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Judgments of Omitted BE and DO in Questions as Extended Finiteness Clinical Markers of SLI to Fifteen Years: A Study of Growth and Asymptote

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Judgments of Omitted *BE* and *DO* in Questions as Extended Finiteness Clinical Markers of SLI to Fifteen Years: A Study of Growth and Asymptote

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Abstract

Purpose—Clinical grammar markers are needed for children with SLI older than 8 years. This study followed children studied earlier on sentences with omitted finiteness to determine if affected children continue to perform at low levels and to examine possible predictors of low performance. This is the first longitudinal report of grammaticality judgments of questions.

Method—Three groups of children participated: 20 SLI, 20 age controls and 18 language-matched controls, followed from ages 6–15 years. An experimental grammaticality judgment task was administered with *BE* copula/auxiliary and *DO* auxiliary in Wh- and Yes/No questions for 9 times of measurement. Predictors were indices of vocabulary, nonverbal intelligence, and maternal education.

Results—Growth curve analyses show that the affected group performed below the younger controls at each time of measurement, for each variable. Growth analyses show linear and quadratic effects for both groups across variables, with the exception of *BE* acquisition which was flat for both groups. The control children reached ceiling levels; the affected children reached a lower asymptote.

Conclusions—The results suggest an on-going maturational lag in finiteness marking for affected children with promise as a clinical marker for language impairment in school-aged and adolescent children and probably adults as well.

Investigations of potential clinical markers for the condition of SLI yielded significant advances in the last ten to fifteen years as the field moved toward genetic investigations in need of behavioral phenotypes (cf. Tager-Flusberg and Cooper, 1999) and longitudinal growth studies in need of conceptually linked measures over a wide age span (Law, Tomblin and Zhang, 2008; Rice, 2007; in press). The study of finiteness marking (sometimes referred to as “grammatical tense marking”) was noted by Tager-Flusberg and Cooper (1999) as a promising clinical marker. This line of investigation includes the earliest study of finiteness marking by Rice, Wexler and Cleave (1995) and the first longitudinal study of the growth of finiteness marking by Rice, Wexler and Hershberger (1998). Evidence for finiteness as a clinical marker has been widely replicated, as reviewed below. Bishop, Adams and Norbury (2005) reported strong heritability for a finiteness marker independent of non-word repetition heritability in their study of 6-year-old twins. Falcaro et al. (2008) report significant familial aggregation and gene linkage for tense marking for affected individuals.

Although progress is evident, there are notable gaps in the available information about finiteness marking. The first gap to be noted is that the evidence is age-constrained. The evidence is strongest for the early childhood period, roughly 3 to 8 years of age (cf. Rice and Wexler, 2001), but at the upper age levels for this period on the available grammatical structures and tasks the difference between affected and control groups narrows. The issue is that the tasks that work well for the younger children in this age range are a bit too easy for the upper range, even for affected children. Clinical finiteness markers for children at the next levels of development are needed.

Second, the relationship between early finiteness marking abilities/weaknesses and later extensions of this domain into other linguistic contexts is not fully worked out. There is a need for theoretically motivated extensions of the linguistic contexts known to be problematic for young children with SLI to linguistic contexts that are conceptually linked to early weaknesses in finiteness and are age-appropriate for older children. Such a marker would be useful for research as well as clinical applications. For example, we need markers for the identification of affected children not previously identified in clinical situations and also in family/genetic studies of siblings of affected children.

A third gap is closely related to the other two. The set of grammatical morphemes that express finiteness marking poses many challenges for language acquisition, such as the need to learn multiple forms, the grammatical properties of finiteness and the underlying syntactic structures. Current investigations examine contrasting accounts of the early stages of finiteness acquisition. One matter of dispute is the extent to which the acquisition process is guided by common functions across the set of morphemes (cf Guasti, 2002), with error patterns predicted by the common function, versus a more isolated acquisition process of individual forms driven by the differentiating properties of individual morphemes within the set (such as phonological form or frequency of use in adult utterances) (cf Pine, Conti-Ramsden, Joseph, Lieven and Serratrice, 2008). Long-term longitudinal data can help clarify the extent to which the shared feature of finiteness underlies growth, or if growth varies across forms, and the extent to which persisting weaknesses in finiteness marking is evident across forms. This information will be helpful in evaluating competing accounts of the ways in which children acquire the finiteness marking properties of the adult grammar.

A fourth gap is the lack of direct longitudinal assessments of the finiteness marker in older children to determine if the children “out-grow” this deficit or if it persists over time. We need to know if the growth in finiteness marking during the early childhood period indicates that the grammatical immaturity in finiteness marking has been resolved, or if there is likely to be ongoing weakness evident in later-acquired linguistic contexts. Although there is growing evidence to suggest that the language impairments of children with SLI are likely to remain into adulthood (cf. Johnson et al, 1999) the evidence base largely consists of performance on omnibus measures (Johnson et al, 1999; Law, Tomblin and Zhang, 2008) or cross-sectional studies of affected and control children on a variety of experimental measures of language or processing tasks (cf. Montgomery and Windsor, 2007). In particular, there is a need for longitudinal assessments of children whose earlier levels of performance on related tasks are known, as a first step in the development of clinical grammar markers suitable for growth studies across a wide age range.

This need is evident in studies of genetic etiology. Falcaro et al (2008) examined a behavioral phenotype of past tense marking on lexical verbs in a participant sample with a mean age of 14 years. They found significant familial aggregation when tense marking was treated as a binary/categorical variable, but not when treated as a continuous variable. Linkage for the binary measure was observed on chromosome 19; for the continuous measure, linkage was significant on chromosome 16 as well as 19, although stronger on 19. They suggest “that tense

marking may not be a phenotypic trait that is measurable as a continuous dimension across development but instead may be a skill in which competence is either acquired or not acquired by early school age, comparable to a Piagetian stage in learning. In this sense, qualitative distinctions in the trait is what appears to be familial…" (p. 399). Quantitative variation is attributable, under this account, to non-familial factors, such as age-related differences in motivation or attention to task. The relevance here is that a grammar marker related to earlier finiteness marking that shows variation in older children would be very valuable as a potential phenotype to help clarify genetically influenced variation and evaluate the interpretation of Falcaro, et al (2008).

This study aims to fill these four gaps in the literature by following up on the children who were first studied longitudinally for the finiteness marker from ages 3 to 8;8 years (Rice, Wexler and Hershberger, 1998) and later on a judgment task of declarative sentences with omitted finiteness (Rice, Wexler and Redmond, 1999). In this study a grammaticality judgment task is designed to track finiteness marking in single-clause questions as a theoretically motivated extension of the earlier investigation of simple declaratives. This involves more detailed information about the acquisition of copula and auxiliary *BE* and auxiliary *DO* in wh- and yes/no questions. The study tracks the affected children from 8 to 15 years of age, with the prediction that affected children should be more likely than control groups to accept omitted BE and DO forms in questions, for a period of time that extends beyond what is evident in simple declarative clauses.

Shared properties of finiteness marking in matrix clauses and questions for auxiliary and copula *BE* and auxiliary *DO* in questions

The property of finiteness marking is widely accepted as a central grammatical property that links matrix clauses and questions (see Quirk, Greenbaum, Leech and Swartvik, 1985). X' theory provides a precise model of the relationship between finiteness marking in matrix clauses and questions (cf Chomsky, 1993,1995; Haegeman1994), a model that arguably captures universal properties of grammar. Within this model, morphology is tightly related to syntax because morphological elements carry word order and phrasal movement requirements, hence the term "morphosyntax" (Pollack, 1989). In this model of the adult grammar, simple matrix clauses consist of a Noun Phrase (NP) and a Verb Phrase (VP). Verbs carry Tense (TNS) and Agreement (AGR) features that are essential for clause structure. An additional projection, the Inflection Phrase (IP), is needed for finiteness marking to meet the requirements of TNS and AGR checking in simple clauses. See Figure 1. The subject NP is assumed to originate in the "specifier" position to the left of V and move to the "specifier" position to the left of the finite verb in I position. The finite verb originates in the V ("head") of the VP and, if it is an auxiliary like *is*, moves to the I (head) of the IP.

Note that this model lays out the clausal architecture that describes a site for finiteness marking as well as distributional requirements for the placement of related grammatical elements, such as negation (cf Pollock, 1989). The model requires a single occupant of the finiteness site per clause, thus capturing the ungrammaticality of sentences like **the bug is sleeps in the bed* and the fact that progressive *–ing*, although a verbal affix, does not mark finiteness because it appears in combination with *is* as the occupant of the finiteness slot in the clause (**he running* is ungrammatical). Copula *BE*, as in *The bug is happy*, occupies the same site in the clause, with the predicate adjective in the lower VP. Such distributional patterns and other linguistic characteristics identify the following set of morphemes, among others, as finiteness markers in English: Third person singular non-past *–s* on thematic/lexical verbs, regular and irregular past tense on thematic/lexical verbs, copula and auxiliary *BE* and auxiliary *DO*. *DO* has special properties. In matrix declarative clauses auxiliary *DO* does not appear in affirmative clauses unless it has an additional meaning of emphasis, such as "He *does* want to go!" In

negative clauses *DO* must be inserted to precede the negation marker *not* before lexical verbs, as in "She does not go home."

Under this model, questions are derived from the matrix clauses via movement of TNS and AGR features to a projection above (i.e. to the left of) the IP, known as the Complementizer Projection (CP). This projection also includes two sites, C and the specifier of C' position. Questions can be formed as yes/no questions in which the copula or auxiliary occupy the C position, such as "Is the bug happy?" See Figure 2.

Questions can also be formed using a *wh* form (including *who, what, when, where, why* as well as *how*, among others), which occupies the specifier of C'position to the left of C which is occupied by the auxiliary or copula. *BE* auxiliaries move out of the I position into C whereas progressive forms of the thematic/lexical verb are left in the lower VP; *BE* copulas move out of the I position into C with the predicate adjectival phrase left in the lower VP. As shown in Figure 3, the wh-element at the beginning of the question represents a thematic element that originates in the lower VP.

Non-emphatic auxiliary *DO* also occupies the C position in CP. It is not clear if *DO* is generated directly in this position or if it moves from IP in the same way as *BE* (see Chomsky, 1995, p. 164, footnote 20). The special properties of *DO* auxiliary in questions is related to the fact that English, unlike other languages, does not allow the thematic/lexical verb to raise to C in the formation of questions, as is possible in other languages (cf. Pollack, 1989). This constraint is evident in the ungrammaticality of clauses such as *"*where sleeps the bug?*" It is important to note that the non-emphatic auxiliary *DO* in questions is thought to be different from the emphatic *DO* auxiliaries of matrix non-negated declaratives because the semantics of the declarative context is not evident in the question context. Thus, *DO* and *BE* occupants of finiteness in English questions are considered to be structural requirements of grammar mostly free of semantic information. See Figure 4 for an example of the representation of *DO* auxiliaries in Wh- questions ("What does the bug like to eat?") and Figure 5 for the representation of *DO* auxiliaries in Yes/no questions ("Does she like to swim?").

