The Use of Tense and Agreement by Hungarian-Speaking Children With Language Impairment

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Purpose: Hungarian is a null-subject language with both agglutinating and fusional elements in its verb inflection system, and agreement between the verb and object as well as between the verb and subject. These characteristics make this language a good test case for alternative accounts of the grammatical deficits of children with language impairment (LI).
Method: Twenty-five children with LI and 25 younger children serving as vocabulary controls (VC) repeated sentences whose verb inflections were masked by a cough. The verb inflections marked distinctions according to tense, person, number, and definiteness of the object.
Results: The children with LI were significantly less accurate than the VC children but generally showed the same performance profile across the inflection types. For both groups of children, the frequency of occurrence of the inflection in the language was a significant predictor of accuracy level. The two groups of children were also similar in their pattern of errors. Inflections produced in place of the correct inflection usually differed from the correct form on a single dimension (e.g., tense or definiteness), though no single dimension was consistently problematic.
Conclusions: Accounts that assume problems specific to agreement do not provide an explanation for the observed pattern of findings. The findings are generally compatible with accounts that assume processing limitations in children with LI, such as the morphological richness account. One nonmorphosyntactic factor (the retention of sequences of sounds) appeared to be functionally related to inflection accuracy and may prove to be important in a language with numerous inflections such as Hungarian.

KEY WORDS: Hungarian, language impairment, morphosyntax, language disorders

Children with language impairment (LI) show significant deficits in language ability without accompanying deficits such as hearing impairment, neurological damage, or mental retardation. Although children with LI represent a heterogeneous population, common profiles can be identified. In English, for example, a very common profile is a mild to moderate deficit in lexical skills and a more serious deficit in morphosyntax. Within the area of morphosyntax, the use of tense and agreement morphemes seems to be especially problematic.

One complicating factor in the study of LI is that a common profile in one language is uncommon or even absent in another language. For example, word order errors are common in Swedish and German but not in English. In Italian, verb inflections that express agreement with the subject are not among the areas of special difficulty, unlike the case for English.

Proposals for these cross-linguistic differences are beginning to emerge in the literature. Following a brief review of these proposals, we will describe a study employing Hungarian, a language that represents an excellent test case for the suitability of these alternative proposals. Hungarian differs from other languages studied by LI researchers in key respects. One characteristic is the agglutinating morphology with respect to tense and agreement, where an inflection marking tense is followed by an inflection marking agreement, both attached to the verb stem. A second important characteristic of Hungarian is the fact that verb inflections agree with both the subject (in person and number) and the object (in definiteness). As will be seen below, these characteristics have implications for current accounts of the morphosyntactic difficulties seen in LI.

Recent Accounts of Morphosyntactic Deficits in LI

Morphological Richness

The morphological richness account has evolved from the findings of Leonard and his colleagues (Leonard, 1998, pp. 255–257; Leonard, Sabbadini, Leonard, & Volterra, 1987; Dromi, Leonard, Adam, & Zadunaisky-Ehrlich, 1999). According to this account, extraordinary difficulties with tense and agreement morphemes are the result of an interaction between a more general limitation in language ability and the properties of the particular system of grammar that must be learned. Key details of the morphological richness account were inspired by the competition model (e.g., Bates & MacWhinney, 1989; MacWhinney, 1987), such as the views that languages differ in the details of grammar that have the greatest cue validity, that the discovery and use of these cues are probabilistic in nature, and that some cues have greater processing cost than others.

An important assumption of the morphological richness account is that children with LI have a limited processing capacity. For languages such as English, this limitation can be problematic for the learning of grammatical morphology. Inflections are sparse in English, and bare stems are frequent. Faced with a limited processing capacity, then, children with LI might devote their limited resources to the more prevalent information conveyed by word order. Fewer resources would remain for the learning of grammatical morphology, requiring more encounters with grammatical morphemes before they can be learned. In contrast, children with LI acquiring languages with a rich inflectional morphology are expected to devote their limited resources to this area of the grammar. Thus, differences in the use of grammatical morphology between these children and their typically developing peers will be smaller than in a language such as English. It is for this reason that the account gets its name—*morphological richness.*

However, if the inflections themselves reflect a complex combination of grammatical dimensions (e.g., tense, number, person, gender), problems can arise even in the area of inflections in a language with a rich morphology. The more dimensions children must consider simultaneously, the greater the demands on their limited processing capacity. These demands can result in incomplete processing, requiring more encounters with the inflection before it can become a stable part of the children's grammar. Based on findings from Italian and Hebrew, Leonard (1998) proposed that children with LI may approach their processing limitations when four dimensions must be considered simultaneously. According to Leonard, incompletely processed inflections are the functional equivalent of inflections with low frequency of occurrence because they are not registered consistently and therefore do not achieve sufficient strength in the child's grammar to be retrieved as reliably as can be accomplished by typically developing children. Given that children with LI must have a greater number of encounters with each inflection before it is sufficiently established to be retrieved for production with facility, the frequency of occurrence of the inflection in the input is an important factor in the morphological richness account. It is predicted that accuracy will be greater for inflections that are encountered more frequently in the input.

The morphological richness account's focus on the number of dimensions in an inflection system differs from an approach such as the competition model in that the latter places an emphasis on cue validity. Thus, an inflection that reflects a complex combination of four dimensions would be expected to be challenging for children with LI according to the morphological richness account, but if that inflection has high cue validity, the number of dimensions would play a much smaller role according to the competition model.

Another assumption of the morphological richness account is that if errors occur, the substitute inflection is expected to share most features with the inflection that it replaces. In many instances, this will be a "near-miss" error—an inflection that possesses most but not all features reflected in the correct form (e.g., Bedore & Leonard, 2001; Dromi et al., 1999). For example, a third person plural form in the past might be replaced by a third person plural form in the present or a third person singular form in the past. Children with LI are not expected to resort to a default form. Furthermore, if an inflection used as a substitute is found to differ from the correct inflection on multiple dimensions (e.g., tense, person, and number), the substitute should prove to have high frequency of occurrence in the language (leading to greater strength in the paradigm). Only forms of high frequency should serve as competitors to inflections that constitute near misses, as retrieval is assumed to be driven initially by shared features and only highly frequently occurring forms should have enough strength to alter the retrieval process. The morphological richness account grants no special status to any given dimension. Thus, if the correct inflection is not retrieved, the substitute should differ only minimally from the correct form, but no single dimension will dominate. Thus, although all dimensions are operative, they are not hierarchically arranged.

Agreement Deficit

Clahsen and his colleagues (Clahsen, Bartke, & Göllner, 1997; Clahsen & Dalalakis, 1999; Clahsen & Hansen, 1997; Eisenbeiss, Bartke, & Clahsen, 2005) have proposed that children with LI have a selective syntactic deficit that affects agreement in particular. These investigators adopted Chomsky's (1995) distinction between interpretable and noninterpretable features and posited that in LI, the verb's noninterpretable features are not properly acquired. Even in null-subject languages, subject–verb agreement is posited to be problematic (Clahsen & Dalalakis, 1999). Errors are expected to be productions of default forms, such as the production of a present third person singular inflection in contexts that obligate a different inflection. The agreement deficit account does not predict difficulties with tense.

Nonmorphosyntactic Language Processing Factors

The morphological richness account is concerned with processing limitations within the scope of morphosyntactic learning and use. This emphasis is well placed, of course, given the striking limitations that children with LI exhibit in this area of language. However, other important areas are important in LI, and these may have at least an indirect, negative impact on morphosyntactic ability. Bishop, Adams, and Norbury (2006) have identified two fundamental impairments in children with LI that are both heritable yet show minimal etiological overlap (see also Conti-Ramsden, 2003). Not surprisingly, one of these is a reduced ability to carry out grammatical computations. The behavioral measure most frequently used to identify this limitation is a test of morphosyntactic ability, including the use of tense and agreement morphemes (e.g., Rice & Wexler, 2001). The other fundamental impairment is a deficit in the ability to retain sequences of speech sounds for brief periods of time. Nonword repetition tasks constitute the most frequent measures for this type of problem (e.g., Gathercole, Willis, Baddeley, & Emslie, 1994).

Although an ability to retain sequences of sounds is often associated with word learning (e.g., Gathercole & Baddeley, 1993), it should be clear how limitations in the ability to retain sound sequences could also play havoc with the learning of inflections. If a child cannot retain a sequence that represents an inflection that marks tense and agreement, it is likely that the acquisition of this inflection will be delayed. To the degree to which the inflection system of a language contains many different sequences, the detrimental effect of this retention problem could be considerable. This influence could occur even though retention of sound sequences and grammatical computation are genetically and etiologically distinct. First, as noted by Bishop et al. (2006), many children with LI have a double deficit—a deficit in both of these areas. Second, although poor retention of sound sequences appears to be a deficit distinct from a deficit in grammatical computation, if the inflection system of a language involves many different sequences, each of which must be detected and retained by the child, the functional relationship between these two areas may be stronger than in a language such as English.

The Contribution of Hungarian

Hungarian possesses characteristics that make it extremely useful for evaluating the morphological richness and agreement deficit accounts. Research on LI in this language, then, might not only contribute to the development of clinical assessment and treatment methods for Hungarian-speaking children with LI but also to theory development or refinement. We provide a more detailed description of the structure of Hungarian tense and agreement morphology in the next section. However, some of the highlights of Hungarian and its relevance to these accounts of LI can be stated here. Hungarian is a null-subject language with inflections for tense and inflections that simultaneously mark agreement with the subject in person and number and agreement with the object (if any) in definiteness. The agreement deficit account assumes that the difficulty with agreement resides in the agreement features of the verb. Therefore, even in a null-subject language such as Hungarian, agreement inflections will be difficult for children with LI. This may be especially so given that agreement is of two different types—agreement between the subject and verb, and agreement between the verb and the object. Errors of agreement are expected to be default forms such as present third person singular. However, tense features are not affected; for this reason, errors on the tense marking of inflections are not predicted.

