1995). The syllable in phonological theory. In J. A. Goldsmith (Ed.), *The handbook of phonological theory* (pp. 206–244). Oxford, England: Blackwell.

Blom, E., de Jong, J., Orgassa, A., Baker, A., & Weerman, F. (2013). Verb inflection in monolingual Dutch and sequential bilingual Turkish-Dutch children with and without SLI. *International Journal of Language and Communication Disorders, 48,* 382–393.

Chondrogianni, V., & Marinis, T. (2012). Production and processing asymmetries in the acquisition of tense morphology by sequential bilingual children. *Bilingualism: Language and Cognition, 15,* 5–21.

Clahsen, H. (2008). Chomskyan syntactic theory and language disorders. In M. J. Ball, M. Perkins, N. Mueller, & S. Howard (Eds.), *The handbook of clinical linguistics* (pp. 165–183). Oxford, England: Blackwell.

Clements, G. N. (1990). The sonority cycle and syllable organization. In W. Dressler, H. Luschützky, O. Pfeiffer, & J. Rennison (Eds.), *Phonologica 1988* (pp. 63–76). Cambridge, England: Cambridge University Press.

Damhuis, R., de Glopper, K., Boers, M., & Kienstra, M. (1992). *Woordenlijst voor 4- tot 6-jarigen: Een streeflijst voor kleuters* [Glossary for 4- to 6-year-olds: A target list for preschoolers]. Rotterdam, the Netherlands: CED Groep, Het Projectbureau OVB.

de Jong, J. (1999). *Specific language impairment in Dutch: Inflectional morphology and argument structure* (Doctoral dissertation). Retrieved from http://dissertations.ub.rug.nl/FILES/faculties/arts/1999/j.de.jong/14_thesis.pdf

de Jong, J., Blom, E., & Orgassa, A. (2013). Dummy auxiliaries in children with SLI: A study on monolinguals and bilinguals. In E. Blom, I. van de Craats, & J. Verhagen (Eds.), *Dummy auxiliaries in first and second language acquisition* (pp. 251–280). Berlin, Germany: de Gruyter.

Ernestus, M. (2000). *Voice assimilation and segment reduction in casual Dutch: A corpus-based study of the phonology-phonetic interface* (Unpublished doctoral dissertation). Holland Institute of Generative Linguistics, Utrecht, the Netherlands.

Eyer, J. A., & Leonard, L. B. (1994). Learning past tense morphology with specific language impairment: A case study. *Child Language Teaching and Therapy, 10,* 127–138.

Ferreira, M. F., Henderson, J. M., Anes, M. D., Weeks, P. A., Jr.., & McFarlane, D. K. (1996). Effects of lexical frequency and syntactic complexity in spoken-language comprehension: Evidence from the auditory moving-window technique. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22,* 324–335.

Gathercole, S. E., & Baddeley, A. D. (1990). Phonological memory deficits in language disordered children: Is there a causal connection? *Journal of Memory & Language, 29,* 336–360.

Gerrits, E., & de Bree, E. (2009). Early language development of children at familial risk of dyslexia: Speech perception and production. *Journal of Communication Disorders, 42,* 180–194.

Hooper, J. B. (1972). The syllable in phonological theory. *Language, 48,* 525–540.

Johnson, B., & Morris, S. (2007). Clinical implications of the effects of lexical aspect and phonology on children's production of the regular past tense. *Child Language Teaching and Therapy, 23,* 287–306.

Kenstowicz, M. (1994). *Phonology in generative grammar*. Oxford, England: Blackwell.

Keuleers, E., Brysbaert, M., & New, B. (2010). SUBTLEX-NL: A new measure for Dutch word frequency based on film subtitles. *Behavior Research Methods, 42,* 643–650.

Kort, W., Compaan, E., Bleichrodt, N., Resing, W., Schittekatte, M., Bosmans, M., … Verhaeghe, P. (2002). *WISC-III NL. Handleiding*. London, England: Psychological Corporation.

Leonard, L. B. (1998). *Children with specific language impairment*. Cambridge, MA: MIT Press.

Leonard, L. B. (2007). Processing limitations and the grammatical profile of children with specific language impairment. In R. Kail (Ed.), *Advances in child development and behavior* (Vol. 35, pp. 139–171). New York, NY: Elsevier.

Leonard, L. B. (2009). Cross-linguistic studies of child language disorders. In R. G. Schwartz (Ed.), *Handbook of child language disorders* (pp. 308–324). New York, NY: Psychology Press.