Thus, *BE* and *DO* forms in questions share the property of finiteness marking in a projection directly related to matrix clause structure. This makes it possible to evaluate children's emerging knowledge of finiteness marking in linguistic contexts a short step away from simple matrix declarative clauses, involving a projection to the CP beyond the IP.

Short summary of finiteness marking in simple matrix clauses of young children with and without SLI

The first phase of investigation of children's knowledge of finiteness marking in simple clauses focused on the early stages of grammatical acquisition of typically developing children. Wexler (1994) formulated an Optional Infinitive account [1] of English-speaking children's tendency to omit finiteness markers early on. A significant insight of this model is the recognition of the relevance for children's grammars of the shared property of finiteness marking across different morphemes of English, including the lexical affixes for third person singular present or habitual tense *–s*, past tense regular *–ed* or the several irregular past tense morphological variants, auxiliary and copula *BE* and auxiliary *DO*. Note that recognition of the shared grammatical properties of these forms does not bring with it the claim that the various forms of finiteness marking are all the same; instead it is recognized that there are obvious differences across these forms as well as the shared property, differences that are likely to influence the ways in which

[1]The OI model was later updated to the Agreement Tense/Omission Model (Schütze &Wexler, 1996; Wexler, Schütze & Rice, 1998) and the Unique Checking Constraint Model (Wexler, 1998). The updates do not change the analysis of English presented here.

children master them, although such differences do not over-ride the shared function of finiteness marking (cf Rice, Wexler and Hershberger, 1998, p. 1427).

This model was translated to a model of language impairment in the Extended Optional Infinitive (EOI) account, which posited that the elements of the VP likely to be omitted by children with SLI were the finiteness morphemes as in younger typically developing children although the period of omissions persisted for a longer time for the children with SLI. From the outset this has been regarded as an extended developmental model (Rice and Wexler, 1996). A program of investigation of matrix declarative clauses evaluated the predictions of the EOI account. On the normative side, young unaffected English-speaking children are likely to drop finiteness morphemes until approximately 4 years of age (Rice, Wexler and Cleave, 1995; Rice and Wexler, 1996; Rice, Wexler, and Hershberger, 1998). The pattern is shared by lexical affixes, *BE* and *DO*. With regard to affected children, these same studies demonstrated that children with SLI lag behind younger language-equivalent control children, a lag also demonstrated in the emergence of *BE* and *DO* in the grammars of younger affected children (Hadley and Rice (1996)). Longitudinal studies found that the lag in affected children persists for years (Rice, Wexler, and Hershberger, 1998; Rice, Tomblin, Hoffman, Richman and Marquis, 2004) and adds support to the interpretation of shared weakness across the set of morphemes across time. Grammaticality judgment tasks established that the phenomenon was not a production limitation. Unaffected, normative control groups showed that children were likely to accept matrix clauses with missing finiteness marking as grammatical until around 4;6–5;0 years, a pattern that persisted through 8 years for children with SLI (Rice, Wexler and Redmond, 1999). It is noteworthy that the SLI group's mean performance was not at ceiling for omitted finiteness at the last time of measurement, suggesting that the grammaticality judgment format would be suitable for extension to older ages of assessment if the linguistic context were more challenging.

Rice (2003; 2004; 2007) interprets the longitudinal outcomes as a disrupted grammatical trajectory in which finiteness markers are weaker than other elements of the grammar, even when adjusted for a late onset. A replicated finding in these studies, for both production and judgment tasks, is that performance on finiteness marking tasks is not predicted by the children's nonverbal IQ, receptive vocabulary or mother's education, for either the affected children or the comparison groups. This supports the interpretation that the requirement for finiteness marking is largely independent of vocabulary and that grammatical competence or limitations in this domain are not accounted for by general intellectual development.

Cross-sectional studies replicate the generalization that young children with SLI, as a group, are likely to perform less accurately than younger controls on morphemes associated with the finiteness marker. The bulk of the evidence for this generalization comes from children ages 4 to 8 years (cf. Bedore and Leonard, 1998; Conti-Ramsden, Botting, and Faragher, 2001; Eadie, Fey, Douglas, and Parsons, 2002; Grela and Leonard, 2000; Joseph, Serratrice, and Conti-Ramsden, 2002; Leonard, Eyer, Bedore and Grela; Marchman, Wulfeck, and Ellis Weismer, 1999; Oetting and Horohov, 1997). More recent studies document the predicted lag at onset in the 24–36-month age range (Hadley and Holt, 2006; Hadley and Short, 2005).

All told, there is solid evidence for the omission of finiteness morphology in English simple declarative clauses as a clinical marker (cf. Rice and Wexler, 2001), evidence that aligns with the grammatical model sketched above. A few studies extend the evidence to complex clauses within this age range (Schuele and Dykes, 2005; Owen and Leonard, 2006). Although debate continues about the underlying source of the grammatical weakness, the basic phenomenon of shared weakness is empirically robust for the ages of children studied to date, for the available tasks and assessments. At the same time, the declarative clause contexts appropriate for this age range are less sensitive to affectedness by around 8 years for affected children.

Clinical markers for elementary school aged children with SLI

Following the model of functional projections described above, a related consequence of omitted finiteness marking in IP projections in young children could be a tolerance for omitted finiteness marking in the CP projections in the grammars of older children. If affected children continue to trail unaffected children in their growth patterns, as we expect, then finiteness marking in questions is a likely clinical marker.

Two forms of questions are used frequently by children, the yes/no and wh- questions illustrated above. Previous studies have examined young unaffected children's acquisition of yes/no and wh-questions in the context of the movement of copula and auxiliary *BE* forms from I to C, known as subject/auxiliary inversion (SAI). Guasti (2002) provides a review and concludes that SAI may be optional for preschool children, although by school age unaffected children are able to generate questions with SAI. These studies have focused on the movement requirements of CP projections. It is generally thought that the movement from I to C requires additional computational complexity that leads to later acquisition of questions relative to declaratives. The issue of possible lingering acceptance of omitted forms of *BE* and *DO* in questions has not been directly examined as part of the earlier studies, although a persistent weakness in the obligatory properties of TNS/AGR marking is likely to affect the acquisition of questions.

There are hints of the usefulness of yes/no questions as markers for language impairment in the production tasks for *DO* auxiliaries in Rice, Wexler and Hershberger (1998) and also in data reported for the *Rice/Wexler Test of Early Grammatical Impairments* (Rice and Wexler, 2001). This test data reports that a large proportion (82%) of the language impaired group of 50 children ages 8;00–8;11 (the oldest group sampled) scored at or below 91% accuracy (p. 123 of the examiner's manual which reports a sensitivity of .82). This is compared to a large proportion (72%) of the control group of 50 children at age 6;06–6;11 (the oldest control age group sampled) who scored above the same level (91%) (p. 122 of the examiner's manual which reports a specificity of .72)). Thus there was little overlap of the affected group's performance with the performance levels of children about 2 years younger, suggesting a significant off-set in the growth trajectory for *DO* auxiliaries in questions.

In a recent study of school age children learning English as a second language compared to a group of children with SLI and a control group of unaffected children, levels of production of *DO* auxiliaries were lower than *BE* auxiliaries for all three groups of children (Paradis, Rice, Crago and Marquis, 2008). It may be that the extra difficulty of adding a morpheme (*DO*) that doesn't occur in the declarative form creates some difficulty for children as they develop language. In this same study, *BE* copulas and auxiliaries in question contexts were more likely to be omitted by children with SLI than the same forms in declarative sentences, adding further evidence in support of CP projection as a potential grammatical marker of finiteness weakness.

Finally, the earlier longitudinal study of grammaticality judgment tasks comprised of simple matrix clauses with omitted finiteness markers reported by Rice, Wexler and Redmond (1999) offers further indication of lingering weakness in judgments of finiteness omission. The tasks involved judgments of sentences such as "he drinks milk" versus "*he eat toast" and "he is hiding" versus "*he running away" (Following linguistic conventions, the * indicates ungrammatical items.) In that study, the SLI group at the last time of measurement at age 8 years were below ceiling performance on these tasks, with average A' scores of .82 for affected children, as compared to .88 for children two years younger.

The study reported here followed the earlier study of Rice, Wexler and Redmond (1999) with investigation of grammaticality judgments of *BE* copula and auxiliaries and *DO* auxiliaries in single-clause wh- and yes/no questions, to evaluate the following questions:

1. Will children with SLI who have a documented early history of an EOI period continue to show optional finiteness marking in their willingness to accept omitted BE/DO in questions for a prolonged time? If so, what will be the length of this time?
2. Do affected children outgrow the deficit in finiteness marking or does it persist? Are the growth rates similar for affected and control children throughout the observed time, leading to a persistent gap, or is the affected group able to accelerate growth in order to close the gap? Are the linear and non-linear growth parameters similar in affected and control groups or is there a group X time interaction?
3. Will Wh- and yes/no questions show similar patterns of growth in grammaticality judgments of finiteness marking over time?
4. Will DO auxiliaries show lower levels of performance than BE forms in questions, with a persistent gap in growth relative to BE? Will the difference be observed for the SLI group only (in a stage of acquisition less mature than the LM group), or for both groups?
5. Will indices of nonverbal IQ, vocabulary, mean length of utterance, and mother's education at the outset predict growth in question finiteness judgments? Does earlier performance on judgments of omitted finiteness in simple matrix clauses predict growth in question finiteness judgments?

METHODS

Participants

The participants in this study are the children who participated in earlier longitudinal studies documenting the clinical marker status of omitted finiteness in simple matrix clauses (Rice, Wexler and Hershberger, 1998; Rice, Wexler and Redmond, 1999). As described in the previous studies, the SLI group originally met the following inclusionary criteria: (a) Identified as SLI and receiving clinical services in the year prior to kindergarten enrollment (ages 4;5–5;0; (b) Receptive language performance one or more standard deviations below the mean on the Peabody Picture Vocabulary Test-Revised (PPVT-R; Dunn and Dunn, 1981); and (c) mean length of utterance (MLU) one standard deviation or more below age expectations, according to the age norms of Leadholm and Miller (1993). In addition the Test of Language Development-Primary (TOLD-P:2, Newcomer and Hammill, 1988) was administered to each child. Children were admitted with standard scores of 85 or below, with two exceptions who met other entry criteria—one child with a score of 88 and one with a score of 93. In addition, children in the SLI group met the following exclusionary criteria: (a) none had been identified as having autism, behavioral or social impairments, and (b) their speech-language pathologists reported their social development to be within normative expectations. Their intellectual functioning was above clinical levels of intellectual impairment, with an age deviation score of 85 or above on the Columbia Mental Maturity Scale (CMMS; Burgemeister, Blum, and Lorge, 1972) and they passed a hearing screening at 25 dB (30 dB in noise environments) at 1, 2, and 4000 Hz.

Two groups of control children were recruited from preschool attendance centers in the same residential areas as the children in the SLI group. These children were regarded as "normally developing" by their classroom teachers, passed the hearing screening, and had scores on the PPVT-R and the TOLD-P:2 in the normal to high normal range. One group of children constitutes an age control group (AG). Another group of children constitute a language control group, equivalent for mean length of utterance derived from spontaneous language samples (see Rice, Redmond and Hoffman, 2006 for MLU and PPVT longitudinal outcomes), referred to here as the Language Matched (LM) Group.