According to the morphological richness account, children with LI acquiring a language such as Hungarian, in which inflectional morphology plays a central role, will

Table 1. Inflections and their allomorphs for the four paradigms tested in the study.

		Definite (e.g., Én tolom a dobozt "I am pushing the box")		Indefinite (e.g., Én tolok egy dobozt "I am pushing a box")	
Tense	**Person**	**Singular**	**Plural**	**Singular**	**Plural**
Present	1st	*-om/em/öm*	*-juk/jük*	*-ok/ek/ök*	*-unk/ünk*
	2nd	*-od/ed/öd*	*-játok/itek*	*-sz/ol/el/öl*	*-tok/tek/tök*
	3rd	*-ja/i*	*-ják/ik*	*0*	*-nak/nek*
Past	1st	*-tam/tem*	*-tuk/tük*	*-tam/tem*	*-tunk/tünk*
	2nd	*-tad/ted*	*-tátok/tétek*	*-tál/tél*	*-tatok/tetek*
	3rd	*-ta/te*	*-ták/ték*	*-t/ott/ett/ött*	*-tak/tek*

differ from typical peers to a lesser extent than in a language such as English. However, this account explicitly predicts that the processing capacity of children with SLI will begin to reach its limits when four dimensions must be considered simultaneously as in Hungarian, in which tense, person, number, and definiteness play a role in the verb inflection system. Errors should not be default forms; rather, inflections that differ from the correct inflection on only a single dimension (e.g., present first person singular indefinite in place of present first person plural indefinite) should be the most likely. Accuracy will be greater for inflections with higher frequency of occurrence in the language.

Hungarian is also a highly suitable language to evaluate the role that limitations in the ability to retain sound sequences might play in the use of tense and agreement inflections by children with LI. Although problems in nonword repetition are notorious in this population, their effects on tense and agreement inflection use has not yet been put to a stringent test, as the languages studied have relatively sparse inflection systems. In contrast, the verb inflections of Hungarian make 24 different distinctions, with all but one of these involving two or more different allomorphs. Problems in the retention of sound sequences might well slow the development of inflections in this language. If problems of this type are playing a role, the children's accuracy with inflections should be related to factors such as inflection length and nonword repetition ability.

A Sketch of Hungarian Tense and Agreement Morphology

In Hungarian, verb inflections mark tense and mode, agreement with the subject in person and number, and agreement with the object in definiteness. (Of these dimensions, distinctions according to mode are not examined in the present study; all inflections assessed are in the indicative.) Although Hungarian is often referred to as an agglutinating language, the dimensions of person and number are clearly fusional, and there is a complex relationship between agglutinating and fusional elements. We will return to this issue after introducing the verb inflections under investigation.

Table 1 provides the tense and agreement inflections with their allomorphs. Table 2 shows the tense and agreement inflections applied to the verb *tol* "push."[1] Inflections appear in bold for ease of illustration. In these tables, we divide the inflections into four "paradigms." However, this division is primarily for illustrative purposes, as the inflections for tense, person, number, and definiteness can be viewed as a single paradigm.

Several details can be noted from an inspection of the tables. First, Hungarian's use of agreement between the verb and the object (in definiteness) as well as between the subject and the verb (in person and number) effectively doubles the size of the paradigm. The number of inflections that must be learned by Hungarian-speaking children, then, is quite large indeed. Verb–object agreement is typologically much less common than subject–verb agreement. In fact, many languages show subject–verb agreement without verb–object agreement, but the reverse does not seem to occur. Note from the tables that any difficulty that is specific to verb–object agreement should be detectable. For example, in contexts requiring a present first person singular form, a child might produce *tolok* instead of *tolom* (or vice versa).

The indefinite conjugation is regarded as unmarked. It is used with intransitive verbs as well as with transitive verbs with indefinite objects. It is also employed when the object is a first or second person

[1]For ease of exposition, we use standard Hungarian orthography and do not give phonetic transcriptions. Hungarian orthography is fairly transparent, geminates are marked by double consonants (also by doubling the first letter in a consonant digraph), and accents above vowels mark length. However, not every accented vowel is phonetically equivalent to their short counterpart, so we present the phonetic symbols for Hungarian vowels and nontransparent consonantal letters here. Vowels: a [ɔ], á [a:], o [o], ó [o:], u [u], ú [u:], e [ɜ], é [e:], i [i], í [i:], ö [ø], ő [ø:], ü [y], ű [y:]; consonants: c [ts], cs [ʧ], dzs [dʒ], g [g], gy [j], j [j], ly [j], ny [ɲ], r [r], s [ʃ], sz [s], ty [ç], zs [ʒ].

Table 2. Inflected forms for *tol* "push" in the four paradigms tested in the study.

Tense	Person	Definite (e.g., Én tolom a dobozt "I am pushing the box") Singular	Definite Plural	Indefinite (e.g., Én tolok egy dobozt "I am pushing a box") Singular	Indefinite Plural
Present	1st	*tol**om***	*tol**juk***	*tol**ok***	*tol**unk***
	2nd	*tol**od***	*tol**játok***	*tol**sz***	*tol**tok***
	3rd	*tol**ja***	*tol**ják***	*tol*	*tol**nak***
Past	1st	*tol**tam***	*tol**tuk***	*tol**tam***	*tol**tunk***
	2nd	*tol**tad***	*tol**tátok***	*tol**tál***	*tol**tatok***
	3rd	*tol**ta***	*tol**ták***	*tol**t***	*tol**tak***

pronoun.[2] The definite conjugation is chosen when the object noun phrase (NP) is clearly marked with a definite article (*a* or *az* "the") and when the object is a possessively modified noun. Proper names as object NPs also take the definite conjugation. There are additional factors that are associated with the choice of a definite or indefinite inflection that go beyond the scope of the present study. For a more detailed description, see Bartos (1997) and MacWhinney and Pléh (1997).

A second notable detail that is evident in Tables 1 and 2 is the relatively large number of allomorphs. Most of the variation in the form of the inflection is a function of the vowel harmony rules of Hungarian. These rules seem to be acquired at a rather young age by Hungarian-speaking children (e.g., MacWhinney, 1985), even if they render the relationship between agreement inflections in present and past tense less clear. Other allomorphs are a product of phonological conditioning. Chief among these is the present indefinite second person singular allomorph, *-sz,* whose form is determined by the particular consonant appearing at the end of the verb stem.

Many languages with rich inflectional paradigms do not permit bare verb stems. Hungarian is an exception, in that the present indefinite third person singular inflection is a "zero" form, as in *tol*. The existence of a finite bare stem form in Hungarian means that, in principle, a child could employ such a form as a default whenever the appropriate inflected form is not known or is difficult to retrieve in the moment. Finally, it can be seen in Tables 1 and 2 that there is minimal syncretism (MacWhinney & Pléh, 1997); the only neutralization occurs in the past first person singular forms where the same inflection is used for both definite and indefinite objects (thus, *toltam* is used for both "I was pushing the box" and "I was pushing a box").[3] Hereafter, we employ the following abbreviations: "1", "2", and "3" for first, second, and third person, respectively; "Sg" for singular and "Pl" for plural; "Pres" for present and "Past" for past; and "Indef" for indefinite and "Def" for definite.

The subject–verb agreement (for person and number) reflected in Tables 1 and 2 corresponds to that seen in many other languages (apart from its fusion with definiteness marking). However, Hungarian subject–verb agreement operates somewhat differently because quantified nouns do not formally agree in number with their quantifiers. For example, *ten bottles* is expressed with a singular noun *tíz üveg* "ten bottle" rather than a plural noun **tíz üvegek* "ten bottles." The same is true for nouns preceded by terms corresponding to "many," "some," and "all." This characteristic has implications for subject–verb agreement because agreement is based on formal marking and not conceptual plurality. Thus, a subject such as "ten bottle" would require a verb inflected for singular.

The relationship between agglutinating and fusional elements of the inflection system is very complex. When (past) tense is overtly marked, this element precedes elements reflecting person and number. Thus, in Table 2 it can be seen that in the indefinite past third person plural, past tense *–t-* precedes third person plural *–unk*; the present tense counterpart has no overt tense element preceding *–unk*. However, for inflections marked for definite, position is less transparent. For example, whereas definite past third person plural has the sequence *–t-uk,* definite present third person plural has the sequence *–j-uk,* with *–j-* representing an element marking definiteness, not tense. This complexity has led to proposals (e.g., Rebrus, 2005) that the same position can serve more than one grammatical function, depending on the particular tense, definiteness, and person and number features involved. Phonologically conditioned allomorphy in Hungarian can also reduce the transparency of the agglutinating elements of the inflections. For example, whereas *tolom* is the form for definite present first person singular "I am pushing," the form *toltam* is used for definite past first person singular "I was pushing," not **toltom,* due to lowering of mid-vowels after past tense *–t-*.

[2]There is also a special inflection in the indefinite conjugation when the subject is first person singular and the object is in the second person, expressing both persons in a single inflection, as in *tol-lak* "I push you."
[3]Here we are constraining our description to the section of the verbal paradigm under investigation in our study.

