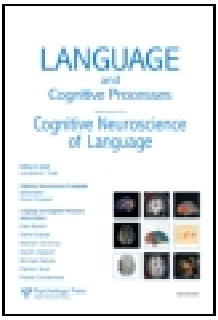

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Production of change-of-state, change-of-location and alternating verbs: A comparison of children with specific language impairment and typically developing children

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Production of change-of-state, change-of-location and alternating verbs: A comparison of children with specific language impairment and typically developing children

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Correct use of verb argument structure relies on accurate verb semantic representations whose formation depends partly on use of reverse linking. We predicted that children with Specific Language Impairment (SLI), who have difficulties with reverse linking, would have inaccurate semantic representations for verbs and hence difficulties with verb argument structure. Fifteen participants with SLI (mean age: 13;1), grammar-matched (GM) (8;3), vocabulary-matched (VM) (8;8), and chronological age-matched (CAM) controls (13;1) described 24 video scenes involving four change-of-state, four change-of-location, and four alternating verbs. All groups performed worse on change-of-state than change-of-location verbs. The participants with SLI performed significantly worse than VM and CAM but not GM controls on change-of-state verbs. However, they did not differ from any group on alternating or change-of-location verbs. We concluded young people with persistent SLI have difficulties with aspects of verb argument structure into their teenage years.

Keywords: Verb argument structure; Specific language impairment.

INTRODUCTION

Verb argument structure is at the interface of syntax and semantics and includes information about which participants in an event are obligatorily expressed and the syntactic positions in which they should appear. Thus, some verbs can only appear in particular syntactic constructions. Consider for example the verbs *eat* versus *devour*

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and *pour* versus *fill*: *eat* does not require a direct Object (*the man is eating*) whereas *devour* does (**the man is devouring* is ungrammatical); for *pour* and *fill* the participants need to appear in different syntactic positions depending on which verb they follow, so *the girl is pouring the water in the cup* is acceptable whereas **the girl is filling the water in the cup* is not because *the cup* needs to appear in the direct Object position rather than *the water*. Several researchers have proposed that in order to use verb argument structure accurately, children need to have detailed semantic representations of verbs (Gropen, Pinker, Hollander, & Goldberg, 1991b; Pinker, 1989). Others claim that for such detailed semantic representations to be learned in the first place, syntax plays a crucial role (Fisher, Hall, Rakowitz, & Gleitman, 1994; Gleitman, 1990; Gillette, Gleitman, Gleitman, & Lederer, 1999). Thus, children with language impairments affecting semantics and/or syntax are likely to make more errors in the production of verb argument structure than typically developing (TD) children with better semantic and/or syntactic knowledge.

Children with Specific Language Impairment (SLI) have difficulties in acquiring language despite adequate intelligence, hearing, physical development, and exposure to language. SLI is estimated to affect approximately 7% of kindergarten children (Tomblin et al., 1997), and for some children, language impairment persists into early adolescence (Beitchman, Wilson, Brownlie, Walters, & Lancee, 1996; Botting, Faragher, Simkin, Knox, & Conti-Ramsden, 2001) and beyond into late adolescence (Conti-Ramsden, 2008) and adulthood (Clegg, Hollis, Mawhood, & Rutter, 2005; Mawhood, Howlin, & Rutter, 2000). Persisting language impairments have negative effects on children's educational achievements (Conti-Ramsden, 2008; Dockrell & Lindsay, 2008; Mawhood et al., 2000) and social adjustment (Clegg et al., 2005; Conti-Ramsden, 2008; Howlin, Mawhood, & Rutter, 2000), although a recent study reveals better social outcomes than earlier studies (Carroll & Dockrell, 2010).

Given the long-term impact of language impairments on educational and social development, it is important to study children with SLI of all ages, not only young children. There are surprisingly few studies of older children but these studies have found that impairment in specific areas of language remains even when compared with controls matched on other language abilities. These areas are: use of tense and agreement (e.g., Leonard, Bortolini, Caselli, McGregor, & Sabbadini, 1992; Rice, Hoffman, & Wexler, 2009; van der Lely & Ullman, 2001), comprehension and production of syntax (e.g., Bishop, 1979; Leonard, 1995; van der Lely, 2005), and use of reverse linking or syntactic bootstrapping (e.g.,O'Hara & Johnston, 1997; Shulman & Gudeman, 2007; van der Lely, 1994). This study focuses on the possible consequences of difficulties with reverse linking/syntactic bootstrapping, particularly considering change-of-state verbs.