This study started about 4 years into the original longitudinal study. There were 20 children in the SLI group; 20 in the AG; and 18 in the LM group. Mother's education levels for all children were assessed on a 6-point scale, with 1 = some high school; 2 = high school degree; 3 = some college, no degree; 4 = bachelor's degree; 5 = some graduate school; and 6 = graduate degree. The means and standard deviations per group are as follows: SLI, 2.45 (1.19); Age, 4.3 (1.17); LM, 4.4 (1.34). The full sample was comprised of 50 White children, 2 American Indian, 1 Black, 2 Multi-racial, and 3 Hispanic children; 27 females and 31 males. Dialectal variation was monitored and any children for whom there were concerns were assessed on a standardized instrument (Seymour, Roeper, and deVilliers, 2003). None of the children were identified as speaking non-standard dialects.

Table 1 summarizes means and standard deviations at the outset and again at the last time of measurement, for chronological age and other assessments. At the first and last time of measurement nonverbal intelligence was assessed with the Wechsler Intelligence Scale for Children-Third edition (WISC) (Wechsler, 1991); CMMS was also used at the first time of measurement as a validation check on the earlier use of the CMMS as a criterion measure for entry in the longitudinal study. At the last time of measurement the omnibus language assessment was the Clinical Evaluation of Language Fundamentals-Third edition (CELF-III) (Semel, Wiig and Secord, 1995). The age period covered for the SLI and Age Control group is 7;6 to 15 years of age; for the LM controls, 5;9 to 13 years of age. The calendar period of the longitudinal study is 7 years, encompassing an age range of 9 years over the two groups. The SLI group continues to show the SLI profile throughout this period, with the nonverbal IQ in normal or low normal range, receptive vocabulary scores borderline normal (about 10 standard score points below the nonverbal IQ score averages) and omnibus language test scores in the clinical range, more than one standard score below the normative mean.

Procedures

The children completed the experimental assessments at 6-month intervals until age 8 years and at 12-month intervals thereafter. A total of 9 times of measurement were included in the analyses for the SLI group; three data points mid-way in the study are missing for the LM group when data were not collected, for a total of 6 times of measurement; 5 times of measurement are available for the age controls with four points not collected mid-way in the study.

The task was a 40-item grammaticality judgment task with affirmative Wh- and Yes/No questions, with *BE/DO* forms present or omitted. The task is structured as 5 items each in 8 categories. The categories are grammatical versus ungrammatical versions of Wh-*BE*; Yes/no BE; Wh-DO; Yes/no *DO* questions. The ungrammatical versions are questions with omitted *BE* or *DO* forms. The task was not designed to evaluate movement operations, only presence/absence of *BE* or *DO* in the licensed C sites. The question items are all affirmative, without negation; the argument structures and semantics are chosen to be familiar to the children at the first time of measurement; vocabulary for the lexical verbs and noun arguments varies across items; wh-questions use "what", "why," "when", or "where" forms; copula and auxiliary forms are intermingled in the *BE* condition; second and third person subjects are used, with the constraint that omitted *DO* in second person yes/no questions was avoided because pragmatics allow for subject and auxiliary drop in conversational contexts such as "…want a cookie?" where the subject and associated auxiliary are assumed. Example items are reported in Table 2.

The items were presented in the same order for all participants, with the item order randomized following the constraint that there were no more than 3 grammatical or ungrammatical items in sequence. The items were audio-recorded in natural prosody and presented via headphones.

The participants judged each item as "good" or "not so good," via oral response recorded by the examiner on hard copy data forms.

Results

Following Rice, Wexler, and Redmond (1999) the primary dependent variable for longitudinal analyses was A', calculated as A' = 0.5 + (y – x) (1 + y – x)/ 4y (1 – x), where x = the proportion of false alarms (saying "yes" to an ungrammatical item) and y = hits (saying "yes" to a grammatical item) (cf. Linebarger, Schwartz, and Saffran, 1983). A' is appropriate because it adjusts for children's tendency to default to "yes" responses, and the ungrammatical items in this study are predicted to yield "yes" responses from affected children.

The analyses were carried out for a summary variable collapsed across all conditions (GJ Ques), a variable collapsed across *BE* (BE) versus *DO* (DO) conditions, and a variable collapsed across Wh- (WH) versus Yes/No (Y/N) questions, for a total of five outcome variables. As expected, the AG group performed well on the tasks. The means and standard deviations for the GJ Ques variable for this group for the first three times of measurement are: .95 (.05); .95 (.09); .95 (. 06) and for the last two times of measurement are: .96 (04), .93 (.09). Given the persistent ceiling effects they are not included in statistical group comparisons, although effect sizes are reported below.

The primary analyses focus on the SLI and LM groups. Table 3 presents the means, standard deviations, and Cohen's **d** estimates for effect sizes (Cohen, 1988) for each variable at each time of measurement for these groups. Inspection of the means shows differences between the two groups throughout, for all variables, with large effect sizes—24 of the 30 estimates are 1.00 or above, indicating a standard deviation or more advantage for the LM group. Effect sizes are, of course, even larger for the comparison of the SLI group and the AG. For GJ Ques, the values are: **d** = 3.6, 2.11, 2.83, 4.75 and 1.78, for each available time of measurement, indicating an advantage for the age controls of approximately 1.5–4.75 standard deviations, as a consequence of the expected high levels of performance and low variation in the grammars of the AG group.

Returning to the comparison of the SLI and LM groups, at the outset performance levels on the Yes/No questions were higher than the Wh- questions and the LM group was higher than the SLI group as shown by a multivariate ANOVA at time 0 with significant main effects of question type, F (1,33) = 10.5, $p < .01$,and group, F (1,33) = 7.6, $p < .01$, but no interaction of question type and group. A similar picture holds for *DO* versus *BE*, with higher performance for *BE* at the outset, and higher performance by LM group, as shown by a multivariate ANOVA at time 0 with significant main effects of question type, F (1,33) = 8.1, $p < .01$,and group, F (1,33) = 7.6, $p < .01$, but no interaction of question type and group.

Model Estimation

Patterns of change over time were investigated via growth modeling. Linear mixed models were estimated for each of the five outcome variables (GJ Ques, BE, DO,WH and Y/N) using SAS PROC MIXED. Restricted maximum likelihood was used to estimate model parameters and to assess the significance of random effects; denominator degrees of freedom were estimated using the Satterthwaite method. Years in study was centered at the first occasion, such that the intercept represented initial status (mean age 5;9 for the LM group and mean age 7;8 for the SLI group); the linear slope represented the expected instantaneous rate of change in each outcome for a one-year interval as evaluated at the initial occasion, and the quadratic slope represented the expected rate of deceleration in the linear slope over time. Means for each time point were estimated using the LSMEANS method and are plotted with the predicted trajectories for each outcome, as described below. Pseudo-R^2 values for the effects of group

were calculated as described in Singer and Willett (2003), and represent the proportion reduction in the random effects variances relative to the unconditional growth model. Main effects of group serve to reduce the random intercept variance, whereas interactions of group by time would serve to reduce the random slope variance.

The unequal intervals in the times of assessment do not pose analytic problems for the mixed models used for the growth curve analyses. The models make use of all available data and allow a continuous model for time. That is, best-fit slopes are used to describe trajectories over time using whichever occasions are there, and extrapolating through occasions in between. Thus, rates of change can be interpreted per year regardless of the actual intervals measured.

Planned time-invariant covariates, as used in previous studies, were examined as potential predictors of individual differences in growth parameters, including group (LM vs. SLI), Mother's Education, and age-standardized scores for the PPVT, WISC, and CMMS. Mother's Education was centered such that mothers with a college education served as the reference group, whereas PPVT, WISC, and CMMS were each centered at 100, such that children with average levels of performance for each covariate served as the reference group. Only group had significant effects in any outcome, however. None of the extrinsic predictors were significant for either group, for any of the variables. Model parameters for each outcome are given in Table 4. We also examined whether children's earlier performance on judgments of omitted finiteness in simple matrix clauses predicted growth, as described below.

Growth Models

For GJ Ques, significant fixed effects were observed for the linear and quadratic growth parameters. Specifically, as shown in Table 4, the expected accuracy at baseline for the SLI group was .75, with a significant instantaneous positive linear rate of change of .02 per year as evaluated as baseline. This positive linear rate of change was reduced over time, as indicated by the significant negative quadratic coefficient of −.003, such that for every additional year in the study, the linear rate of change became less positive by .006 (e.g., twice the quadratic coefficient). These model terms work in conjunction to create the positive decelerating function shown in Figure 6. Significant individual differences (i.e., random effects) were observed only for initial status. A significant main effect of group was observed, such that the LM group had greater levels of accuracy initially, and maintained this advantage over time. The linear and quadratic rates of change did not differ between the two groups. The LM group's predicted scores were in the .90–.95 range throughout, whereas the affected group did not reach that level, remaining in the .75–.80 range throughout. It is also clear in the figures that the models demonstrated good fit, with close alignment of the observed and predicted outcomes.

For DO, the growth model is the same as for GJ Ques: Significant fixed effects for linear and quadratic growth (i.e., a positive decelerating function), individual differences only for initial status, and the predicted significant main effect of group. The change over time for DO showed modest increases, with a somewhat lower initial level of performance compared to GJ Ques. As shown in Figure 7, the LM group's predicted scores at outset were at .84 and rose to the .90–.93 range, whereas the SLI group's predicted scores rose from .70 to .77. For both groups, performance on DO started somewhat lower and ended at about the same levels.

The growth model for BE brings a contrast in outcomes. No significant fixed or random effects of time were observed. A significant main effect of group was observed, however, such that the LM group had greater levels of accuracy initially, and maintained this advantage over time, as shown in Figure 8. BE levels start at the levels of asymptote observed for DO (about 4 years later), for both groups, and maintain the group differences in a flat asymptote throughout the 9 years of the study.

In relation to question 4, a multivariate mixed model was then estimated to compare the means of the BE and DO outcomes at each occasion within the SLI group. Significant differences between the outcomes were found only at the first and third time of measurement, such that BE was higher at those occasions. There were no significant differences between the two forms within the LM group.

Regarding question type, growth models for WH yielded significant fixed effects for the linear and quadratic growth parameters such that a positive decelerating growth function was again observed overall. As seen in Figure 9, however, the increase in predicted WH accuracy across time is modest and similar to that of DO—from .87 for the LM group at outset to .92; from .73 for the SLI group to .78. Significant individual differences (i.e., random effects) were observed for initial status and in the rates of linear growth across time, however. The predicted significant main effect of group was also obtained, such that the LM group had greater levels of accuracy initially and maintained this advantage over time.

The growth model for Y/N yielded the same components as for GJ Ques and DO: Significant fixed effects for the linear and quadratic growth parameters, with a positive decelerating growth function overall; significant individual differences only for initial status; and the predicted significant main effect for group. The LM group's predicted levels started at .93 and rose to .95; the affected group started at .73 to .78.