Hungarian-Speaking Children: Previous Findings

Although no systematic experimental examination has been done thus far on the development of agreement marking by typically developing Hungarian-speaking children, two case studies (Lengyel, 1981, data from a boy between 1;0 and 3;0 [years;months]; Meggyes, 1971, data from a girl between 1;8 and 2;2) and a more extensive analysis of data from 3 Hungarian children between 1;8 and 2;9 from the CHILDES database (Babarczy, 2005) report errors in agreement or other inflection details. According to these studies, the very first verb forms are usually either imperative forms or third person singular declarative forms that are sometimes applied to non-third-person referents. In early verb usage, Hungarian children generally use all three singular forms together with Pl1 to express Sg1 meanings. For example, in contexts requiring *tolok* "I am pushing [indefinite]," a child might produce *tolok, tolsz, tol, or tolunk* (see Table 2). Because these utterances usually lack a subject, there is no overt error of subject–verb agreement in such utterances. Based on these three studies, there seems to be individual variation in the extent children use Sg2 as a substitute for Sg1, but for some children such errors are more common in the beginning than Sg3 substitutions, which frequently occur with all children and for a longer period. Pl2 first appears in imperative form, and even when it does appear in declarative form, it is fairly uncommon. There are very few errors in marking Pl3 from the beginning, but these forms are also not frequent. Past tense forms also appear toward the end of the second year, and at first they are generally used to express completed actions.

Babarczy (2005, 2007), in her analysis of CHILDES data from 6 Hungarian children between 1;8 and 2;10, found many errors in definiteness agreement, revealing the children's preference for using the default indefinite form with a definite object (she was focusing on imperative forms) and fewer errors in subject–verb agreement. Based on a comparative analysis of early verb forms, she found that subject–verb agreement is delayed in English relative to Hungarian. Interestingly, she also observes that there is no sentence length effect on the agreement errors that young Hungarian-speaking children make. Lengyel (1981) points out that although mixing up first and third person is common in the indefinite conjugation, it is very rare in the definite conjugation. In summary, typically developing children first mainly use singular forms, they most often to refer to first person, and they make many errors of using Sg3, Sg2, and Pl1 forms for Sg1 meanings. Indefinite verb forms are sometimes used in place of definite forms.

Systematic studies of Hungarian-speaking children with LI have also been few in number. Vinkler and Pléh (1995) reported on a child with LI who had difficulty with noun as well as verb morphology. This child often resorted to a more frequently occurring inflection as a substitute for the required form. Marton, Schwartz, Farkas, and Katsnelson (2006) compared the working memory performance of Hungarian-speaking and English-speaking children with specific language impairment. They found that, for the Hungarian-speaking children, morphological complexity played a larger role than sentence length, whereas syntactic complexity was the most influential factor for the English-speaking children.

Hypotheses

Given the details of tense and agreement inflections in Hungarian, several hypotheses can be advanced. First, according to the agreement deficit account, children with LI should be significantly less accurate than their typically developing peers in the agreement details of the inflections. Errors are likely to be default forms such as third person singular forms. Tense should be correctly marked. According to the morphological richness account, the rich inflectional morphology and null-subject character of Hungarian will lead children with LI to make much more use of tense and agreement inflections than is the case for children with LI in English. However, the four dimensions of tense, definiteness, person, and number that are required in Hungarian inflections (rather than the more commonly encountered three dimensions seen in other languages studied) will place demands on these children's limited processing capacity, leading to small but statistically reliable differences between children with LI and typically developing children. When errors are observed, a disproportionate number should constitute near misses, with no single dimension consistently serving as the source of error. Substitute inflections that are exceptions to the near-miss pattern will tend to have higher frequency of occurrence in the language. Default forms should not be seen. If nonmorphosyntactic language processing factors such as poor retention of sound sequences are involved, errors not clearly attributable to the number of dimensions involved in the inflections should be found, and the children's use of inflections should prove to be related to factors such as the length of the inflection and the children's ability in nonword repetition.

Method

Participants

Fifty children participated in the study. Twenty-five children were selected for the LI group from two special schools for children with language impairments. All of these children met the criteria for LI. Each child scored above 85 on the Raven's Coloured Progressive Matrices (Raven, Court, & Raven, 1987), a measure of nonverbal intelligence. All children passed a hearing screening, and no child had a history of neurological impairment. Each child scored at least 1.5 *SD*s below age norms on at least two of four language tests administered. These four tests included two receptive tests and two expressive tests. The receptive tests were the Hungarian standardizations of the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1981; Csányi, 1974) and the Test for Reception of Grammar (TROG; Bishop, 1983). The expressive tests were the Hungarian Sentence Repetition Test (Magyar Mondatutánmondási Teszt [MAMUT]; Kas & Lukács, 2008) and the Hungarian Nonword Repetition Test (Racsmány, Lukács, Németh, & Pléh, 2005). The rationale for including a nonword repetition test (described below) in the assessment battery is that the ability to repeat nonwords has proven to be one of the most accurate means of identifying children with LI (e.g., Dollaghan & Campbell, 1998; Tager-Flusberg & Cooper, 1999), demonstrating excellent sensitivity and specificity, and seems to be one of the fundamental and heritable weaknesses seen in this type of disorder (Bishop et al., 2006).

Although the PPVT was used as one of the language tests in our selection battery, it was also used as the basis for matching participant groups, as seen in a subsequent section. The Hungarian adaptation of the original TROG is being standardized on children from 4 to 12 years of age.[4] Items assess the children's comprehension of increasingly difficult grammatical structures. The test consists of 20 blocks, each with four sentences of the same construction (such as sentences with comparatives, postmodified subjects, and embedded clauses). The test has an 80-page booklet, each with four pictures, and on each page the child must point to the picture that matches the sentence spoken by the experimenter. A block is considered completed if the child responds correctly to all four pictures in the block. Performance is measured in terms of number of blocks correctly completed.

The Hungarian Sentence Repetition Test (MAMUT; Kas & Lukács, 2008) manipulates length and structural complexity independently. Its 40 sentences are distributed evenly across five types of grammatical constructions: (a) simple subject-verb-object (SVO), (b) simple OVS sentences, (c) complex sentences containing SS relative clauses, (d) SO relative clauses, and (e) OS relative clauses. Sentence length varies between 8 and 15 syllables within each type. The task of the participant is to immediately and accurately repeat the sentences presented by the experimenter. Performance is measured in terms of the number of correctly repeated sentences, which can be evaluated based on grouping by syllable number and by grammatical construction.

[4]We thank Dorothy Bishop for providing us with the Test for the Reception of Grammar (TROG) for this purpose. Thus far, 600 typically developing children have been seen as part of the norming process; the scores for the children with LI were compared against the values obtained for the typically developing children.

The Hungarian Nonword Repetition Test (Racsmány et al., 2005) requires the repetition of meaningless but phonotactically licit strings of Hungarian phonemes. The test contains 36 nonwords between one and nine syllables in length. Each length is represented by four nonwords. The phonological structure of the nonwords does not reflect frequency distributions of Hungarian phoneme sequences, but the test avoids sequences that would be articulatorily difficult for speakers. The span of the participant is the highest syllable number for which he or she could correctly repeat at least two out of the four nonwords.

The remaining 25 children were typically developing. These children scored above −1 *SD* on each of the four language tests that were administered to the children with LI. These children were matched with the LI group on the basis of their raw scores on the PPVT. Because the children with LI scored below age level on the PPVT, the typically developing children matched on this measure were younger. A typically developing child was considered a match if his or her PPVT score was within 3 points of the PPVT score of a child in the LI group. Hereafter, this group will be referred to as the vocabulary control (VC) group. The use of younger typically developing children matched on a nongrammatical language measure was designed to detect whether the difficulties of the children with LI on tense and agreement morphology exceeded their more general limitations in language. If so, group differences favoring the VC group should be seen. Of course, differences in the two groups' pattern of use across the different tense and agreement morphemes was also of interest. Means for age (in years; months) and raw scores on each of the tests together with ranges for both groups are given in Table 3.

Method

Given the large number of tense and agreement inflections in Hungarian, we devised a structured method of eliciting responses that ensured multiple opportunities

Table 3. Means (and ranges in parentheses) for the language impairment (LI) and vocabulary controls (VC) groups for age in years; months and in raw scores on the Peabody Picture Vocabulary Test (PPVT), the Test for the Reception of Grammar (TROG), the Nonword Repetition Test, and the Sentence Repetition Test.

Variable	LI	VC
Age	9;10 (7;6–11;10)	7;1 (5;2–8;5)
PPVT	91.3 (61–114)	92.1 (62–115)
TROG (blocks correct)	12.30 (8–18)	13.76 (6–20)
Nonword Repetition Test	3.5 (1–5)	5.8 (3–8)
Sentence Repetition Test	22.0 (0–39)	33.6 (18–40)

for the child to produce each inflection of interest. The children were asked to repeat sentences; however, the target inflections in each sentence were actually masked by a carefully inserted cough that prevented the child from hearing the inflection but not the stem or the remaining portions of the sentence. This method was adapted from Warren's (1970) phoneme restoration procedure. The restoration effect has been demonstrated at the morpheme level as well, such as for affixes in Hungarian (Dankovics & Pléh, 2001), but the effect has not yet been exploited in developmental studies as an elicited production method. Importantly, in our study the fully audible portions of the sentence (notably, the temporal adverbial, the person and number of the subject, and the definiteness of the object) made it clear (to a mature speaker of Hungarian) which verb inflection was the appropriate one to use. The child was only asked to repeat the sentences and was not told that information was missing.

Specifically, children were instructed to repeat sentences they heard through a loudspeaker. The sentences were recorded by a female speaker and digitized with coughs inserted to replace the inflections only (see subsequent elaboration). All sentences were normalized for a length between 8 and 14 syllables. Although the target inflections in the middle of the sentence were replaced by a cough, the remainder of the sentence contained all the source features for unequivocal identification of the missing inflection. Children occasionally commented that the speaker was coughing a lot; in these cases, we told them that she had a cold, and that they should just disregard the coughs.