Leonard, L. B., Davis, J., & Deevy, P. (2007). Phonotactic probability and past tense use by children with specific language impairment and their typically developing peers. *Clinical Linguistics & Phonetics, 21,* 747–758.

Leonard, L. B., Weismer, S. E., Miller, C. A., Francis, D. J., Tomblin, J. B., & Kail, R. V. (2007). Speed of processing, working memory, and language impairment in children. *Journal of Speech, Language, and Hearing Research, 50,* 408–428.

Leonard, L. B., Miller, C. A., & Finneran, D. A. (2009). Grammatical morpheme effects on sentence processing by school-aged adolescents with specific language impairment. *Journal of Language and Cognitive Processes, 24,* 450–478.

Marchman, V. A., Wulfeck, B., & Weismer, S. E. (1999). Morphological productivity in children with normal language and SLI: A study of the English past tense. *Journal of Speech, Language, and Hearing Research, 42,* 206–219.

Marinis, T. (2010). Using on-line processing methods in language acquisition research. In E. Blom & S. Unsworth (Eds.), *Experimental methods in language acquisition research* (pp. 139–162). Amsterdam, the Netherlands: John Benjamins.

Marinis, T., & Saddy, D. (2013). Parsing the passive: Comparing children with specific language impairment to sequential bilingual children. *Language Acquisition, 20,* 155–179.

Marshall, C. R., & van der Lely, H. K. J. (2006). A challenge to current models of past tense inflection: The impact of phonotactics. *Cognition, 100,* 302–320.

Marshall, C. R., & van der Lely, H. K. J. (2007). The impact of phonological complexity on past tense inflection in children with Grammatical-SLI. *Advances in Speech-Language Pathology, 9,* 191–203.

Miller, C. A., Kail, R., Leonard, L. B., & Tomblin, J. B. (2001). Speed of processing in children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 44,* 416–433.

Montgomery, J. W., & Leonard, L. B. (1998). Real-time inflectional processing by children with specific language impairment: Effects of phonetic substance. *Journal of Speech, Language, and Hearing Research, 41,* 1432–1443.

Montgomery, J. W., & Leonard, L. B. (2006). Effects of acoustic manipulation on the real-time inflectional processing of children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 49,* 1238–1256.

Morelli, F. (1999). *The phonotactics and phonology of obstruent clusters in optimality theory* (Unpublished doctoral dissertation), . University of Maryland, College Park.

Neville, H. J., Coffey, S. A., Holcomb, P. J., & Tallal, P. (1993). The neurobiology of sensory and language processing in language-impaired children. *Journal of Cognitive Neuroscience, 5,* 235–253.

Oetting, J. B., & Horohov, J. E. (1997). Past-tense marking by children with and without specific language impairment. *Journal of Speech, Language, and Hearing Research, 40,* 62–74.

Orgassa, A. (2009). *Specific language impairment in a bilingual context: The acquisition of Dutch inflection by Turkish-Dutch learners* (Doctoral dissertation, University of Amsterdam). Retrieved from http://dare.uva.nl/document/147433

Orsolini, M., Sechi, E., Maronato, C., Bonvino, E., & Corcelli, A. (2001). Nature of phonological delay in children with specific language impairment. *International Journal of Language and Communication Disorders, 36,* 63–90.

Paradis, J., Rice, M. L., Crago, M., & Marquis, J. (2008). The acquisition of tense in English: Distinguishing child second language from first language and specific language impairment. *Applied Psycholinguistics, 29,* 689–722.

Pharr, A. B., Bernstein Rattner, N., & Rescorla, L. (2000). Syllable structure development of toddlers with expressive specific language impairment. *Applied Psycholinguistics, 21,* 429–449.

Redmond, S. M., & Rice, M. L. (2001). Detection of irregular verb violations by children with and without SLI. *Journal of Speech, Language, and Hearing Research, 44,* 655–669.

Rice, M. L., Wexler, K., & Redmond, S. M. (1999). Grammaticality judgments of an extended optional infinitive grammar: Evidence from English-speaking children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 42,* 943–961.

Rispens, J., & Been, P. (2007). Subject-verb agreement and phonological processing in developmental dyslexia and specific language impairment (SLI): A closer look. *International Journal of Language and Communication Disorders, 42,* 293–305.