We also examined possible predictive relationships between the children's earlier performance on the judgments of omitted finiteness markers in simple declarative matrix clauses (Rice, Wexler, and Redmond, 1999) and their performance on the question judgment task. The variables were the composite score from the earlier study of finiteness marking in declarative clauses (BE forms and lexical affixes for past and present tense) and the composite GJ Ques variable of this study. Concurrent measurement of the two variables is available at the first time of measurement for the GJ Ques task, yielding correlations of $r = .677$ ($df =$ ***38***, $p < .001$) for the combined group, $r = .665$ ($df = 20$, $p = .001$) for the affected group, and $r = .543$ ($df = 18$, $p = .020$) for the younger control group. As expected, the two indices show significant positive association for concurrent measurement.

We followed up with growth predictive modeling to examine the effect of the earlier index of judgments of finiteness omission on initial status and rates of change on GJ Ques. The predictor was defined as the children's performance on the composite finiteness index at 6 years of age, when the SLI group's mean was .63 (*SD* = .124) compared to .88 (*SD* = .155) for the younger control group. Earlier ability was a marginal predictor of the intercept for each outcome (*p*-values ranging from .05 to .10), such that children with greater earlier ability had higher accuracy rates at the first time of GJ Ques assessment. No effects of earlier ability on rates of change were found, however. Interestingly, after controlling for earlier ability, the effect of SLI vs. LM group became non-significant, indicating that it no longer offered a unique predictive contribution.

DISCUSSION

The main outcome of this study is a significant group effect for all variables. At the outset, there were large differences between the SLI and age control groups, with effect sizes ranging from 1.78–4.75 standard deviations. It is clear that, as a group, the affected children do not "catch up" to their peers on judgments of finiteness marking in simple questions. Furthermore, the affected children do not "catch up" to younger controls. The SLI group performs persistently at lower levels than the younger LM group, for the summative grammaticality judgment variable collapsing across all variations of omitted finiteness in single-clause questions, and for each of the experimental conditions: forms of BE and DO and for Wh-

questions as well as Yes/No questions. The group differences showed large effect sizes throughout. It is clear that children with SLI with a documented early history of an EOI period continue to show optional finiteness marking in their willingness to accept omitted BE/DO in questions for a prolonged time. This study documents that this period extends to 15 years.

As in the younger growth period documented for these groups on different but related variables (Rice, Wexler and Hershberger, 1998; Rice, Wexler and Redmond, 1999), the affected children follow the same growth trajectory as the LM group, as if they were two years younger but with a lower level of performance. As the growth decelerates toward asymptote, there is less room available to detect the shape of growth. Even so, linear and quadratic components are detected for both groups for all but BE, a variable at asymptote throughout for both groups. This indicates that even as the children's performance is closing in on the final levels, the affected children follow the same path as the younger unaffected children. The new findings here show that at the upper levels of finiteness acquisition, as for the earlier levels, the affected children's growth mirrors that of younger children. The implication is that both groups of children are prepared to change in similar ways as they progress toward asymptote in this domain. With this pattern in place the affected children are unable to "catch up" to even their younger controls in finiteness marking—they do not increase their rate of growth early on beyond that of the younger children's rate and the deceleration in growth occurs after the same interval of time, before the expected level of adult-like performance. Other domains of language, such as growth in utterance length, for these same groups, show a different pattern, one in which the affected group does reach the expected levels of performance (Rice, Redmond and Hoffman, 2006). It is remarkable that finiteness marking follows a parallel growth pattern to the younger control children even into a lower level at asymptote, an outcome that increases the value of this part of grammar as a clinical marker, and clarifies why the affected children score so much lower than their age peers.

Note that the SLI group received more administrations of the experimental task (9 times) than the younger control group (5 times). The fact that large group differences were observed notwithstanding any possible advantage for practice effects for the affected group adds further support to our interpretation. Further, any advantage in experience with the task could have helped the SLI group increase their rate of gain in performance accuracy, but the groups' similarity of linear and quadratic slopes clearly show this does not happen.

Regarding the question of possible predictions of growth, as expected from the investigations of the same groups when they were younger, at these older ages the children's performance on nonverbal intelligence assessments, vocabulary assessments, and mother's education did not predict their acquisition of finiteness marking, a generalization that holds for both groups. At the same time, children's earlier performance on judgments of finiteness marking in declarative clauses also did not predict performance on the question judgment task, although the concurrent correlations at 6 years of age were around .60. Although no significant predictors of growth were found, this null finding must be interpreted cautiously because individual differences in growth were not detected in the current study. If the children grow in the same way, detection of predictor relationships is more difficult. This is also related to the small number of children in the study. Our total growth modeling sample size of 35 children is lower than is generally recommended for detecting random effects variances (Snijders and Bosker, 1999). Indeed, the random slope variance was significant only for WH questions. Because individual differences in growth were not able to be detected, it is unlikely that significant prediction of individual differences in growth would be detected either. This is compared to the earlier null findings of Rice, Wexler and Redmond (1999) for nonverbal IQ, vocabulary and mother's education as predictors of judgments of omitted finiteness in declarative sentences. Yet those null findings were in models that yielded significant prediction for mean length of utterance, with a total sample size of 40. All things considered, conclusive investigations of predictor relationships

for growth await larger sample sizes and continued investigation of individual differences in growth.

Turning our attention to the details of grammatical structure of interest here in the formation of questions, the big picture view is clearly of the shared function across the four contexts examined. The great similarity of outcomes across the four measures points toward the presumed shared property of C projection in grammatical representations as a likely source of the lower performance of the affected children relative to the younger control group. Further, this interpretation aligns with the interpretation of the problems with finiteness/tense marking at the younger ages. The common unifying construct is the projection of TNS/AGR to the IP and the CP. The strength of the shared trajectories across the four measures poses a challenge to models of early acquisition that posit that omitted finiteness markers are attributable to differences within the set of morphemes, such as frequency of occurrence in adult utterances directed to children (cf Pine, et al, 2008). The posited factors that account for early omissions of finiteness markers are unlikely to be operative to the same extent into adolescence, yet the shared growth patterns persist across groups and to a large extent across forms. The continuing willingness to accept omitted *BE* and *DO* in questions (especially evident in the affected group) after an earlier period of omission of these forms in simple declaratives is most parsimoniously accounted for by the shared properties of functional projections, an abstract property thought to be affecting early as well as later use of finiteness markers.

At a more fine-grained level, there are indications that the acquisition of *DO* trails that of *BE* for the SLI group, evident in lower performance on DO at the outset. It is interesting that the end levels are similar for BE and DO, for both groups, although the affected group's performance peaks below that of the LM group for both forms. This observation is consistent with the reports of greater difficulty for *DO* for children learning English as a second language at age levels younger than the children studied here. The design of this study does not shed direct light on the reasons for the advantage of *BE*, although it is consistent with the arguments of Ionin and Wexler (2006) for second language learners. They posit that the overt movement of *BE* from the IP to the CP is associated as a matter of linguistic knowledge with obligatory spell-out of the phonological requirements of the morphology. Since *BE* moves (to TNS/AGR) and main verbs don't, this property can guide children in their acquisition of finiteness, making *BE* easier than the lexical affix *–s* for third person singular TNS/AGR. As noted by Paradis, et al (2008) this could account for an advantage for *BE* versus *DO* if *DO* does not move to its position. On the other hand, they note that *DO* appears in left position, arguably a favorable one for acquisition, and its location in the functional layer may not be derived via movement. The import from this study is that both *BE* and *DO* in CP are good candidates for clinical markers of SLI in this age range, although there may be a slight advantage for *DO* as a clinical marker given its lower levels of performance for the affected group at the first times of measurement.

Empirically, this study documents that the earlier EOI period persists well into adolescence, as can be seen by performance on judgment tasks involving CP projection. Even though the children with SLI may have outgrown their earlier period of EOI in simple declarative clauses, the weakness in finiteness marking can be detected in the CP projection of single clause questions. The findings support the model's assumption of a systematic relationship between obligatory TNS/AGR in the IP and CP projections, as diagrammed in Figures 1, 2, 3, 4 and 5.

At the level of theoretical interpretation, the findings highlight two interrelated issues. One is how to account for the children's resolution of the earlier period of finiteness omission in declaratives and the second is how to account for the children's difficulty with finiteness in questions (CP projections). The exact computational and representational components are not fully worked out. One possibility is that the children can draw upon learning and experience

to insert finite forms in declarative sentences, and the similarity in growth curves suggests that the same mechanisms are available to the older affected children as the younger unaffected children. The caution is that these learning mechanisms must also account for the affected children's relatively higher levels of performance on receptive vocabulary and MLU abilities (Rice, Redmond and Hoffman, 2006). At the same time, these mechanisms are not sufficient for more complicated sentences, like questions.

Another possibility relates to the theoretical explanation of the OI and EOI stage, although the answer is not obvious. Wexler’s (1998) *Unique checking constraint*, says that children (and older children with SLI) have difficulty with a double checking (as required by the TNS/AGR checking). The model assumes that the subject is a Determiner Phrase (DP) that raises to the Spec of IP where it checks non-interpretable features (i.e., non-semantic features) at TNS and AGR. The UCC constraint is that such checking can only occur at one of these two functional categories, thus forcing the child to omit either AGR or TNS. Yet in the Wh-questions or yes/no questions in our experiment, the subject DP proceeds no further than SPEC of IP; it does not proceed on to CP. It looks as if the motivation to omit TNS or AGR in questions should work equally in declaratives and in Wh-questions.

Here is a possible answer, that we raise as a hypothesis as to how UCC applies. Consider wh-questions, of the kind that we are studying. There is a second movement in these questions, in addition to the subject raising to Spec of IP. Namely, the object phrase raises to CP. Could this second raising be subject to UCC? In current syntactic studies (Chomsky, 2000) the wh-object DP does raise twice, checking 2 D features as it does so. The first movement is to a specifier position of the verb phrase, where the object DP checks a D feature. So the wh-movements should be subject to UCC.

The model offers predictions for children’s productions. There have been studies of relevant constructions. For example, Wexler (2004) argued that failure to “scramble” in languages like Dutch followed from a UCC (double checking) violation involving the object, V and a higher category; Baek and Wexler (2008) showed that well-known errors on “short-form negation” in Korean followed from a UCC violation on the object and double checking; and Wexler, Gavarró and Torrens (2004) and Tsakali and Wexler (2004) argued that object clitic omission in languages like French and Italian followed from a UCC violation involving double checking of the object (to V, then to a higher Clitic Phrase). Several SLI studies (e.g. Jakubowicz, Nash, Rigaut and Gérard, 1998; Paradis, Crago and Genesee, 2006) show that clitic omission is quite large in children with SLI (compared to control children), verifying that UCC applied to objects still causes extended difficulties for affected children. Paradis, et al. (2006) call clitic omission a “clinical marker” for French-speaking children with SLI. Thus there is reason to believe that UCC applies to objects as well as to subjects.