Six verbs were used in both present and past tense; definite and indefinite conjugations; singular and plural; and in first, second, and third person. Thus, 144 sentences ($6 \times 2 \times 2 \times 2 \times 3 = 144$) were created. The sentences were blocked according to tense and definiteness paradigm. That is, all 36 sentences marked for present definite were presented together, as were the 36 sentences marked for present indefinite, past definite, and past indefinite. Children were tested in at least two different sessions, with the order of the four blocks counterbalanced across children.

Given the vowel harmony involved in the allomorph used for the inflection, we selected three verbs whose stems had front vowels and three that had stems with back vowels. The six verb stems selected for the task were: *tol* "push," *olvas* "read," *simogat* "stroke (pet)," *kerget* "chase," *épít* "build," and *fésül* "comb."

All sentences were simple SVO sentences. Past tense sentences were systematically longer than present tense sentences because they contained the temporal adverbial *tegnap* "yesterday," used to make the past time of the described event clear. (Hungarian does not possess a temporal adverbial that is unique to present tense.) The subsequent examples illustrate the types of sentences used for each tense and definiteness combination. The location of the inflection masked by a cough is indicated by "XXX."

1. *Mi olvas*XXX *egy mesét.*
   Target: *olvas**unk*** ["read" 1PlPresIndef]
   "We are reading a story."
2. *A gyerekek simogat*XXX *a malacot.*
   Target: *simogat**ják*** ["stroke" 3PlPresDef]
   "The children are petting the pig."
3. Tegnap én építXXX egy tornyot.
   Target: *épít**ettem*** ["build" 1SgPastIndef]
   "Yesterday I built a tower."
4. *Tegnap te tol*XXX *a biciklit.*
   Target: *tol**tad*** ["push" 2SgPastDef]
   "Yesterday you pushed the bike."

It was important to ensure that the inserted coughs were sufficient to obscure the inflection and that there were no anticipatory coarticulatory cues in the verb stem that might have provided the children with an indication of the inflection that was masked. Accordingly, we extracted the verb stem plus cough from each recorded sentence and presented them to 15 adult listeners. The listeners were asked to guess which inflection was used with the stem in each case (for all 144 verb forms). For every item, they had to select from 24 possible forms, and they guessed correctly on 5.6% of the items, which, as will be seen, is significantly below the performance level for either group of children (LI = 62%, χ^2 test, $p < .001$; VC = 83%, χ^2 test, $p < .001$). These findings indicated that our stimuli probably did not contain unintended cues that could lead to correct performance without knowing the appropriate inflection. In fact, the adult listeners' guessing behavior suggested that other factors were influencing their choices. The log frequency of allomorphs in Hungarian based on the Hungarian Webcorpus (Halácsy et al., 2004; Kornai, Halácsy, Nagy, Trón, & Varga, 2006) was a significant predictor of the frequency of the listeners' specific choices ($R^2 = .132$, $B = 0.363$, $p < .001$). Not surprisingly, the items whose inflections happened to correspond to the listeners' most frequent choices were most likely to be guessed correctly. However, even the inflection type that was most frequently guessed correctly was associated with only 14% accuracy.

Scoring

Our scoring method emphasized accuracy of tense and agreement marking rather than accuracy of the sentence as a whole. That is, we allowed for differences between the child's response and the stimulus sentence

Table 4. Examples of different types of errors or deviations from the target sentence for the stimulus sentence *Tegnap ti fésül**tétek** az oroszlánt* "Yesterday you (Pl2) were combing (comb PastDefPl2) the lion."

Response type	Child's response	Translation
Person error	Tegnap ti fésül**tük** az oroszlánt.	Yesterday you (Pl2) were combing (PastDefPl1) the lion.
Number error	Tegnap ti fésül**ted** az oroszlánt.	Yesterday you (Pl2) were combing (PastDefSg2) the lion.
Tense error	Tegnap ti fésülitek az oroszlánt.	Yesterday you (Pl2) are combing (PresDefPl2) the lion.
Definiteness error	Tegnap ti fésül**tetek** az oroszlánt.	Yesterday you (Pl2) were combing (PastIndefPl2) a lion.
Nontarget verb with correct agreement	Tegnap ti fésülköd**tétek** az oroszlánt.	Yesterday you (Pl2) were combing (reflexive, PastDefPl2) the lion.
Nontarget subject or object with correct agreement	Tegnap ti fésültetek egy oroszlánt.	Yesterday you (Pl2) were combing (PastIndefPl2) a lion.

provided that the child's response showed internally accurate agreement as well as tense marking. This scoring method was selected to reduce the effects of recall errors and to provide as clear a view of inflection use as possible to evaluate the agreement deficit and morphological richness accounts—two accounts expressly developed to explain the tense and agreement inflection problems of children with LI.

According to this scoring method, if the child used a nontarget verb with correct inflection or if the child used a different subject or object but the verb inflections were appropriate for this change, the response was scored as correct. In addition, if a child produced a past tense form when the stimulus sentence was in present tense (without any other change), the child was credited with a correct response. Although in such cases it is more customary to assume such sentences are in present tense, recall that there is no adverbial that is unique to present tense. (To use the closest English equivalent, whereas we must use past tense with "yesterday," either past or present tense might be appropriate with "today.") As Hungarian has somewhat flexible word order, variations in word order were also permitted, provided that all of the above details were included. Using this method, the following errors could occur: (a) person error; (b) number error; (c) tense error; (d) definiteness error; or (e) other error, such as a sentence that bore no resemblance to the stimulus sentence. If errors (a)–(e) or any of their combinations occurred, the answer was scored 0. The children's use of the wrong allomorph in otherwise correct responses was also noted but was not scored as an error.[5] Examples of error types and deviations from the stimulus sentence that were counted as correct are shown in Table 4.

To assess interjudge reliability, the responses of five children in each group were selected at random and were scored by an independent judge. Percentage agreement ranged from 97.2 to 100.0, with similar percentages of agreement for the LI (M = 98.75) and VC (M = 99.60) groups.

Data Analysis

The data were examined in several ways. First, we examined the children's percentages of correct responses for each inflection type, using a general linear model analysis of variance (ANOVA) with Group as a between-subjects factor and Tense, Definiteness, Number, and Person as within-subjects factors. Second, given the predictions of the morphological richness account, we determined whether the children's scores were related to frequency of occurrence factors. For each inflected verb form, we calculated the following: (a) inflected word frequency (the frequency of the exact inflected verb form), (b) inflection frequency (e.g., the frequency of all PresDefSg3 allomorphs combined), and (c) allomorph frequency (mostly conditioned by stem category for vowel harmony; e.g., the frequency of the *-ja* allomorph of PresDefSg3). The source of frequency data was the Hungarian Webcorpus (Halácsy et al., 2004; Kornai et al., 2006). Calculations employed the logarithm of frequency. Finally, we performed an analysis of the children's errors to test the prediction of the morphological richness account that near-miss errors would be disproportionately high relative to errors differing from the correct form on more than one dimension.

Results

Accuracy According to Group and Inflection Type

The ANOVA on accuracy revealed Group as a significant main effect, $F(1, 48) = 10.02$, $\eta^2 = .173$, $p < .01$. With the exception of Definiteness, $F(1, 48) = 0.09$, *ns*, all within-subjects factors proved to be significant main effects: Tense, $F(1, 48) = 13.91$, $\eta^2 = .225$, $p < .01$; Number,

[5]We also used a second scoring method that was more stringent. This method required that the target verb (in correctly inflected form) be used in the child's response, and no changes were allowed in the person and number of the subject or the definiteness of the object. The pattern of results seen for this scoring method matched those seen for our first scoring method, except that the group effects were even stronger.

$F(1, 48) = 8.91$, $\eta^2 = .157$, $p < .01$; and Person, $F(1, 48) = 27.19$, $\eta^2 = .362$, $p < .001$. The significant interactions were Tense × Definiteness × Person, $F(2, 96) = 7.22$, $\eta^2 = .131$, $p < .01$; Number × Person, $F(2, 96) = 10.05$, $\eta^2 = .180$, $p < .001$; Definiteness × Number × Person, $F(2, 96) = 8.85$, $\eta^2 = .156$, $p < .001$; and Tense × Definiteness × Number × Person, $F(2, 96) = 4.81$, $\eta^2 = .156$, $p < .05$. Pairwise comparisons (LSD tests) at the .05 level revealed that past, plural, and first person were significantly more difficult than present, singular, and first and third person, respectively (first and third person did not differ). Figure 1 provides an illustration of the findings.

It can be seen that overall performance of the LI group was significantly lower than that of the VC group, but no interactions with Group were significant, suggesting that the two groups basically showed the same pattern of performance across the dimensions examined. The interactions involving Person and Number were due to low scores of Second Person and, especially, of Pl2 forms. These difficulties are evident from Figure 1.

Relationship With Frequency

We examined the relationship between several frequency factors and the children's use of the tense and agreement inflections. According to the morphological richness account, children should have greater success producing more frequently occurring inflections than less frequently occurring inflections. However, it is also true that other details such as the frequency of the words themselves could also influence the children's success. To determine if these factors could predict performance on the experimental task, we included them in stepwise regression analyses. We tested the effects of log-inflected word frequency, log inflection frequency, and log allomorph frequency on the total number of correct responses for each test item, separately for the LI and VC groups. Only variables that showed a significant correlation ($p < .05$) with the target variable were entered into the analysis.