Reverse linking and change-of-state versus change-of-location verbs

"Reverse linking" (Pinker, 1989, 1994), or "syntactic bootstrapping" (Fisher et al., 1994; Gleitman, 1990), is the process whereby we can use the syntactic construction in which a verb appears as a cue to the verb's meaning. Thus for an unfamiliar verb, we can work out whether it includes the meaning *X acts* or *X acts on Y* or *X causes Y to move to Z*, by noting the number of arguments appearing with the verb (Fisher, 1996, 2002; Naigles, 1990; Naigles & Kako, 1993). Thus, a verb appearing with just a Subject (e.g., *the boy zaigs*) is likely to describe X acting; whereas a verb appearing with a Subject, direct Object and Prepositional Phrase (e.g., *the boy zugs the girl to the lady*) is likely to describe X acting on Y, causing Y to move to Z. Reverse linking also has a role in refining the semantic representations of verbs in terms of which referent is the Patient. The assignment of arguments to the direct Object position distinguishes change-of-state and change-of-location verbs. Consider, for example *fill* versus *pour:* for *fill*, the Noun Phrase (NP) in the direct Object position changes state (becomes full) (e.g., *the girl is filling THE CUP with water*) whereas, with *pour*, it changes location (e.g., *the girl is pouring THE WATER into the cup*). This reflects an underlying difference in the semantics of these verbs where the focus of the meaning of *fill* is on the "Goal" whereas the focus for *pour* is on the "Theme" which changes location. According to Pinker (1989) and Jackendoff (1990), this focus is captured by the concept of a "Patient". The Patient is "affected" by the action, regardless of whether it is also a Theme or Goal. Furthermore, Pinker (1989) and Jackendoff (1990) propose a set of linking rules which link verb semantics to syntactic structure, and whereby the Patient is linked to the direct Object position. Children use these linking rules in a process Pinker (1989) calls "forward linking" to work out how to link verbs' arguments to structural positions in a sentence, such as the Agent to the Subject position and Patient to the Object position. However, children can only do this if they know the semantics of verbs (in terms of which arguments have the Agent and Patient roles), without which errors may occur. For linking the correct referent to the direct Object position, Gropen et al. (1991b) propose an "Object affectedness rule" whereby "an argument is encodable as the direct object of a verb if its referent is specified as being affected in a specific way in the semantic representation of the verb" (p. 118). Thus, such knowledge is needed in order to use verbs accurately in sentences.

Linking errors (e.g., "Can I fill some salt into the bear?"(Bowerman, 1982), where the Theme appears in the direct Object position instead of the Goal), presumably occur because the child thinks the Theme is the Patient rather than the Goal. Such errors are found in TD children from 3 to 6 years of age and are more common and persist longer with change-of-state verbs (Bowerman, 1982; Gropen et al., 1991b). The evidence suggests that children are more sensitive to the meaning components associated with motion than with changes of state. Indeed Gentner (1978) found that children aged 5–7 years were not sensitive to the change of state component of the verb *mix* (i.e., that the substance must increase in homogeneity). They were just as likely to accept as an example of "mixing" an event in which the homogeneity did not change (e.g., cream being stirred) as one in which it did (e.g., water and salt being mixed together). In contrast, they rejected events as examples of "stirring" where the appropriate action (rotary motion) did not occur. Therefore Gentner (1978) concluded that "children appear to learn the action components of the mixing verbs before they learn the change of state components" (p. 994). Gropen et al. (1991b) found that for the verb *fill*, some children (particularly those aged 4;6–5;11) were biased towards the manner meaning components rather than the change-of-state (e.g., when asked to choose which of two pictures best showed *filling*, they tended to choose the picture showing a pouring manner without a full endstate, over the picture showing a full endstate with no pouring manner). However, the relative sensitivity to changes of state may vary with language ability. Kelly and Rice (1994) showed children with SLI and TD children two video scenes, the first of a single inanimate object spontaneously changing state in a fairly dramatic way (changing color or shape) and the second of the same object moving in a particular way. They then asked them to point to the scene that depicted a novel verb, thus indicating their initial preferred interpretation. They found that TD children aged 4;6–5;8 preferred to associate the novel verbs with the event where the object changed state rather than moved in a particular way. However, the majority of children with SLI of the same age and younger TD children (aged 2;7–3;11) had no such preference; indeed those who did have a preference preferred the motion events.