To summarize, declarative sentences have one possible violation of UCC (one double D-checking). Object Wh-questions have 2 violations of UCC (2 double D-checkings, one for the object and one for the subject). We suggest generalizing UCC to the following: Children try to minimize UCC violations. This hypothesis predicts that a child is more likely to prefer tense omission in a wh-question than in a declarative sentence, since in the former, tense omission reduces the UCC violations to 1. The situation might be slightly more complex for yes/no questions, and we won’t try to deal with it here. We offer the hypothesis here as a minimal extension of the UCC that seems quite natural. Clearly it needs more study.

As noted above, the findings have import for the development of behavioral phenotypes for genetic studies. These findings suggest very strongly that finiteness omissions in affected children are not fully resolved even into the adolescent period, when observed in single-clause questions. Overall, it appears that grammatical judgment tasks of the type used in this study

have potential value for examining the interpretation of Falcaro et al (2008). Judgment tasks could be used to sort out whether the inherited influences on tense marking are restricted to whether or not an early-appearing stage is unresolved, or whether the influence is evident into adolescence or beyond.

For clinical purposes, the findings are relevant to the development of assessments designed to identify affected school age children and on into adolescence and beyond. Such tasks will help ensure that affected children in this age range and young adults are enrolled in language intervention designed to help them prepare for life beyond school and to enrich the language resources they bring to the development of literacy skills.

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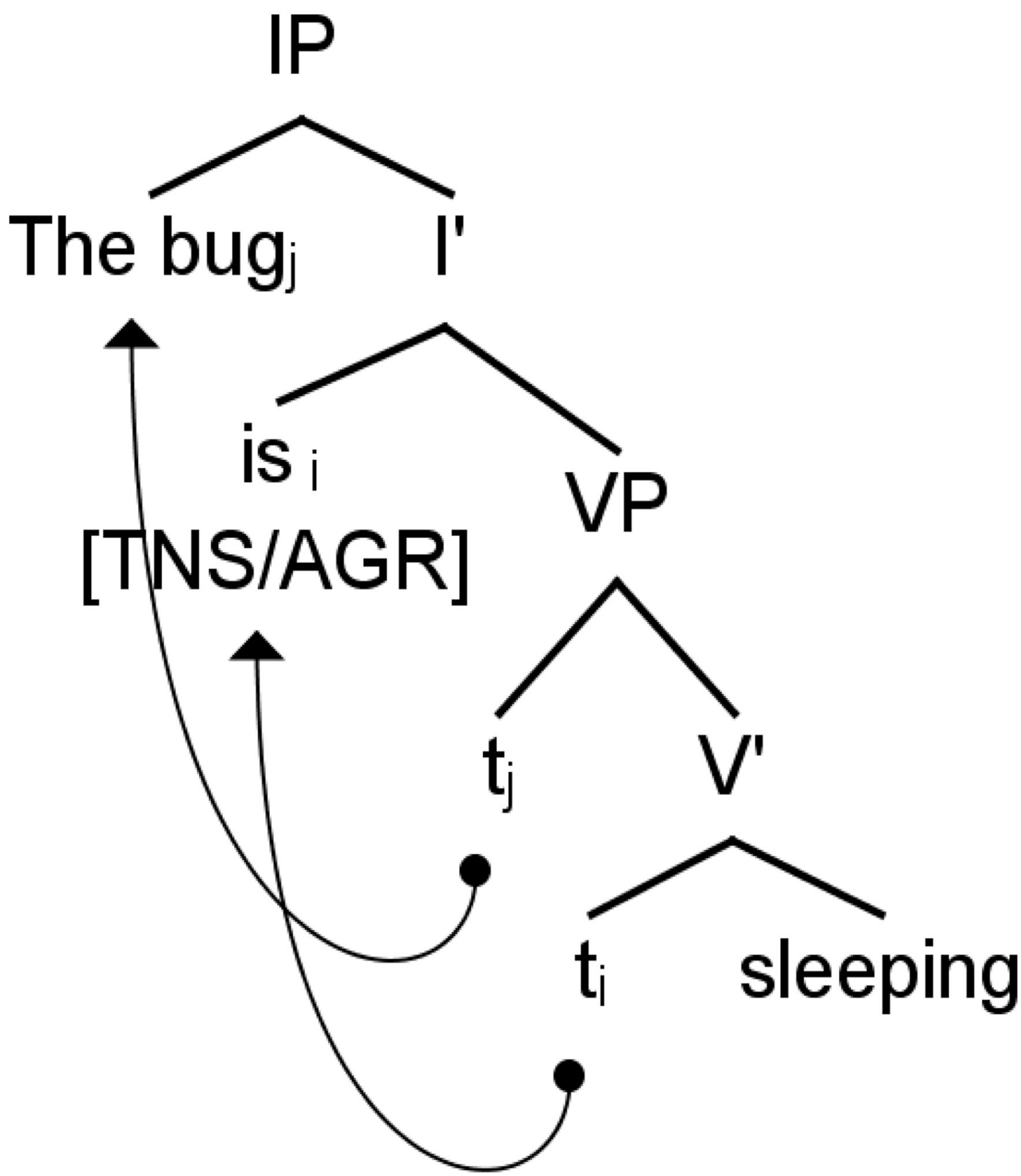