For both groups, the factor that best contributed to predicting performance levels was log inflection frequency. As can be seen in Table 5, the LI data are somewhat better predicted by this factor, where it explains 31% of variance, as opposed to 20% explained in the VC group.

Error Analysis

Both groups of children produced many errors on the task. Out of the 3,600 responses from each group, the VC group produced 371 errors (10.0%), and the LI group erred on 905 (25.1%) responses. It is notable that the number of inappropriate productions of the present

Figure 1. Mean percentage correct for each inflection type for the language impairment (LI) and vocabulary controls (VC) groups. Standard errors are also shown.

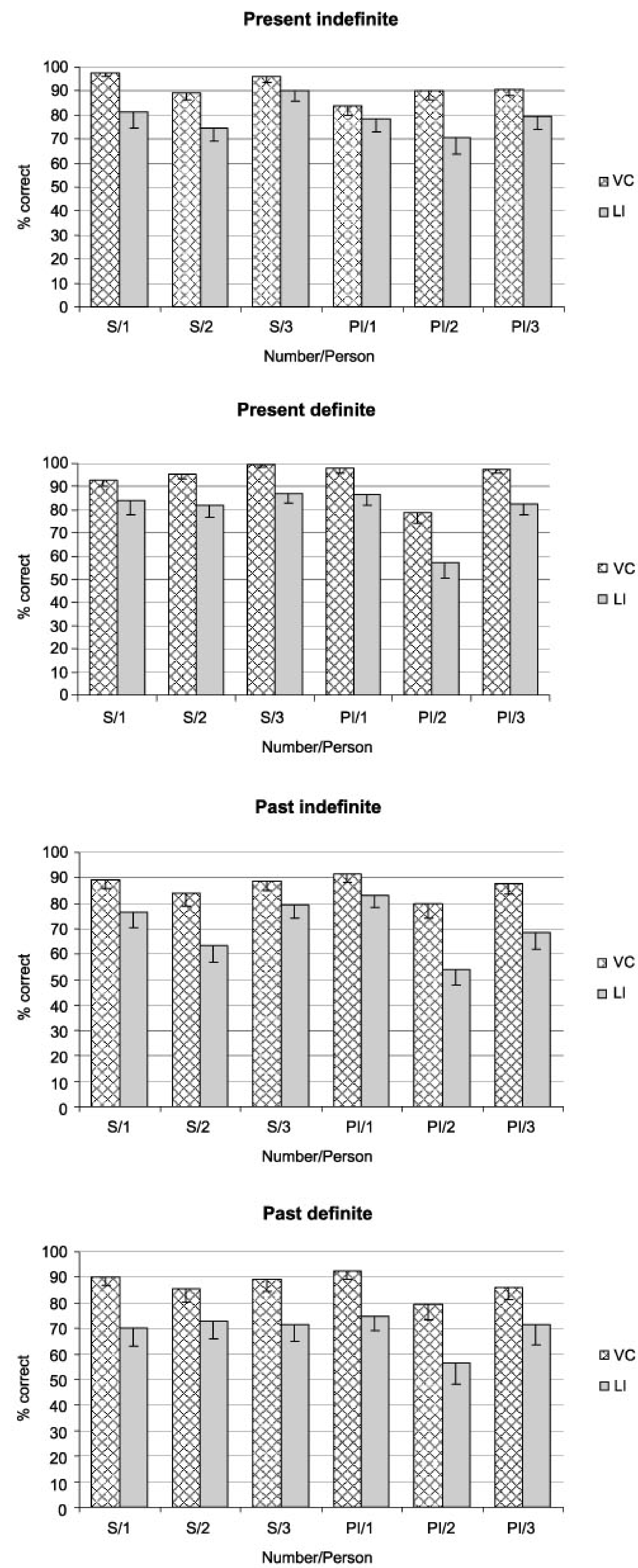


Table 5. Log inflection frequency as a predictor of the performance of the LI and VC groups.

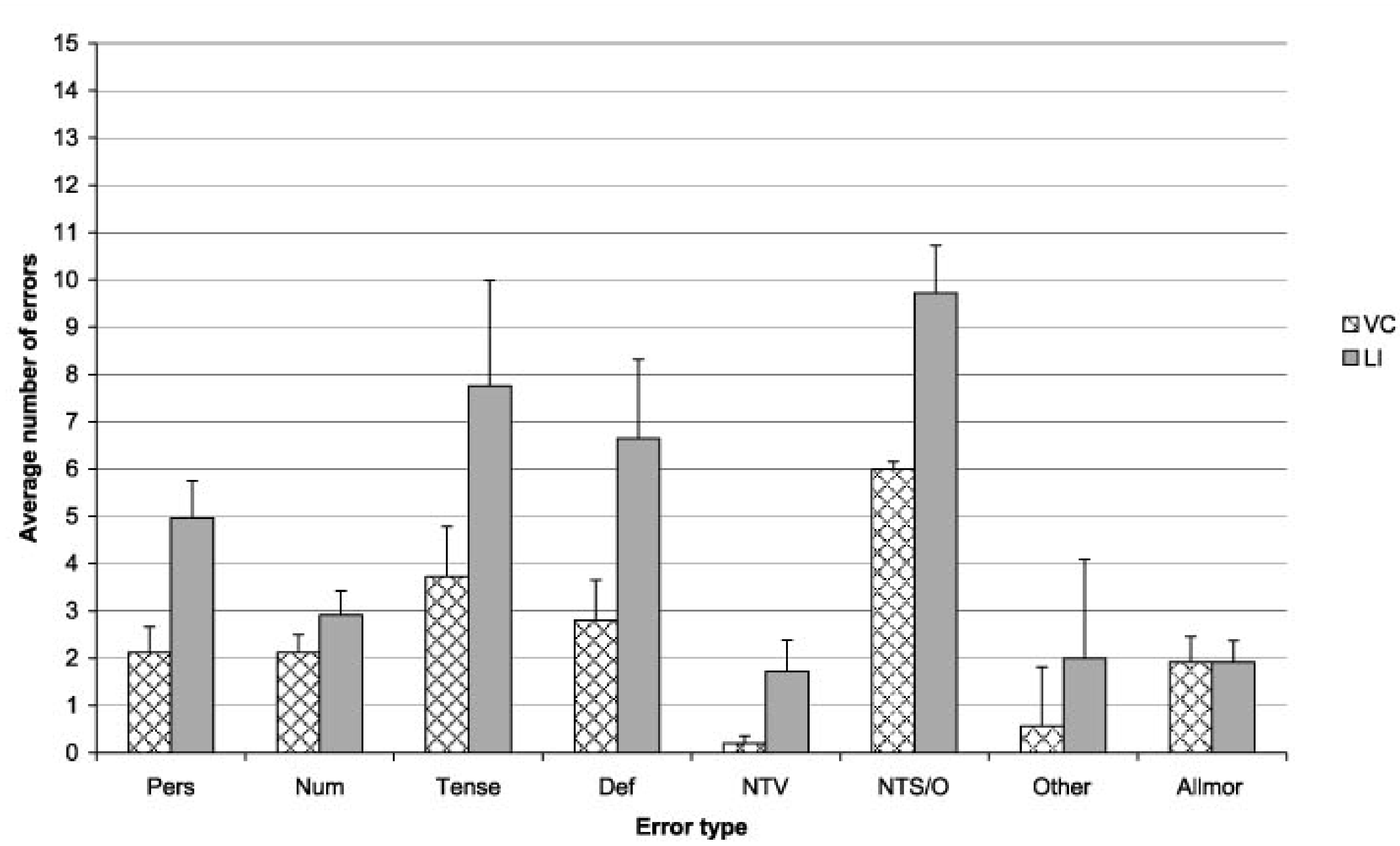
Group	Predictor	*B*	*p*	R^2
VC	Log inflection frequency	0.45	< .001	.20
LI	Log inflection frequency	0.56	< .001	.31

Note. R^2 shows the amount of variance in the data explained by the predictor.

third person singular indefinite—the zero-marked form—was not especially high, suggesting that this form was not used as a default. This zero-marked form constituted only 6.8% of the errors in the VC group and 5.2% of the errors in the LI group. Inappropriate productions of these zero-marked forms were outnumbered by the inappropriate production of inflected forms. For example, the incorrect production of present third person singular definite forms represented 8.2% of the errors for each group, and inappropriate productions of present first person plural definite forms constituted 9.4% of the errors for the VC group and 13.0% of the errors for the LI group.

Figure 2 provides the mean number of errors according to error type. Numbers for each error type represent errors that constituted an error only on that single dimension. Along with the responses treated as errors in the preceding analyses, we include in Figure 2 nontarget responses that were scored as correct in those analyses, namely, the use of a nontarget verb with correct tense and agreement (NTV), the use of a nontarget subject or object with correct agreement (NTS/O), and the use of an incorrect allomorph (Allmor) even though agreement was correct. Figure 2 illustrates several group differences, but not all of them are confirmed by statistical analysis. The LI group made more single-dimension errors overall, $F(1, 49) = 9.2$, $\eta^2 = .21$, $p < .01$. ANOVAs were also performed for each error type separately. The difference reached significance for Person, $F(1, 49) = 8.8$, $\eta^2 = .155$, $p < .01$, and Definiteness, $F(1, 49) = 4.16$, $\eta^2 = .08$, $p < .05$, but not for Number, $F(1, 49) = 1.6$, *ns,* or Tense, $F(1, 49) = 2.68$, *ns*. More detailed comparison of dimension errors across groups shows that among person errors, the LI group only made significantly more errors than VC children in using third person forms, $F(1, 49) = 8.75$, $\eta^2 = .154$, $p < .01$. In definiteness errors, the difference was only significant with using indefinite forms when the target was definite, $F(1, 49) = 7.98$, $\eta^2 = .143$, $p < .01$. The remaining response type treated as an error in the earlier analyses, Other, also revealed a difference between the two groups of children, $F(1, 49) = 4.93$, $\eta^2 = .093$, $p < .05$. None of the deviations from the target originally scored as correct showed a group difference, such as NTV, $F(1, 49) = 1.97$, *ns,* and NTS/O, $F(1, 49) = 2.34$, *ns*. Finally, although use of the wrong allomorph (Allmor) was not considered an error, it can be seen from Figure 2 that the two groups were highly similar in this regard, suggesting that rules of vowel harmony were well established and did not seem to be an area of particular difficulty for the LI group. An inspection of Figure 2 reveals that although the children with LI made a greater number of errors than the VC children, the pattern of errors across error types was highly similar in the two groups.