Any bias towards picking up the manner components of meaning and lack of sensitivity to changes of state would particularly affect verbs such as *fill* and *cover*, which involve both motion and a change of state. Given that children with SLI have fewer preferences for changes of state than TD peers even for simple, salient changes of state (Kelly & Rice, 1994), it is likely that they will be even less sensitive to changes in state when they occur together with changes in location. Therefore, we predict that younger TD children and children with SLI will make more errors with change-of-state verbs when compared with change-of-location verbs and verbs that combine changes of state and location would be particularly prone to errors. However, errors on change-of-state verbs should reduce as children become more competent in their use of reverse linking because this enables them to revise imprecise semantic representations.

Reverse linking in SLI

A few studies have investigated the ability of children with SLI to use reverse linking. Studies carried out by van der Lely (1994), and later by O'Hara and Johnston (1997) revealed that when novel verbs are presented in transitive, transitive locative or dative sentences, children with SLI are significantly worse than younger language controls at using reverse linking to infer which NP has which role in the sentence. However, some studies have found that children with SLI can use information regarding the number of NPs uttered in a sentence with known (Hoff-Ginsberg, Kelly, & Buhr, 1996) and novel verbs (Oetting, 1999) to infer something about the likely meaning of the verb with respect to whether it has a transitive-causative or intransitive-stative meaning. However, if more precise knowledge of syntactic structure is required to distinguish causative and stative meanings, such as when the number of NPs are the same (e.g., "the dogs are kolzim the cats" vs. "the dogs and cats are kolzim"), children with SLI perform at chance (Shulman & Gudeman, 2007). Thus, while some studies (e.g., Hoff-Ginsberg et al., 1996; Oetting, 1999) show that children with SLI can use sentences to identify the correct number of participants, those by van der Lely (1994), O'Hara and Johnston (1997), and Shulman and Gudeman (2007) indicate that they cannot reliably use reverse linking to assign the correct roles to the correct referents.

The ways in which difficulties with reverse linking may affect the production of verb argument structure have not been explicitly studied to date and form the focus of the current study. If children with SLI have more difficulties with reverse linking than TD children, we predict that they would rely more on observational and conceptual cues (such as the salience of changes in the different participants involved in an event) that are outside the linguistic system per se and less on syntactic cues (such as which participant appears in the direct Object position). Therefore we hypothesise they will be less able to use syntax to overcome their already reduced sensitivity to changes in state compared with TD children (cf. Kelly & Rice, 1994) and consequently will make more errors on change-of-state verbs than TD children.

Locative alternation

Errors on change-of-state verbs could occur for reasons other than (or in addition to) difficulties with reverse linking. Overgeneralisation of the locative alternation could also lead to errors. Verbs undergoing the locative alternation (e.g., *pack* and *spread*) can appear both in the change-of-location (e.g., *he is packing his clothes into* *his bag, she is spreading butter on the bread*) and change-of-state constructions (e.g., *he is packing his bag with clothes*, *she is spreading the bread with butter*), thus overgeneralisation of the locative alternation could result in use of change-of-state verbs (e.g., *fill*) in both the correct (change-of-state) and incorrect (change-of-location, *she's filling water in the cup*) constructions. Bowerman's (1982) daughters and the children in Gropen et al.'s (1991b) study showed this pattern for several change-of-state verbs. Thus, errors on change-of-state verbs could arise due to overgeneralisation of the locative alternation, and/or due to difficulties with reverse linking. The locative alternation has not been previously studied in children with SLI, but a study of the causative alternation (i.e., verbs which alternate between unaccusative and transitive constructions, e.g., *the glass broke* vs. *the girl broke the glass*) found children with SLI did not differ from language or CAM controls in their ability to use (or restrict overgeneralisation of) the causative alternation (Loeb, Pye, Richardson, & Redmond, 1998).