Figure 1.
VP-internal IP projection of Auxiliary BE

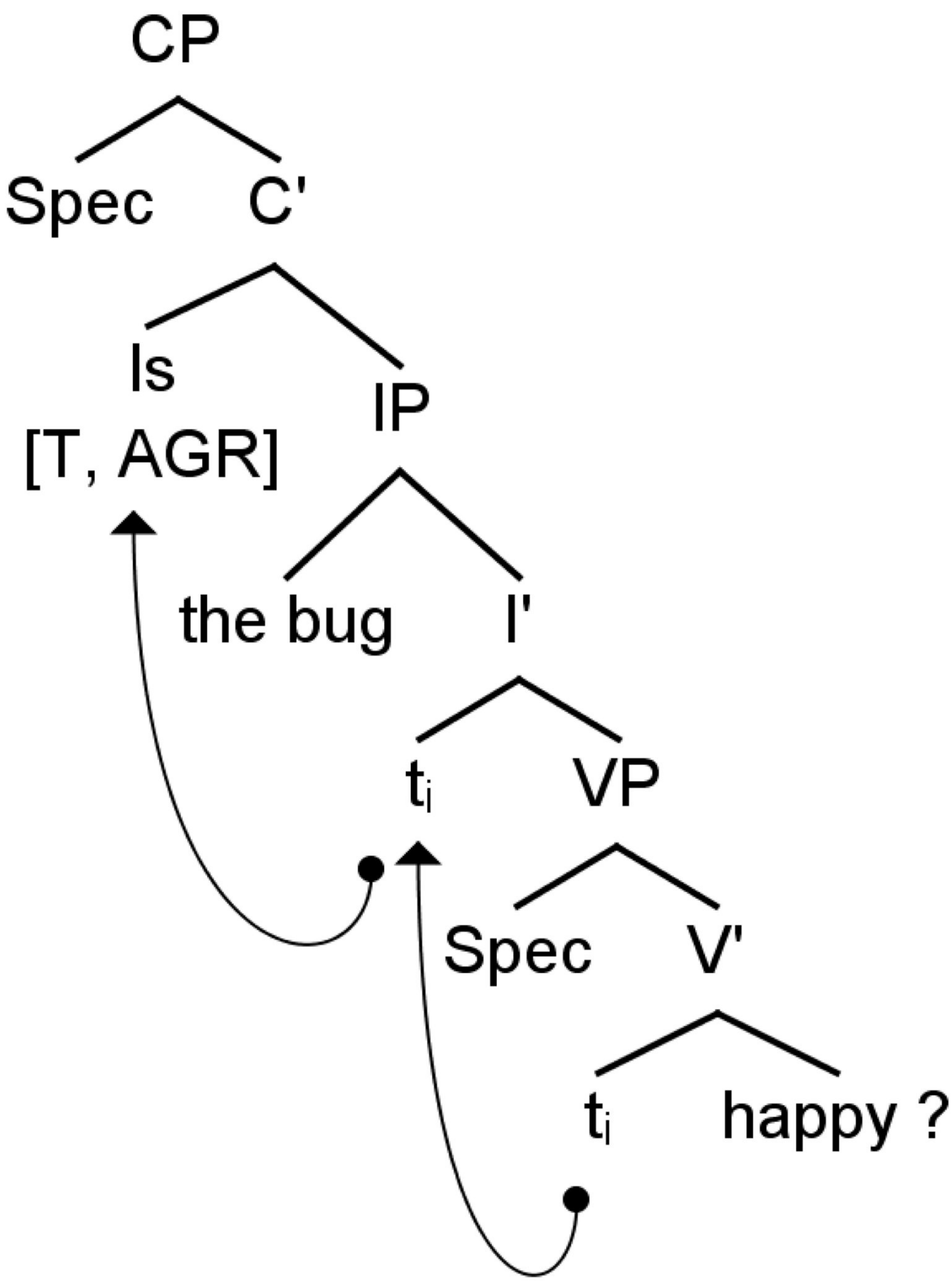

Figure 2.
BE copula yes/no question

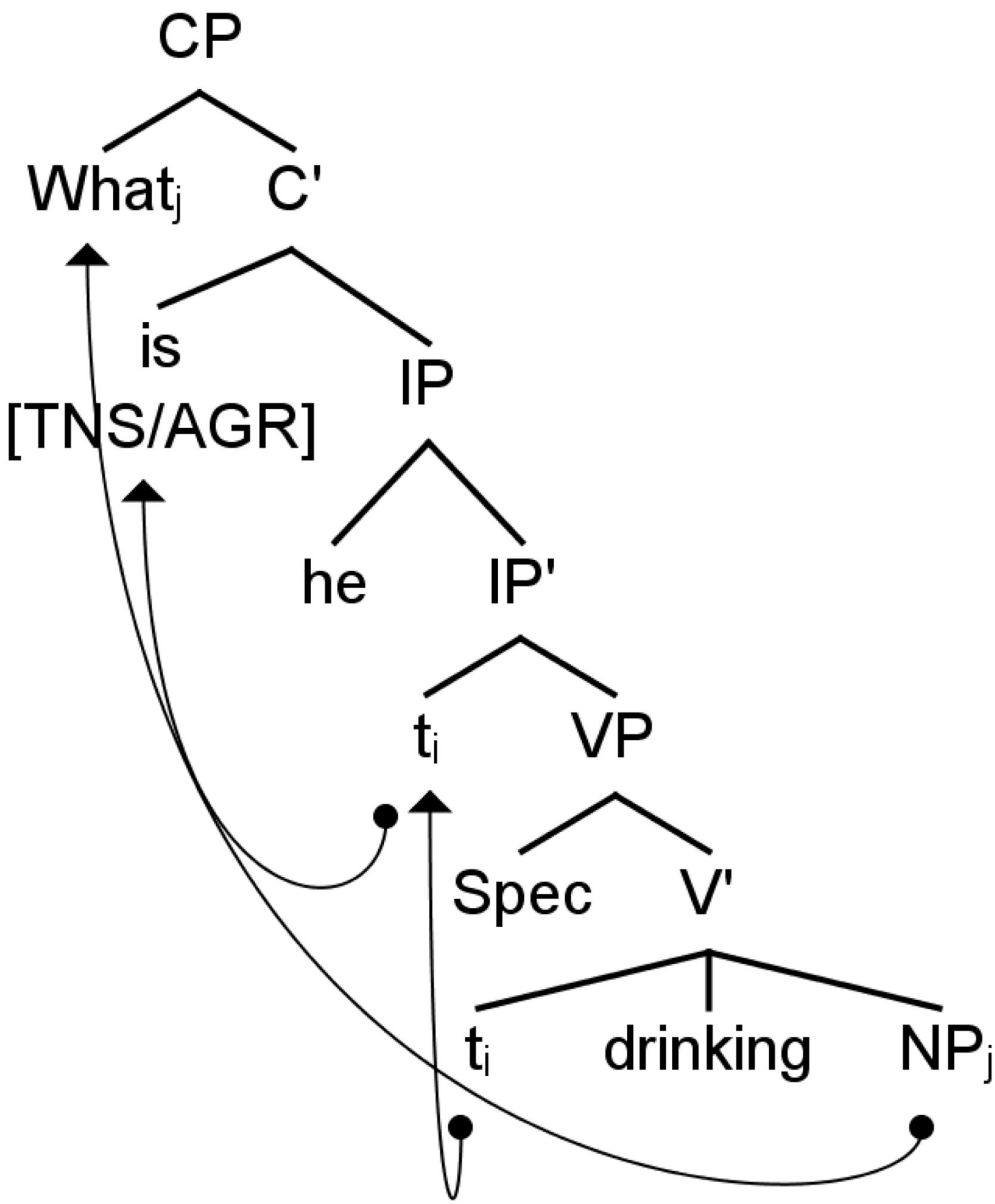

Figure 3.
BE auxiliary wh question

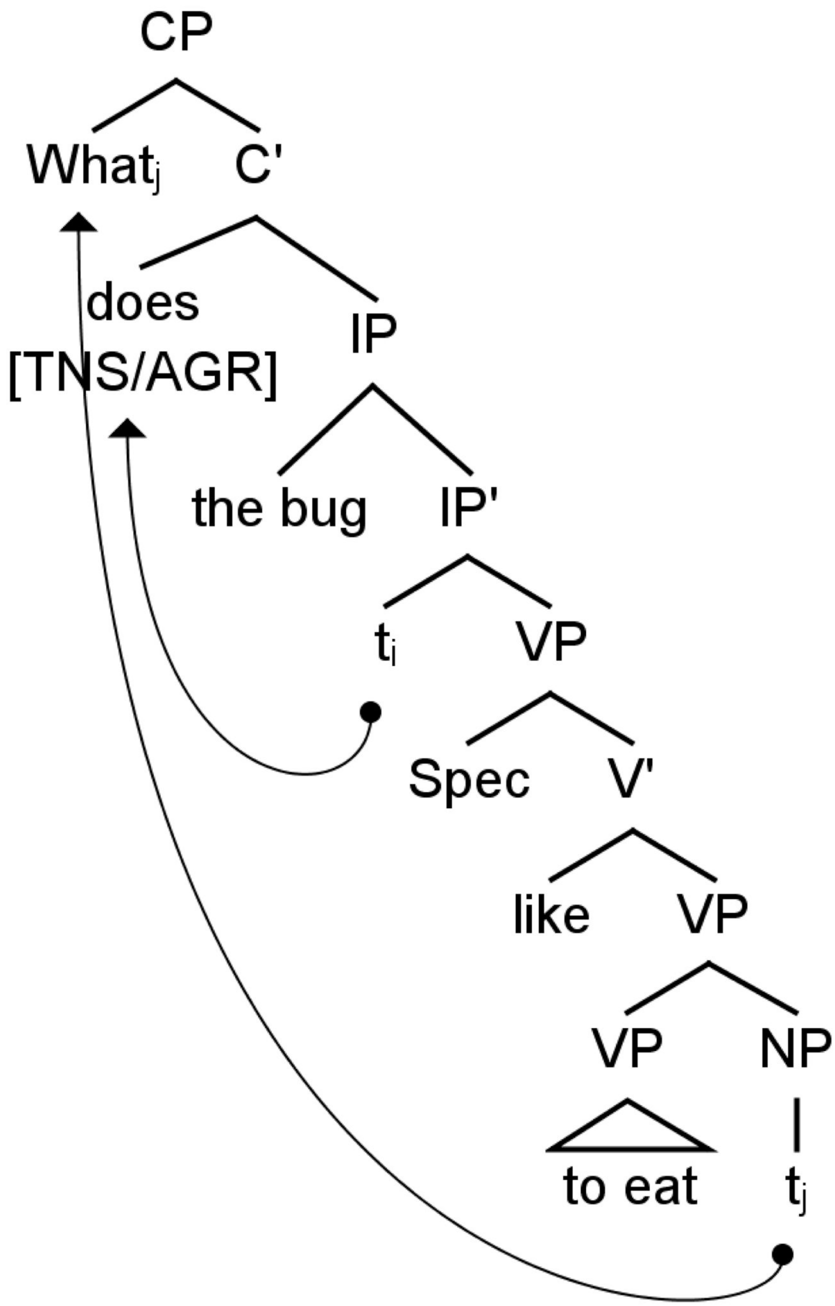

Figure 4.
DO auxiliary Wh question

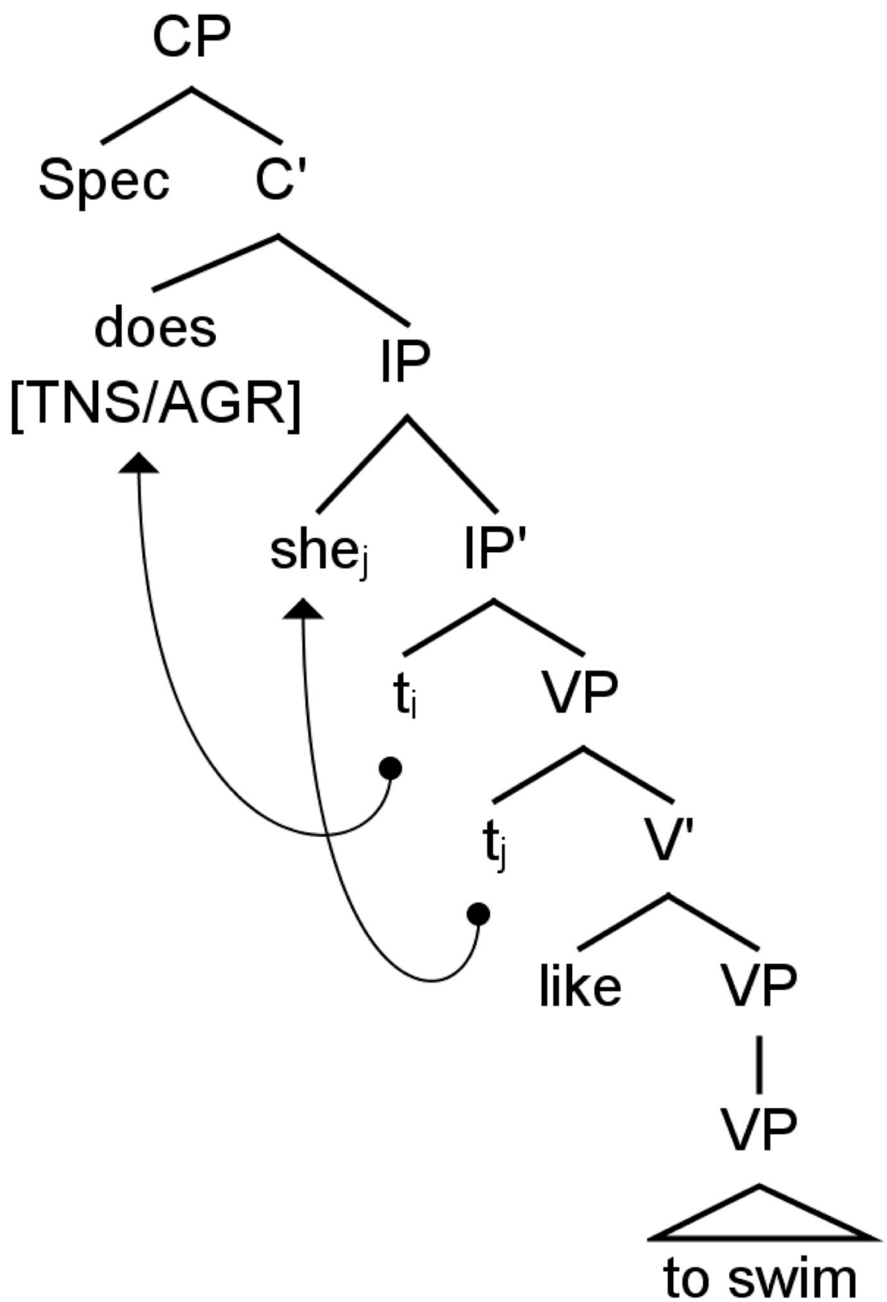

Figure 5.
DO auxiliary yes/no question

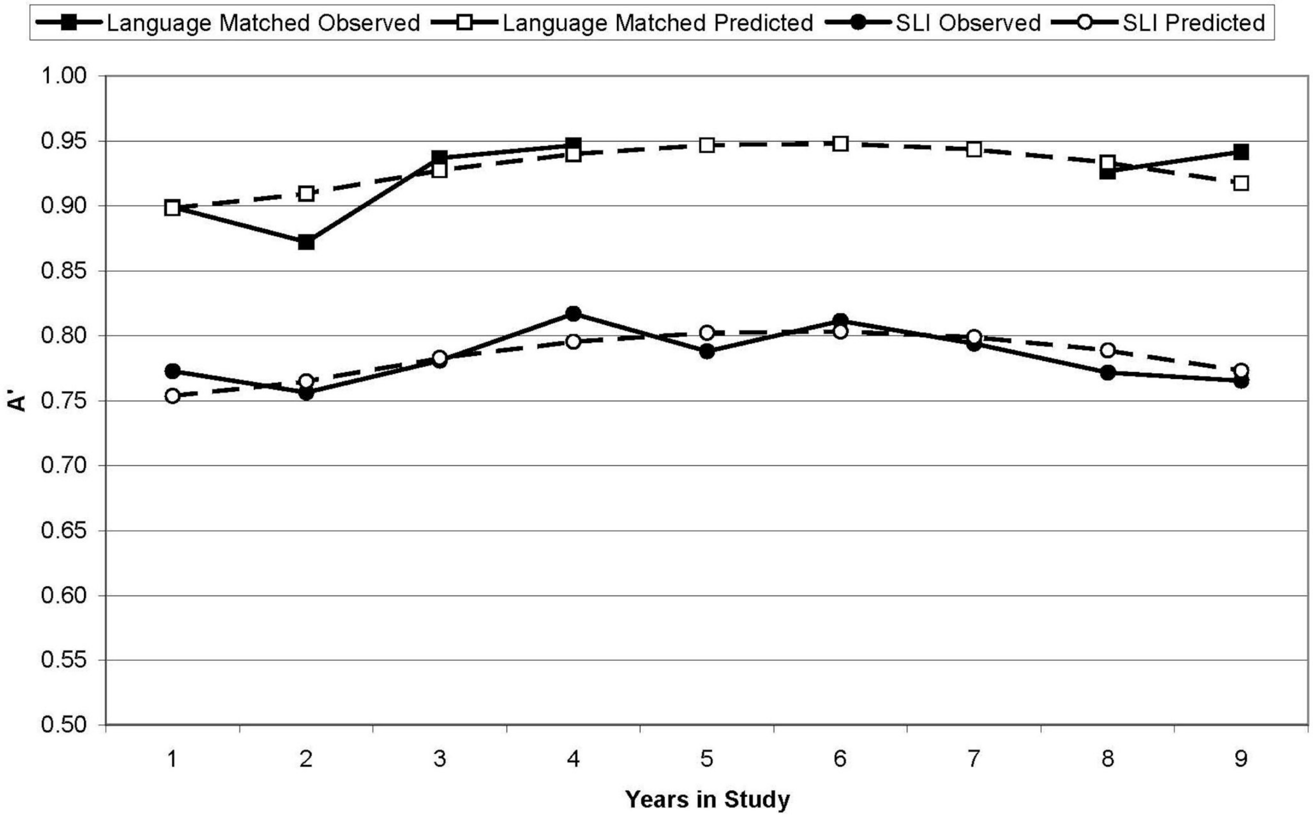

Figure 6.
GJ Ques

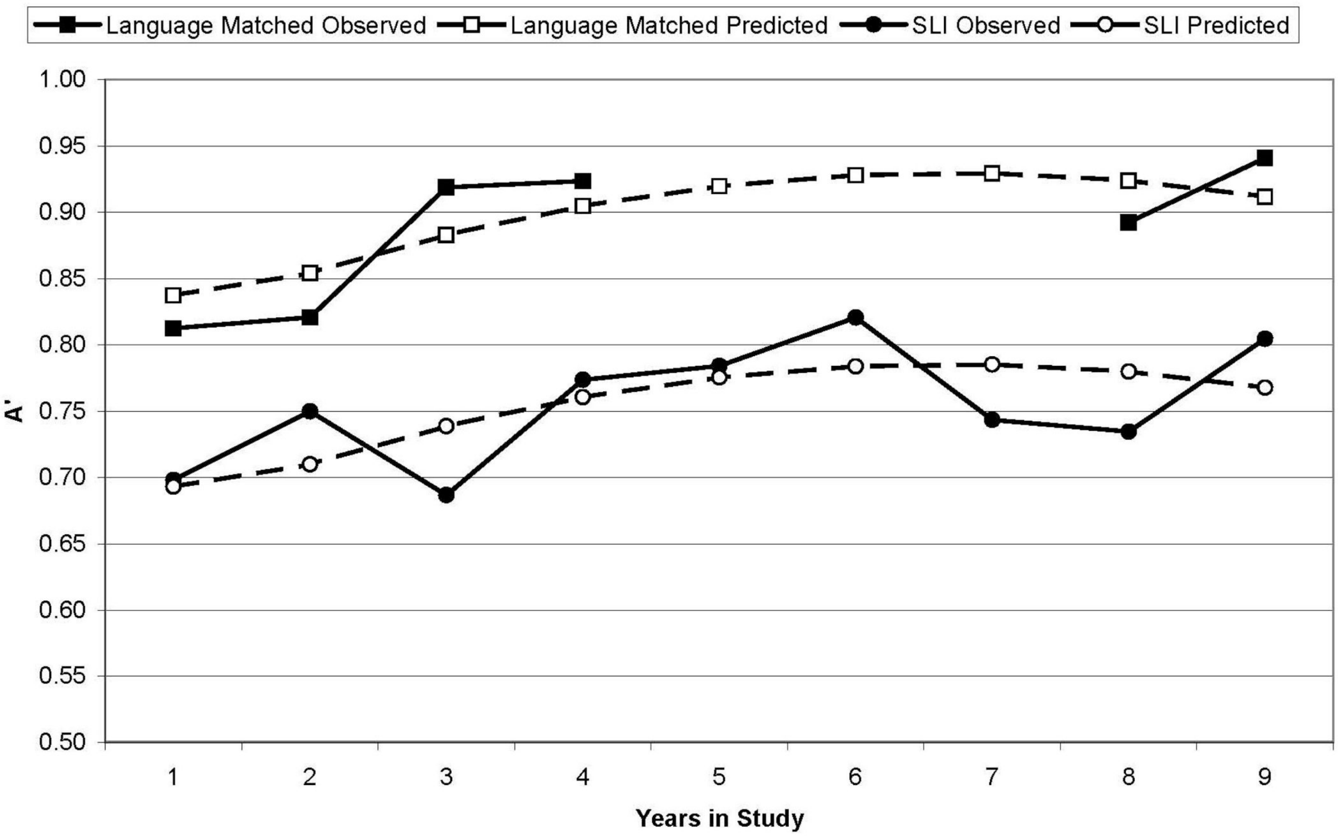

Figure 7.
DO Questions

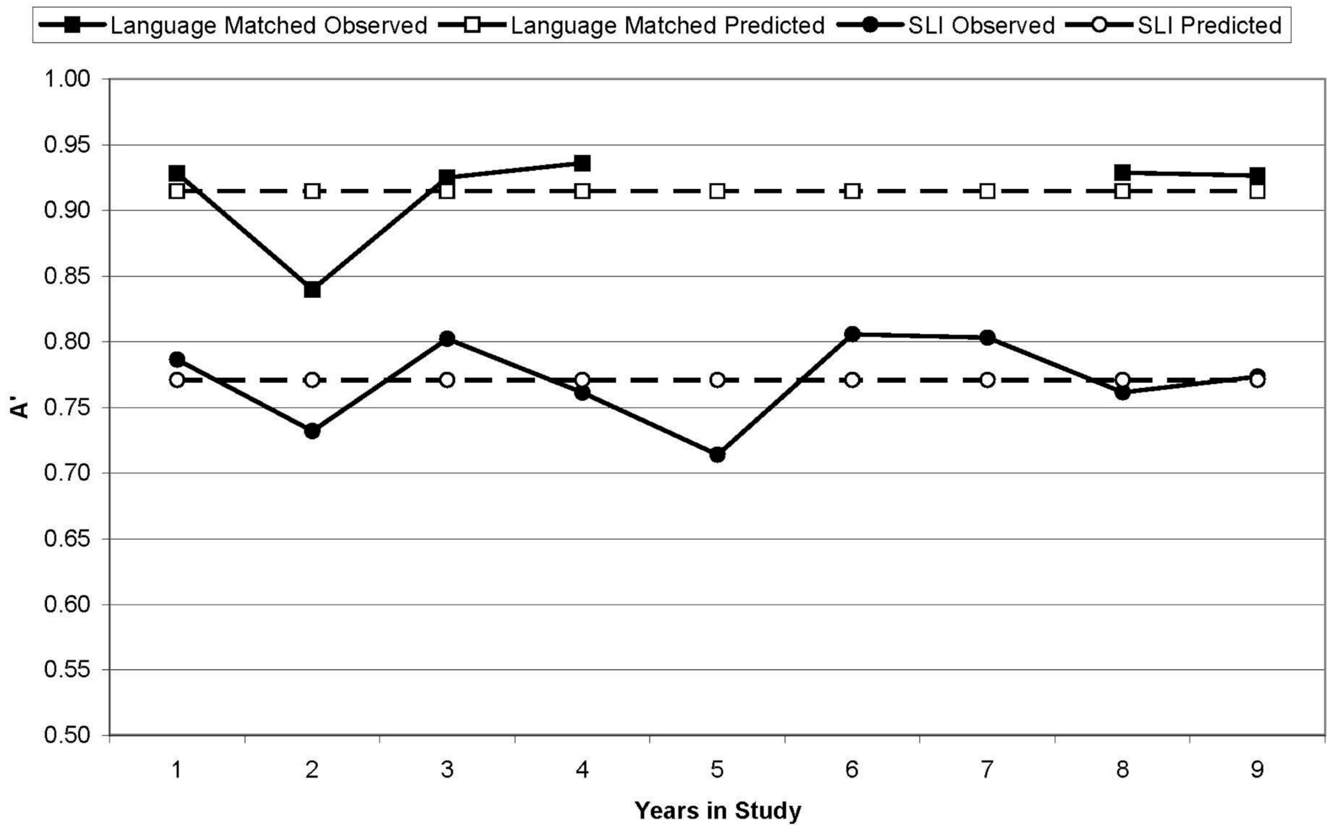

Figure 8.
BE Questions

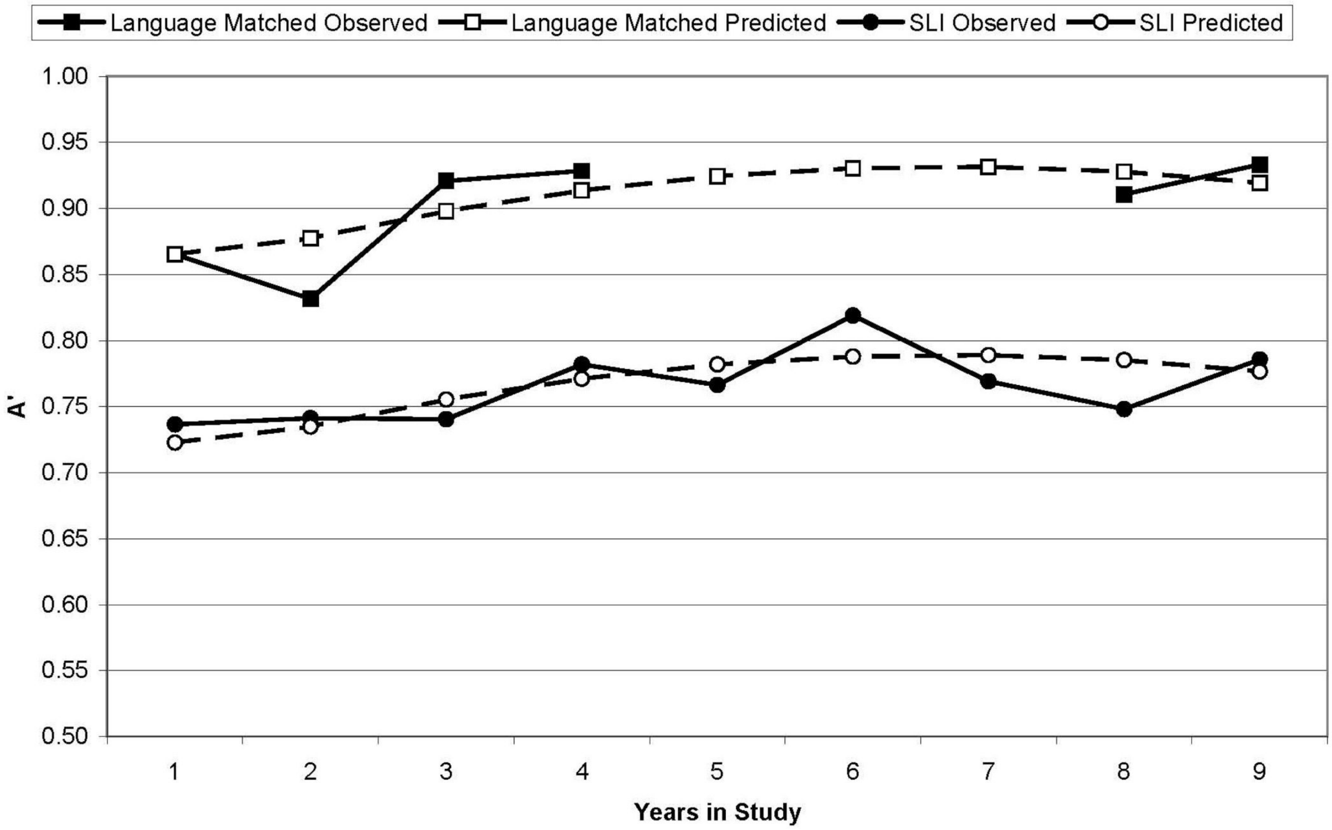

Figure 9.
Wh Questions

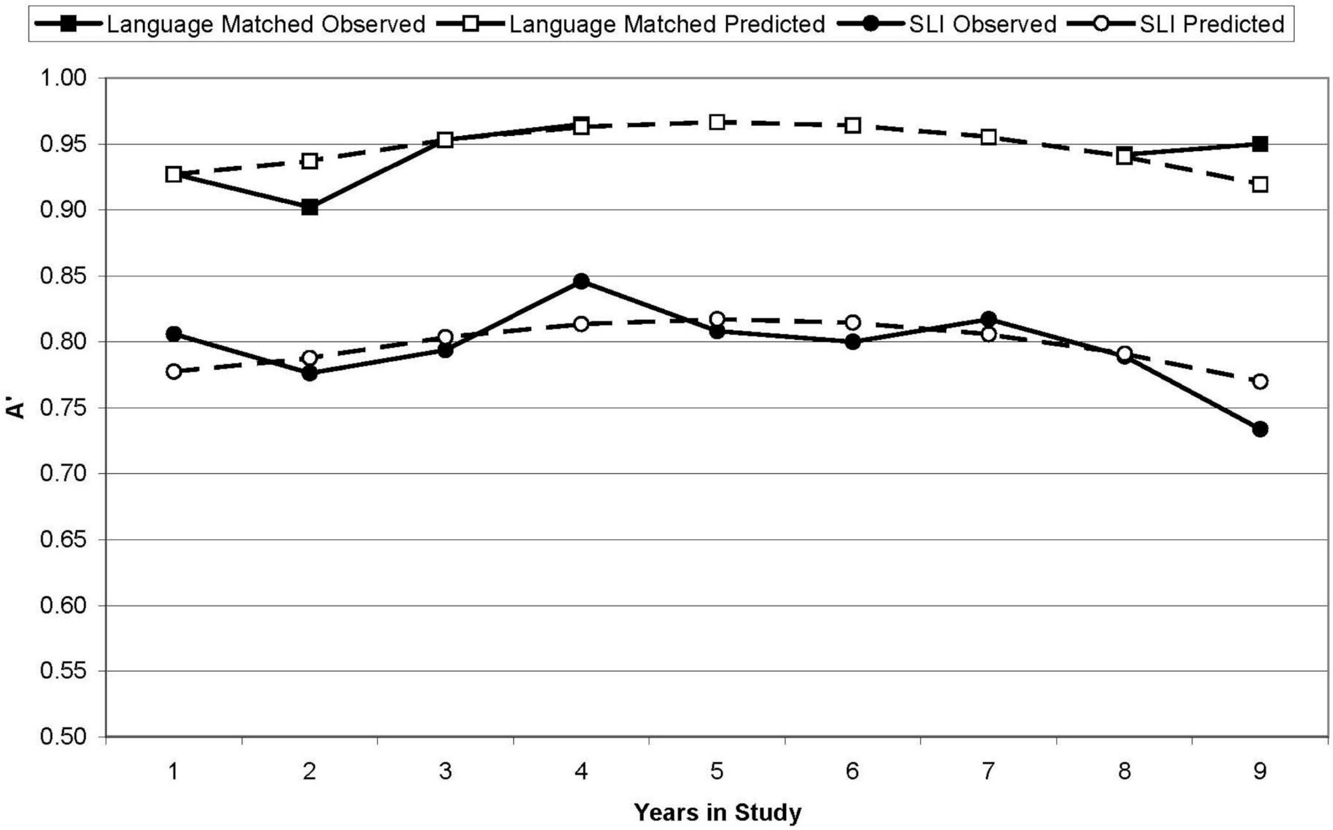

Figure 10.
Yes/No

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Table 1

Age, nonverbal intelligence, vocabulary and omnibus language assessments per group

	Language Matched				Age Controls				SLI			
	First Time		Last Time		First Time		Last Time		First Time		Last Time	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Chronological Age	5;9	0;4	13;1	0;4	7;7	0;4	14,11	0;3	7;8	0;3	15,1	0;3
CMMS Std. Score[1]	109.6	7.1			114.6	14.2			99.8	10.0		
WISC Nonverbal IQ[2]	112.8	15.3	114.6	14.0	113.3	14.0	115.9	14.5	95.1	16.2	96.1	18.4
PPVT-R Std. Score	112.0	11.2	114.1	10.9	116.3	9.2	118.2	9.3	84.4	11.6	85.4	10.5
TOLD-P:2 SLQ	111.4	9.7			108.8	9.1			78.5	8.9		
CELF-3 TLS			108.1	7.67			104.8	11.6			80.0	15.0

[1] CMMS Standard Score for the first time of measurement was given 6 months prior to the grammaticality judgment tasks