Figure 2. Mean number of errors on different error types in the two groups. Only errors in a single dimension are counted. Standard errors are also shown. Pers = person; Num = number; Def = definiteness; NTV = nontarget verb with correct tense and agreement; NTS/O = nontarget subject or object with correct agreement; Allmor = incorrect allomorph.



The morphological richness account predicts that single-dimension or "near-miss" errors will be especially frequent. To test this prediction, we compared the children's near-miss errors to productions that constituted an error on more than one dimension (e.g., an error of tense plus number). Of the 23 inflections that could be used as an incorrect substitute for the correct inflection, 5 differed from the target on only one dimension, 9 differed from the target on two dimensions, 7 differed on three dimensions, and only 2 differed on all four dimensions. This was true for all 24 target inflections. In Table 6, we provide the number of substitution errors for each target inflection. Given that the four types of errors had different probabilities (the most probable were two-dimension errors, the least probable were four-dimension errors), we created adjusted scores by dividing the total number of errors of each type by the number of different inflections that could have created each error type. From Table 6, it can be seen that for 23 of the 24 target inflections for the LI group, a higher total number of errors was seen for one-dimension errors than for each of the other error types. When adjusted scores are considered, the differences are even more dramatic, with all 24 inflections having more one-dimension errors than errors of the other types. This was confirmed by a repeated measures ANOVA by target inflection type performed for each participant group. The analysis for the LI group revealed a highly significant difference, $F(2, 46) = 93.12$, $\eta^2 = .802$, $p < .001$. Post hoc testing at the .05 level revealed that one-dimension errors ($M = 4.81$, $SD = 2.22$) were significantly more frequent than two-dimension errors ($M = 0.86$, $SD = 0.59$), which, in turn, were more frequent than three-dimension errors ($M = 0.28$, $SD = 0.34$). Four-dimension errors were not included in the ANOVA because, as can be seen in Table 6, no errors of this type were found in the data. Nearly identical findings emerged for the VC group although, as noted earlier, these children committed fewer errors than the LI group. Specifically, a significant difference was found for error type, $F(2, 46) = 43.25$, $\eta^2 = .653$, $p < .001$, with one-dimension errors ($M = 1.88$, $SD = 1.25$) being more frequent that two-dimension errors ($M = 0.45$, $SD = 0.43$), which, in turn, were more frequent than three-dimension errors ($M = 0.09$, $SD = 0.20$). Again, four-dimension errors were not seen in the data.

This type of analysis also permitted us to assess a prediction of the agreement deficit account. One-dimension errors could have been an error in tense only, person only, number only, or definiteness only. According to the agreement deficit account, errors in tense are not expected. In fact, we found that problems with tense were concentrated in past tense items. The results indicated that the number of one-dimension errors of tense in past tense items represented 34% ($SD = 18\%$) of the total one-dimension errors by the children with LI. Given the four dimensions possible, this value is clearly in line with the expectation of 25% if difficulty with past tense were comparable to difficulty with each of the other three dimensions. Similar results were seen for the VC group; 37% ($SD = 26\%$) of their one-dimension errors in past tense items involved an error of tense.

Whereas Table 6 provides the types of errors according to the target inflection, in Table 7 we provide the types of errors according to the inflection used as a substitute. As can be seen in this table, all 24 inflections were used as a substitute by the LI group. Furthermore, all 24 were more likely to be used as a substitute when it differed from the target on one dimension than when it differed from the target on two, three, or four dimensions. This was true for total number of errors as well as for adjusted scores. A repeated measures ANOVA by substitute inflection type confirmed this difference for the LI group, $F(2, 46) = 88.35$, $\eta^2 = .793$, $p < .001$. Post hoc testing at the .05 level revealed that one-dimension errors ($M = 4.76$, $SD = 2.69$) were significantly more abundant than two-dimension errors ($M = 0.85$, $SD = 0.99$), which, in turn, were more frequent than three-dimension errors ($M = 0.28$, $SD = 0.58$). Four-dimension errors were not included in the analysis, as this type of error did not occur in the data. The findings for the VC group mirrored those seen for the children with LI. A difference according to error type was seen, $F(2, 46) = 37.38$, $\eta^2 = .619$, $p < .001$. Post hoc testing indicated that one-dimension errors ($M = 1.90$, $SD = 1.40$) occurred more frequently than two-dimension errors ($M = 0.45$, $SD = 0.62$), which, in turn, were more frequent than three-dimension errors ($M = 0.09$, $SD = 0.18$). One of the 24 inflections, third person singular definite in past tense was never used as a substitute. The remaining 23 inflections showed the same pattern evident for the group data, with greater tendency for the inflection to serve as a substitute when it differed from the correct inflection on a single dimension.

Although Table 7 clearly shows that the number of substitutions differing from the target by a single dimension was disproportionately high in the data, as predicated by the morphological richness account, these data do not provide an indication of the role of the substitute inflections' frequency of occurrence. According to the morphological richness account, substitute inflections that differ from the target on two or more dimensions are likely to have relatively strong representations, as estimated by frequency of occurrence in the language. We examined this issue by performing a regression analysis to determine if log inflection frequency served as a significant predictor of the children's tendency to use an inflection as a substitute when it differed from the correct form on two or more dimensions. Indeed, this prediction was borne out for the LI group; log inflection frequency explained 20% of the variance associated with substitutions differing from the target on two or more

Table 6. The number of times the target inflection was replaced by a substitute inflection that differed from the target on one, two, three, or four dimensions, and the adjusted score (Adj Score), computed by dividing the total by the number of different inflections that had the potential to differ from the target on the same number of dimensions.

TARGET	#1-Dimen Err and Adj Score		#2-Dimen Err and Adj Score		#3-Dimen Err and Adj Score		#4-Dimen Err and Adj Score
			LI GROUP				
PRIDSG1	20	4.00	6	0.67	0	0	0
PRIDSG2	21	4.20	11	1.22	3	0.43	0
PRIDSG3	8	1.60	1	0.11	3	0.43	0
PRIDPL1	24	4.80	1	0.11	1	0.14	0
PRIDPL2	24	4.80	10	1.11	4	0.57	0
PRIDPL3	26	5.20	4	0.44	0	0	0
PRDSG1	15	3.00	3	0.33	0	0	0
PRDSG2	8	1.60	10	1.11	2	0.29	0
PRDSG3	12	2.40	3	0.33	1	0.14	0
PRDPL1	13	2.60	2	0.22	1	0.14	0
PRDPL2	40	8.00	11	1.22	1	0.14	0
PRDPL3	22	4.40	0	0	0	0	0
PAIDSG1	21	4.20	9	1.00	0	0	0
PAIDSG2	34	6.80	13	1.44	8	1.14	0
PAIDSG3	21	4.20	5	0.56	1	0.14	0
PAIDPL1	16	3.20	6	0.67	1	0.14	0
PAIDPL2	54	10.80	11	1.22	2	0.29	0
PAIDPL3	32	6.40	9	1.00	2	0.29	0
PADSG1	23	4.60	17	1.89	1	0.14	0
PADSG2	18	3.60	11	1.22	9	1.29	0
PADSG3	20	4.00	11	1.22	5	0.71	0
PADPL1	31	6.20	1	0.11	0	0	0
PADPL2	44	8.80	20	2.22	1	0.14	0
PADPL3	30	6.00	12	1.33	1	0.14	0
M	4.81		0.86		0.28		0
SD	2.22		0.59		0.34		
			VC GROUP				
PRIDSG1	3	0.60	1	0.11	0	0	0
PRIDSG2	10	2.00	6	0.67	0	0.43	0
PRIDSG3	5	1.00	1	0.11	0	0.43	0
PRIDPL1	4	8.00	0	0.11	0	0.14	0
PRIDPL2	7	1.40	8	0.89	0	0.57	0
PRIDPL3	13	2.60	1	0.11	0	0	0
PRDSG1	6	1.20	0	0	0	0	0
PRDSG2	2	0.40	3	0.33	0	0	0
PRDSG3	1	0.20	0	0	0	0	0
PRDPL1	0	0	3	0.33	0	0	0
PRDPL2	15	3.00	13	1.44	0	0	0
PRDPL3	4	0.80	0	0	0	0	0
PAIDSG1	12	2.40	4	0.44	0	0	0
PAIDSG2	13	2.60	11	1.22	4	0.57	0
PAIDSG3	9	1.80	8	0.89	0	0	0
PAIDPL1	10	2.00	3	0.33	0	0	0
PAIDPL2	26	5.20	4	0.44	0	0	0
PAIDPL3	9	1.80	2	0.22	1	0.14	0
PADSG1	10	2.00	3	0.33	2	0.29	0
PADSG2	9	1.80	9	1.00	5	0.71	0
PADSG3	10	2.00	3	0.33	3	0.43	0

(Continued on the following page)

Table 6 *Continued*. The number of times the target inflection was replaced by a substitute inflection that differed from the target on one, two, three, or four dimensions, and the adjusted score (Adj Score), computed by dividing the total by the number of different inflections that had the potential to differ from the target on the same number of dimensions.