Current study

In this study, we investigated four change-of-state and four change-of-location verbs and four verbs which can undergo the locative alternation. We asked the participants to describe two video scenes for each verb. If a participant has difficulties with the task demands (i.e., has general processing deficits), they would be likely to make errors on all verbs. The alternating verbs should reveal any general preferences for the change-of-state versus change-of-location construction. If a participant overgeneralises the locative alternation to nonalternating verbs, they would use both the change-of-state (*she's filling/pouring the cup with water*) and change-of-location constructions (*she's filling/pouring water into the cup*). If they have difficulties with reverse linking and hence are more reliant on observational cues such as the salience of changes undergone by participants in the event, they may be particularly poor with change-of-state verbs. They may think the Theme, undergoing a salient change of location (rather than the Goal, undergoing a less salient change of state) is the "affected object" (i.e., the Patient) and hence would use only the (incorrect) change-of-location construction (e.g., *she's filling water into the* cup) for change-of-state verbs.

We compared a group of participants with SLI with TD participants matched on three different criteria. Our first control group was matched on chronological age and therefore we hypothesised similar opportunities to hear verbs and observe the situations in which they are used. The second group was matched on receptive vocabulary and was thus likely to be most similar to the children with SLI in terms of lexical development. The third group was matched on sentence comprehension and was therefore likely to be at the most similar level of grammatical development. We also carried out the task with adults to ensure that we had correctly classified the change-of-location and change-of-state verbs as nonalternating verbs for Southern British English.

We predicted that difficulties with reverse linking would result in the participants with SLI in our study making more errors on change-of-state verbs than TD chronological age and possibly also vocabulary controls (who have similar lexical levels but possibly better grammatical and hence reverse linking abilities), but would probably not make more errors than their sentence comprehension controls (who are likely to have similar grammatical and reverse linking abilities). If the participants with SLI also have a general processing deficit and therefore difficulty with the task demands, we predict they would be poorer than TD controls not only on change-of-state verbs, but also on change-of-location verbs. A preferred construction for the alternating verbs should indicate any general preference for one construction over the other.

METHODS

Participants

Fifteen participants (four girls and 11 boys) with persisting SLI (mean age: 13;1 years, range: 11;0–14;11), 15 CAM controls (mean age: 13;1, range: 11;3–14;10), 15 vocabulary-matched (VM) controls (mean age: 8;8, range: 5;10–12;2), and 15 GM controls (mean age: 8;3, range: 5;4–11;3) participated in the study. The participants with SLI were all attending a specialist school in the UK which caters for specifically for children with primary language impairments. All children in the school who were aged between 11 and 15 and met the following criteria were recruited: (1) receptive and expressive language difficulties (at least −1.5 *SD* below the mean) as measured on the Clinical Evaluation of Language Fundamentals (CELF-3 UK, Semel, Wiig, & Secord, 1995), (2) typical nonverbal performance abilities (not more than −1 *SD* below the mean) on the mean of Matrices and Pattern construction from the British ability scales II (BAS-II, Elliot, Smith, & McCulloch, 1996), (3) intelligible spontaneous speech (assessed informally), (4) no hearing impairment, neurological dysfunction, structural abnormalities or diagnosis of autism or Asperger's syndrome stated in their medical records, and (5) written consent given by the parents.

The TD controls were recruited from six mainstream schools in the same geographical region as the school for pupils with SLI. No TD controls had identified special educational needs or English as an additional language. They scored within normal limits on both language abilities and performance IQ (above −1 *SD*). As for the children with SLI, performance IQ was measured using the mean of the Matrices and Pattern construction from the BAS-II. The tests used to measure language were the Formulated Sentences subtest of the CELF-3, the British picture vocabulary scale—II (BPVS-II, a multiple-choice vocabulary comprehension test, Dunn, Dunn, Whetton, & Burley, 1997) and the Test of reception of grammar (TROG, a multiple-choice sentence comprehension test, Bishop, 1989). Each language control child was individually matched to a child with SLI on the basis of performance IQ (within one standard deviation) and either the BPVS ("vocabulary-matched (VM) controls": raw score within 3 points) or the TROG ("grammar-matched (GM) controls": matched on exact raw score). They were also required to score within the average range for their age (i.e., not more than 1 *SD* above or below the mean) on the test with which they were matched to the participants with SLI. The CAM controls were individually matched to the participants with SLI by age (within 3 months) and also scored within the normal range (i.e., within one standard deviation from the mean) on the BAS-II (performance IQ).[1] The scores for the four groups on the matching criteria are shown in Table 1.