[2] WISC Nonverbal IQ test for the first time of measurement was given during the third time of measurement

Table 2

Sample items per condition

BE	
Wh-questions	What is she doing?/What _ he drinking?
Yes/No questions	Is the bear big?/ __ the bear mean?
DO	
Wh-questions	Where does the bug like to sleep?/When _ you like to sleep?
Yes/No questions	Do you like to fish?/ _ she like to swim?

Table 3

Group Means and Standard Deviation for A’ per Time of Measurement

	Year in Study	Language Matched			SLI			
		N	Mean	SD	N	Mean	SD	Cohen's d Effect Size
GJ Ques	1	18	0.90	0.08	20	0.77	0.16	1.69
GJ Ques	2	17	0.87	0.13	19	0.76	0.18	0.88
GJ Ques	3	16	0.94	0.08	19	0.78	0.14	1.93
GJ Ques	4	16	0.95	0.06	19	0.82	0.17	2.29
GJ Ques	5	--	--	--	19	0.79	0.16	--
GJ Ques	6	--	--	--	19	0.81	0.16	--
GJ Ques	7	--	--	--	18	0.79	0.15	--
GJ Ques	8	14	0.93	0.05	17	0.77	0.15	3.17
GJ Ques	9	15	0.94	0.05	14	0.77	0.15	3.41
Wh-	1	18	0.87	0.10	20	0.74	0.18	1.28
Wh-	2	17	0.83	0.16	19	0.74	0.16	0.54
Wh-	3	16	0.92	0.10	19	0.74	0.22	1.86
Wh-	4	16	0.93	0.07	19	0.78	0.19	2.25
Wh-	5	--	--	--	19	0.77	0.17	--
Wh-	6	--	--	--	19	0.82	0.15	--
Wh-	7	--	--	--	18	0.77	0.16	--
Wh-	8	14	0.91	0.07	17	0.75	0.16	2.09
Wh-	9	15	0.93	0.05	14	0.79	0.18	2.74
Yes/No	1	18	0.93	0.08	20	0.81	0.17	1.45
Yes/No	2	17	0.90	0.15	19	0.78	0.24	0.85
Yes/No	3	16	0.95	0.09	19	0.79	0.18	1.85
Yes/No	4	16	0.96	0.07	19	0.85	0.17	1.82
Yes/No	5	--	--	--	19	0.81	0.18	--
Yes/No	6	--	--	--	19	0.81	0.19	--
Yes/No	7	--	--	--	18	0.82	0.16	--
Yes/No	8	14	0.94	0.07	17	0.79	0.17	2.09