Rispens, J. E., & de Bree, E. H. (2010). Past tense productivity in Dutch children with SLI: The role of phonology. In K. Franich, K. Iserman, & L. Keil (Eds.), *BUCLD 34: Proceedings of the*

34th annual Boston University Conference on Language Development (pp. 327–338). Somerville, MA: Cascadilla Press.
Sabisch, B., Hahne, A., Glass, E., von Suchodoletz, W., & Friederici, A. D. (2006). Lexical-semantic processes in children with specific language impairment. *Developmental Neuroscience, 17,* 1511–1514.
Schlichting, L., & lutje Spelberg, H. (2002). *Lexilijst-NL* [Lexicon List Dutch]. Amsterdam, the Netherlands: Pearson Assessment and Information.
Schneider, W., Eschman, A., & Zuccolotto, A. (2002). *E-Prime user's guide*. Pittsburgh, PA: Psychology Software Tools.
Schwartz, R. G. (2009). *Handbook of child language disorders*. New York, NY: Psychology Press.
Selkirk, E. O. (1984). On the major class features and syllable theory. In M. Aronoff, R. Oehrle, F. Kelley, & B. W. Stephens (Eds.), *Language sound structures* (pp. 107–136). Cambridge, MA: MIT Press.
Tellegen, P. J., Winkel, M., & Laros, J. A. (1989). *Snijders-Oomen Non-Verbal Intelligence Test: SON-R 5.5-17* [Manual and research report]. Groningen, the Netherlands: Wolters-Noordhoff.
Tomblin, J. B., Records, N. L., Buckwalter, P., Zhang, X., Smith, E., & O'Brien, M. (1997). The prevalence of specific language impairment in kindergarten children. *Journal of Speech, Language, and Hearing Research, 40,* 1245–1260.
van Bon, W. H. J., & Hoekstra, J. G. (1982). *Taaltests voor Kinderen* [Language Test for Children]. Lisse, the Netherlands: Swets & Zeitlinger.
Verhoeven, L., & Vermeer, A. (2002). *Taaltoets Alle Kinderen (TAK)* [Children Language Assessment]. Tilburg, the Netherlands: Zwijsen.
Verhoeven, L., Steenge, J., & van Balkom, H. (2011). Verb morphology as clinical marker of specific language impairment: Evidence from first and second language learners. *Research in Developmental Disabilities, 32,* 1186–1193.
Wexler, K., Schaeffer, J., & Bol, G. (2004). Verbal syntax and morphology in typically developing Dutch children and children with SLI: How developmental data can play an important role in morphological theory. *Syntax, 7,* 148–198.
Windsor, J., & Huang, M. (1999). Testing the generalized slowing hypothesis in specific language impairment. *Journal of Speech, Language, and Hearing Research, 42,* 1205–1218.

Appendix A

Verbs Selected for Production and Processing Task

Verbs Production/Processing Task: Third Person Omission/First Person Substitution Condition

Coda	Third person singular	Bare stem	English
Sonorant	*aait* /aːit/	*aai*	[stroke]
	duwt /dywt/	*duw*	[push]
	slaat /slaːt/	*sla*	[beat]
Fricative	*leest* /leːst/	*lees*	[read]
	geeft /geːft/	*geef*	[give]
	wast/blaast /ʋɑst/blaːst/	*was/blaas**	[wash/blow]
Plosive	*drinkt* /drɪŋkt/	*drink*	[drink]
	koopt /koːpt/	*koop*	[buy]
	knipt /knɪpt/	*knip*	[cut]

Verbs Processing Task: Third Person Substitution Condition

Coda	Third person singular	Bare stem	English
Sonorant	*gooit* /ɣoːit/	*gooien*	[throw]
	neemt /neːmt/	*nemen*	[take]
	tekent /teːkənt/	*tekenen*	[draw]
Fricative	*past* /pɑst/	*passen*	[fit]
	wast /ʋɑst/	*wassen*	[wash]
	poetst /putst/	*poetsen*	[clean]
Plosive	*kijkt* /kɛikt/	*kijken*	[look]
	kookt /koːkt/	*koken*	[cook]
	zoekt /zukt/	*zoeken*	[search]

*The stem of the verb *wash* (*was*) is homophonous with the singular past tense form of *be*. For this reason, a resembling but different verb was chosen (*blow*). Note that in the substitution condition, no issues arose because the plural past form of *be* is irregular (*waren* and not *wassen*).

Appendix B

Words in the Nonword Repetition (NWR) Task

Coda	Word-final	Word-medial
Sonorant	*klaat* /klaːt/	*verblaate* /vərblaːtə/
	vaait /vaːit/	*vermaaite* /vərmaːitə/
	puwt /pywt/	*veruwte* /vərywtə/
Fricative	*dast* /dɑst/	*verpaste* /vərpɑstə/
	peeft /peːft/	*keefte* /keːftə/
Plosive	*moopt* /moːpt/	*versopte* /vərsɑptə/
	binkt /bɪŋkt/	*rikte* /rɪktə/