[1] One age control achieved a z-score of –1.15 on the BAS, but showed no language difficulties, was matched to the child with SLI with the lowest z-score (-0.95) on the BAS and was exactly the same age; he was therefore considered to provide a good match.

TABLE 1
Mean (SD) plus ranges on matching criteria (raw scores for BPVS and TROG, z-scores for BAS, years; months for age)

Test	*SLI*	*GM controls*	*VM controls*	*CAM controls*
BPVS	91.07 (14.24)	87.00 (16.17)	90.87 (13.84)	121.87 (13.45)
	63 to 115	58 to 120	65 to 112	99 to 149
TROG	15.40 (2.32)	15.40 (2.32)	17.00 (1.69)	18.33 (0.90)
	9 to 18	9 to 18	15 to 19	17 to 20
BAS	−0.04 (0.82)	0.33 (0.60)	0.53 (0.68)	0.06 (0.66)
	−0.95 to 1.55	−0.60 to 1.25	−0.55 to 1.95	−1.15 to 1.60
Age	13;1 (1;3)	8;3 (1;8)	8;8 (1;6)	13;1 (1;3)
	11;0 to 14;11	5;4 to 11;3	5;10 to 12;2	11;3 to 14;10

In order to validate the matching procedures, the groups were compared on age, performance IQ, and raw scores of the language tests used for matching. We found a significant effect of chronological age, $F(3, 56) = 51.18$, $p < .001$, $\eta p^2 = 0.73$, where the participants with SLI did not differ from the CAM controls ($p = 1.0$, $d = 0.004$), but differed significantly from both GM ($p < .001$, $d = 3.35$) and VM controls ($p < .001$, $d = 3.03$). The latter two groups did not differ from each other ($p = 1.0$, $d = 0.3$), but did differ from the CAM controls (TROG: $p < .001$, $d = 3.34$; BPVS: $p < .001$, $d = 3.03$). The four groups showed no difference in their performance IQ as measured on the BAS, $F(3, 56) = 2.14$, $p = .11$, $\eta p^2 = 0.10$.

The four groups differed significantly on the BPVS raw score, $F(3, 56) = 18.874$, $p < .001$, $\eta p^2 = 0.50$. Post-hoc tests showed the participants with SLI did not differ from either their VM ($p = 1.0$, $d = 0.01$) or GM controls ($p = 1.0$, $d = 0.28$) but scored significantly lower than their CAM controls ($p < .001$, $d = 2.13$), as did both the GM ($p < .001$, $d = 2.41$) and VM controls ($p < .001$, $d = 2.15$) who did not differ from each other ($p = 1.0$, $d = 0.27$).

The four groups also differed significantly on the TROG raw score ($\chi^2(3) = 23.46$, $p < .001$).[2] Post-hoc tests showed the participants with SLI did not differ from either their GM ($W = 232.5$, $n_1 = 15$, $n_2 = 15$, $p = 1.0$) or VM controls ($W = 74.5$, $n_1 = 15$, $n_2 = 15$, $p = .11$), but did differ from their CAM controls ($W = 130$, $n_1 = 15$, $n_2 = 15$, $p < .001$). The GM controls differed from the CAM controls ($W = 130$, $n_1 = 15$, $n_2 = 15$, $p < .001$) whereas the VM controls did not ($W = 185.9$, $n_1 = 15$, $n_2 = 15$, $p = .05$; the Bonferroni corrected significance value is $0.05/6 = 0.008$). Again, the GM and VM controls did not differ significantly from each other ($W = 194.5$, $n_1 = 15$, $n_2 = 15$, $p = .11$).

We also carried out the task on 10 adults (five aged 25–50, and five aged 50–75) who lived in the same geographical region as the school attended by the child/adolescent participants.

Stimuli, procedure and scoring

The stimuli were part of a larger study of verb argument structure in SLI. The full test consisted of 72 video scenes (each 5 seconds on average) showing adults and children carrying out common actions with everyday objects. However, in this paper we report only on a subset[3]; those verbs which exclusively use either the change-of-state

[2] The non-parametric Kruskal-Wallis and Wilcoxon signed ranks tests were used because the data for the SLI and language control groups were not normally distributed (the SLI and GM groups were positively skewed, while the VM controls showed a bi-modal distribution).

construction (*fill, build, cover*, and *rob*) or the change-of-location construction (*pour, put, spill*, and *steal*) or those which alternate between these two forms (*pack, spread, peel*, and *wipe*—the latter two of which involve removing an item from a location). Two video scenes were shown for each verb; these are described in Appendix 1. The stimuli were recorded by the first author and piloted on three TD children (aged 6–8 years) and four adults to ensure that the events were correctly interpreted. New scenes were recorded where there was any sign of confusion.