TARGET	#1-Dimen Err and Adj Score		#2-Dimen Err and Adj Score		#3-Dimen Err and Adj Score		#4-Dimen Err and Adj Score
PADPL1	9	1.80	2	0.22	0	0	0
PADPL2	20	4.00	11	1.22	0	0	0
PADPL3	19	3.80	2	0.22	0	0	0
M	1.88		0.45		0.09		0
SD	1.25		0.43		0.20		

Note. PR = present tense; PA = past tense; ID = indefinite; D = definite; SG = singular; PL = plural; 1 = first person; 2 = second person; 3 = third person. Adjusted (Adj) scores are not presented for four-dimension errors (Err) because such errors did not occur. Dimen Err = dimension error.

dimensions ($B = 0.45$, $p < .05$, $R^2 = .20$). In contrast, log inflection frequency was not a significant predictor of the total number of times that an inflection served as a substitute when the number of dimensions on which it differed from the target was ignored. Clearly, the frequency of occurrence effect was limited to multi-dimension substitutions in the LI group. Identical analyses using the VC group data indicated that, as expected, log inflection frequency was not a significant predictor of the total number of times that an inflection served as a substitute when the number of dimensions was disregarded. However, log inflection frequency was also not a predictor of the number of times an inflection served as a substitute when it differed from the target on two or more dimensions. This finding differed from that observed for the LI group. As can be seen in Table 7, the number of two- and three-dimension errors was extremely low for the VC group, raising the possibility that floor effects obviated the detection of log frequency effects.

Nonmorphosyntactic Language Processing Factors

The agreement deficit account and the morphological richness account predict difficulties according to the nature of the dimension involved (e.g., agreement) or the number of dimensions involved (e.g., four) in the inflections. However, if the children's use of inflections is also influenced by factors pertaining to the retention of sound sequences, factors other than the specific nature or number of dimensions involved should be observable. One such factor is the length of the verb plus inflection, measured in number of phonemes. Accordingly, we determined whether length in number of phonemes could serve as a significant predictor of the children's accuracy of inflection use, as measured by the total number of accurate responses for each inflection. This proved true for each group. For the VC group, this factor accounted for 20% of the variance in the children's inflection accuracy scores ($B = 0.45$, $p < .001$, $R^2 = .20$); for the LI group, 31% of the variance was explained by this factor ($B = 0.55$, $p < .001$, $R^2 = .31$).

Recall, however, that log inflection frequency also proved to be a predictor of the children's accuracy of inflection use. Some inflections that were relatively low in frequency such as the second person plural inflections (e.g., *játok*, *tatok*) are also among the longest inflections. Therefore, we performed a regression analysis to determine if length in phonemes contributed to the prediction of the children's inflection accuracy even when log inflection frequency is taken into account. The results appear in Table 8. As can be seen, for each group, length in number of phonemes proved significantly related to the children's inflection accuracy along with log inflection frequency; together, these factors explained 27% of the variance in the VC data and 41% of the variance in the LI data.

The data in Table 8 address the degree to which length of the verbs with inflections related to the children's inflection accuracy, but this factor cannot be divorced from the dimensions (e.g., person, number) reflected in the inflections. To gain an impression of the role of length independent of tense and agreement, we used the children's scores on the nonword repetition test as a covariate and again compared the VC and LI groups. Although low (LI group) or age-appropriate (VC group) Nonword Repetition Test scores constituted one of the bases on which the children were selected, the typically developing comparison group (mean age = 7;1) was, on average, more than 2 years younger than the LI group (mean age = 9;10). Nevertheless, the two groups differed on this measure: LI, $M = 3.5$, $SD = 1.5$; VC, $M = 5.8$, $SD = 1.3$, $t(48) = 6.14$, $p < .001$. When nonword repetition was entered as a covariate, the group difference in inflection accuracy disappeared, $F(1, 47) = 0.68$, *ns*.

Table 7. The number of times an inflection (INFLECT) was used as an incorrect substitute (SUBST) when it differed from the target on one, two, three, or four dimensions, and the adjusted score, computed by dividing the total by the number of different inflections that had the potential to differ from the target on the same number of dimensions.

INFLECT USED AS SUBST	# Times Differ by 1 Dimen and Adj Score		# Times Differ by 2 Dimen and Adj Score		# Times Differ by 3 Dimen and Adj Score		# Times Differ by 4 Dimen and Adj Score
			LI GROUP				
PRIDSG1	15	3.00	2	0.22	2	0.29	0
PRIDSG2	8	1.60	0	0	1	0.14	0
PRIDSG3	31	6.20	10	1.11	4	0.57	0
PRIDPL1	30	6.00	22	2.44	11	1.57	0
PRIDPL2	28	5.60	3	0.33	0	0	0
PRIDPL3	23	4.60	8	0.89	1	0.14	0
PRDSG1	25	5.00	2	0.22	0	0	0
PRDSG2	16	3.20	3	0.33	0	0	0
PRDSG3	38	7.60	17	1.89	6	0.86	0
PRDPL1	61	12.20	39	4.33	17	2.43	0
PRDPL2	16	3.20	3	0.33	1	0.14	0
PRDPL3	48	9.60	8	0.89	1	0.14	0
PAIDSG1	5	1.00	0	0	0	0	0
PAIDSG2	7	1.40	2	0.22	0	0	0
PAIDSG3	23	4.60	10	1.11	0	0	0
PAIDPL1	36	7.20	17	1.89	0	0	0
PAIDPL2	23	4.60	3	0.33	0	0	0
PAIDPL3	20	4.00	6	0.67	2	0.29	0
PADSG1	8	1.60	2	0.22	0	0	0
PADSG2	10	2.00	0	0	0	0	0
PADSG3	23	4.60	7	0.77	1	0.14	0
PADPL1	35	7.00	13	1.44	0	0	0
PADPL2	17	3.40	3	0.33	0	0	0
PADPL3	26	5.20	5	0.55	0	0	0
M	4.76		0.85		0.28		0
SD	2.69		0.99		0.58		0
			VC GROUP				
PRIDSG1	7	1.40	2	0.22	0	0	0
PRIDSG2	1	0.20	2	0.22	0	0	0
PRIDSG3	11	2.20	7	0.78	0	0	0
PRIDPL1	7	1.40	1	0.11	1	0.14	0
PRIDPL2	7	1.40	11	1.22	4	0.57	0
PRIDPL3	4	0.80	2	0.22	0	0	0
PRDSG1	3	0.60	1	0.11	0	0	0
PRDSG2	11	2.20	0	0	0	0	0
PRDSG3	17	3.40	19	2.11	0	0	0
PRDPL1	12	2.40	9	1.00	3	0.43	0
PRDPL2	10	2.00	3	0.33	1	0.14	0
PRDPL3	25	5.00	2	0.22	2	0.29	0
PAIDSG1	1	0.20	0	0	0	0	0
PAIDSG2	3	0.60	0	0	0	0	0
PAIDSG3	2	0.40	1	0.11	0	0	0
PAIDPL1	20	4.00	17	1.89	4	0.57	0
PAIDPL2	12	2.40	0	0	0	0	0
PAIDPL3	6	1.20	0	0	0	0	0
PADSG1	0	0	0	0	0	0	0
PADSG2	10	2.00	1	0.11	0	0	0
PADSG3	7	1.40	4	0.44	0	0	0

(Continued on the following page)

Table 7 *Continued.* The number of times an inflection (INFLECT) was used as an incorrect substitute (SUBST) when it differed from the target on one, two, three, or four dimensions, and the adjusted score, computed by dividing the total by the number of different inflections that had the potential to differ from the target on the same number of dimensions.

INFLECT USED AS SUBST	# Times Differ by 1 Dimen and Adj Score		# Times Differ by 2 Dimen and Adj Score		# Times Differ by 3 Dimen and Adj Score		# Times Differ by 4 Dimen and Adj Score
PADPL1	23	4.60	13	1.44	0	0	0
PADPL2	18	3.60	0	0	0	0	0
PADPL3	11	2.20	2	0.22	0	0	0
M	1.90		0.45		0.09		0
SD	1.40		0.62		0.18		0

Note. Adjusted scores are not presented for four-dimension errors because such errors did not occur.

The effect of nonword repetition was significant, $F(1, 47) = 4.75$, $\eta^2 = .096$, $p < .05$. These findings suggest that factors such as ability to retain sequences of sounds may have had a bearing on the children's use of inflections on our experimental task.

Conclusions

In this study, we found that a group of Hungarian-speaking children with LI performed significantly below the level of younger VC children in a task in which the children had to repeat sentences and supply the appropriate tense and agreement inflections. Although the two groups differed in accuracy, their patterns of performance across inflection types—both in terms of inflections with greatest and least accuracy and in terms of error types—were highly similar. Before discussing the implications of these findings, we discuss some potential limitations of the study.

One potential limitation is that we cannot be certain that our task yielded results that were representative of the children's actual abilities. Studies of children with LI in other languages have typically employed spontaneous speech samples and/or sentence completion tasks. We believe our choice of tasks was highly appropriate given the characteristics of Hungarian. For example, the distinction between agreement inflections as a function of the definiteness of the object is not one that can be easily manipulated through sentence completion tasks. Despite the novel nature of our task, the higher scores by the younger VC children compared to the children with LI suggest that it was developmentally appropriate.