Yes/No	9	15	0.95	0.07	14	0.73	0.17	3.12
Be	1	18	0.93	0.08	20	0.79	0.19	1.73
Be	2	17	0.84	0.18	19	0.73	0.19	0.61
Be	3	16	0.93	0.09	19	0.80	0.16	1.41
Be	4	16	0.94	0.07	19	0.76	0.30	2.39
Be	5	--	--	--	19	0.71	0.25	--
Be	6	--	--	--	19	0.81	0.14	--
Be	7	--	--	--	18	0.80	0.15	--
Be	8	14	0.93	0.08	17	0.76	0.20	2.06
Be	9	15	0.93	0.07	14	0.77	0.20	2.23
Do	1	18	0.81	0.18	20	0.70	0.19	0.58
Do	2	17	0.82	0.18	19	0.75	0.17	0.41
Do	3	16	0.92	0.16	19	0.69	0.24	1.49
Do	4	16	0.92	0.08	19	0.77	0.18	1.91
Do	5	--	--	--	19	0.78	0.21	--
Do	6	--	--	--	19	0.82	0.19	--
Do	7	--	--	--	18	0.74	0.19	--
Do	8	14	0.89	0.12	17	0.73	0.19	1.33
Do	9	15	0.94	0.06	14	0.80	0.19	2.21

Table 4

Model parameters for each outcome variable in growth models

Term	GJ Ques Est	GJ Ques SE	WH Est	WH SE	Y/N Est	Y/N SE	DO Est	DO SE	BE Est	BE SE
Intercept	0.754*	0.026	0.723*	0.031	0.777*	0.028	0.69*3	0.034	0.771*	0.027
Linear Time	0.024*	0.008	0.025*	0.009	0.022	0.012	0.035*	0.012		
Quadratic Time	−0.003*	0.001	−0.002*	0.001	−0.003*	0.002	−0.003*	0.002		
SLI vs. LM	0.144*	0.036	0.143*	0.040	0.149*	0.037	0.144*	0.045	0.144*	0.040
Intercept Variance	0.010*	0.003	0.016*	0.005	0.009*	0.003	0.015*	0.004	0.011*	0.003
Intercept-Slope Cov.			−0.001	0.001						
Slope Variance			0.000*	0.000						
Residual Variance	0.008*	0.001	0.009*	0.001	0.014*	0.001	0.016*	0.002	0.018*	0.002
Deviance	−406		−353		−269		−233		−234	
AIC	−402		−345		−265		−229		−230	
BIC	−399		−339		−262		−226		−227	
Intercept R^2 for Group	0.201		0.144		0.351		0.228		0.289	

* $p < .05$