Table 8. Length in number of phonemes and log inflection frequency as predictors of the performance of the LI and VC groups.

Group	Predictor	*B*	*p*	R^2
VC	Number of phonemes	−0.32	< .001	.27
	Log inflection frequency	0.28	< .01	
LI	Log inflection frequency	0.38	< .001	.41
	Number of phonemes	−0.36	< .001	

Note. R^2 shows the amount of variance in the data explained by the predictor.

Another potential limitation is our use of younger typically developing children matched with the LI group according to receptive vocabulary rather than according to an expressive measure such as MLU. However, for a language with a rich morphology such as Hungarian, MLU matching would carry the risk of matching two groups on the very ability that we were wishing to compare. Nevertheless, matching on the basis of receptive vocabulary was a more stringent test of the status of tense and agreement morphology in Hungarian LI than would be the case if chronological age controls had been used. As can be seen in Table 3, the children with LI were nearly 3 years older than the VC children, yet they did not perform as well as these younger typically developing children.

Another potential criticism of the study is that given our use of a nonword repetition test and a sentence repetition test as two of the four tests in our diagnostic battery, it might be argued that we selected only or primarily those children with LI with limitations in working memory. However, all of the children with LI earned low scores on the PPVT—a receptive vocabulary measure that seems to place fewer working memory demands on the children than all of our other measures. In addition, the children's enrollment in special schools for children with language impairments required a diagnosis made by professionals prior to the children's participation in this study. Thus, although these children may have had limitations in working memory, they were not clearly different from the more general population of children with LI in having working memory limitations along with problems with language itself.

Hungarian is a language with agreement required between both the subject and the verb and between the verb and the object. According to the agreement deficit account, children with LI should have more difficulty than the VC children in the marking of agreement. To evaluate the predictions of this account, it is important to examine the children's accuracy with regard to tense separately from their accuracy with regard to agreement. As can be seen in Figure 2, the children with LI made a greater number of tense errors than the VC children, but this difference did not achieve statistical significance. On the other hand, one-dimension errors involving past tense implicating past tense difficulty were no less frequent than would be expected if all four dimensions (tense, person, number, and definiteness) were equally vulnerable to error. As would be predicted by this account, agreement errors were clearly evident in the responses of the LI group. Yet, the group difference for number errors was not significant. These errors were relatively infrequent by the LI group. In addition, considering that 24 different inflections were required in our task, all involving agreement of some type, the LI group's mean percentage of correct use of 60% suggests that these children were clearly not producing inflections at random. Furthermore, these children were clearly not relying on a default form when responding to the items. These findings suggest that if the agreement deficit account is generally correct, provisions must be made in the account to explain how children with LI can use all person, number, and definiteness forms with some degree of accuracy, and not differ from VC children in the use of number. In addition, the agreement deficit account provides no reason for the special difficulty with Pl2 forms experienced by the children with LI.

Hungarian differs from languages with a rich inflectional morphology such as Italian and Spanish in that distinctions in four dimensions—tense, person, number, and definiteness—are required rather than the distinctions in three dimensions required in these other languages. According to the morphological richness account, rich inflectional morphology is beneficial to children with LI up to a point; however, four dimensions have been proposed as the number of dimensions that begin to tax these children's limited capacities. For this reason, Hungarian-speaking children with LI are expected to perform below the level of typically developing peers even though their levels of inflection use should be considerably higher than the levels reported for children acquiring English.

The findings were in keeping with this prediction. Furthermore, this account predicts that the inflections with the greatest likelihood of accuracy in the speech of children with LI will be those of higher frequency of occurrence. Our results were also consistent with this expectation.

An additional finding in line with the morphological richness account was the disproportionate number of one-dimension errors relative to errors of two, three, or four dimensions. For the LI group, this finding held true for all 24 target inflections and all 24 inflections used as substitutes. One might argue that even the differences between two-dimension errors and three- and four-dimension errors also support this account, as the likelihood of a substitution was found to decrease as the number of dimensions differing from the target increased. In fact, it is noteworthy that across the 24 target inflections, there were 288 opportunities for a four-dimension error to occur in the data for each child (2 different inflections could have differed from the target by four dimensions, each with 6 items, for each of 24 target inflections, thus $2 \times 6 \times 24 = 288$). Yet, not a single error of this type was seen—a striking finding considering that there were 25 children in each group. The absence of these errors was not due to the children's avoidance of particular inflections. For each child, all 24 inflections had two opportunities (for a total of 12 items) to be used in place of a target that differed by four dimensions, and all of these inflections were used correctly to some degree, and in substitutions in which the inflection replaced the target inflection when it differed on one dimension.

These findings show that even though the children with LI were less proficient than the VC children, their production of inflections—even when in error—reflected some degree of knowledge of the target. This pattern of performance is consistent with an assumption that processing limitations contributed to the children's performance. All inflections were used correctly to some extent, with greater accuracy seen for inflections that occur more frequently in the language, and errors usually approximated the target by differing on relatively few dimensions.

Another prediction of the morphological richness account is that if a substitute inflection differs from the target on two or more dimensions, the substitute should have relatively high frequency of occurrence in the language because only such inflections are assumed to have sufficient strength in the paradigm to alter the tendency for a near miss to be retrieved when an error occurs. The regression analyses confirmed this prediction; log inflection frequency was a significant predictor of the number of times an inflection was a substitute that differed from the target on two or more dimensions. This frequency effect was quite specific. Log frequency of the inflection did not predict the total number of times it was used as a substitute when distance from the target was ignored.

Although the data were consistent with several predictions of the morphological richness account, there are details in the data that this account does not explain in its current formulation. As a case in point, we noted that children with LI produced a greater number of definiteness errors than the VC group but did not differ from the VC group in committing errors involving number. Both definiteness and number require agreement, both have contrasts of two features (definite vs. indefinite, singular vs. plural), and both are crossed with tense and person distinctions in the same way in the sentence stimuli. Therefore, the fact that the LI and VC groups differed in the number of errors on one of these dimensions and not the other suggests that factors beyond the number of dimensions are probably relevant.

Given the gaps that remain in explaining the data, other proposals should be considered and a determination should be made as to whether they might supplement or even fully replace the morphological richness account. For example, Rispoli (1991) noted that transitive verb inflections in Hungarian may be difficult for children because they require a "global case marking" system, given that agreement with both the subject (in person and number) and the object (in definiteness) is necessary. We believe that such global agreement might well increase processing demands, yet the morphological richness account in its current formulation captures this fact only in terms of the number of dimensions that must be considered, not in terms of whether agreement must occur with both the subject and the object. Thus, in the present formulation, the morphological richness account makes no distinction between, for example, the Hebrew verb paradigm that involves four dimensions with all three agreement dimensions (person, number, gender) involved in subject–verb agreement and the Hungarian verb paradigm that involves four dimensions with two of the agreement dimensions (person, number) involved in subject–verb agreement and the third (definiteness) involved in verb–object agreement.

Contributions may also come from work conducted within the framework of other processing-related accounts. For example, in an application of the competition model to Hungarian, MacWhinney and Pléh (1997) noted that adults' interpretations of sentences relied less on definiteness agreement between the verb and the object than on other cues. These investigators suggested that definiteness agreement in Hungarian has relatively low "contrast availability." That is, because in Hungarian both the subject and the object may be definite, or both may be indefinite, definiteness is often noncontrastive and, as a result, adults seem to depend less on this type of cue than on other types of cues. It is possible that factors such as contrast availability influence production as well, and perhaps especially so in the case of children with LI. An application of the competition model to the study of inflection use in children with LI might prove quite informative in this regard.

Along with their well-documented problems in the area of morphosyntax, children with LI often have considerable difficulty retaining sequences of sounds, as measured by tasks such as nonword repetition (see Graf Estes, Evans, & Else-Quest, 2007, for a recent meta-analysis). Although these two deficits are separable (Bishop et al., 2006), many children with LI have both of these deficits. An assumption of the present study is that in a language with a multitude of inflections and allomorphic variations such as Hungarian, children's ability to retain sequences of sounds may have a greater influence on their ability to learn the inflection system than is seen in a language such as English.

Our findings seem consistent with this assumption. The length of the verb with inflection proved related to the children's inflection accuracy even when log inflection frequency was taken into account. More importantly, the very clear differences between the two groups in inflection accuracy were no longer evident when the children's nonword repetition scores were used as a covariate.

Collectively, our findings lend support to the notion that processing-related factors play a role in the inflection limitations of children with LI in a language such as Hungarian. However, it is likely that we have not identified all of the factors related to processing that were at play in this study. Earlier, we noted that factors considered in the competition model such as contrast availability may prove important. In addition, other types of processing factors might be identified. For example, the children sometimes changed the verb or a subject or object in the stimulus sentence. It is true that even when such changes were allowed (provided that the verb inflection was correct), group differences favoring the VC children were seen in inflection accuracy. Nevertheless, it seems important to determine why such substitutions of verbs, subjects, and objects were relatively frequent in the data.

In summary, the findings of this investigation indicate that models assuming processing limitations on the part of children with LI are more compatible with the pattern of verb inflection use seen in Hungarian-speaking children with LI than are accounts based on an assumption of deficits specific to agreement. One processing-related approach, the morphological richness account, seems to predict a substantial portion of the findings, though unexplained gaps remain. Nonmorphosyntactic language processing factors such as the retention of sequences of sounds may well account for additional details in the findings. We suspect that this factor may play a larger than usual role in a language laden with inflections such as Hungarian. Yet, it seems likely that other factors will prove important as well. Additional research is clearly warranted.

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