The order of the video scenes was randomised but then checked by hand to ensure that there was a gap of at least two items between different scenes involving the same target verb. All participants watched the scenes in the same order. For each scene, the participant was shown the video clip once while the experimenter provided the target verb in the gerund: "this is *VERB*ing". The clip was then repeated and the participant was asked: "What is happening?" Four practice items at the beginning of the test were used to train the participant to use the target verb in a complete sentence. These followed the same format as the test items and used the verbs *ringing*, *dropping*, *walking*, and *telling* for scenes showing a lady ringing a bell, a girl dropping from a climbing frame, a man walking to a shed and a lady telling a story to a little girl. These items required a varying number of arguments and the participants were encouraged to include a subject and any obligatory postverbal arguments, but were not required to produce optional arguments. Responses were recorded on a DAT tape recorder (TCD-D8) using an external Sony Electret condenser microphone and transcribed later.

Some participants omitted obligatory arguments (usually direct objects or prepositional phrases) and these errors were analyzed elsewhere (Ebbels, 2005). For the purposes of this paper, the responses were coded according to whether the direct Object changed state or location. Hence omissions of Prepositional phrases were ignored, but failure to use a direct Object meant the response could not be coded and was therefore recorded as missing data. The first author carried out all the testing, transcription, and scoring. The third author also coded the responses of 12 (20%) randomly selected participants (four with SLI and eight controls). The Kappa coefficient for inter-rater agreement was .975; disagreements were resolved through discussion.

RESULTS

Alternating verbs

We first consider the participants' willingness to use alternating verbs in both constructions associated with the locative alternation aiming to establish whether they have any general or verb-specific preferences for a particular construction and whether the participants with SLI differ from their controls. Table 2 shows the mean use of the change-of-state construction for the locative alternation, for all groups, including the adults. Equal use of the two possible constructions for each alternation would result in a score of 0.50. Table 2 shows the overall mean and standard deviation for

[3] The other scenes (reported in Ebbels, 2005) investigated the dative and causative alternations. For the dative alternation, this involved the alternating verbs *pass* and *give*. Investigation of the causative alternation involved verbs which are obligatorily intransitive (two unergative: *jump* and *laugh* and two unaccusative verbs: *bubble* and *fall*) and verbs which can undergo the causative alternation (in the transitive form two verbs involve changes of location: *hang* and *roll* and two involve changes of state: *melt* and *open*).

TABLE 2
Proportion of participants using change-of-state construction with alternating verbs for individual video scenes (described with change-of-state construction) and overall

	SLI	*GM*	*VM*	*CAM*	*Adults*
Man packing a suitcase (with clothes)	0.27	0.27	0.60	0.73	0.90
Girl packing bag (with jumpers)	0.47	0.33	0.60	0.73	0.80
Mean	0.37	0.30	0.60	0.73	0.85
Man spreading toast (with butter)	0.00	0.00	0.00	0.00	0.20
Lady spreading bread (with choc spread)	0.20	0.13	0.07	0.13	0.30
Mean	0.10	0.07	0.03	0.07	0.25
Lady peeling apple	1.00	0.73	1.00	0.93	1.00
Man peeling a bannana	0.93	0.93	0.93	1.00	1.00
Mean	0.97	0.83	0.97	0.97	1.00
Man wiping table	1.00	0.93	0.93	1.00	0.90
Man wiping his face	0.93	1.00	1.00	1.00	1.00
Mean	0.97	0.97	0.97	1.00	0.95
Overall mean (SD)	0.60 (0.41)	0.54 (0.40)	0.64 (0.41)	0.69 (0.40)	0.76 (0.32)

production of the change-of-state construction, and for the individual verb scenes. It can be seen that there is a considerable variation in responses for the different verbs, resulting in large standard deviations and non-normally distributed data, therefore we used nonparametric statistics in the analyses.

First we compared the overall performance of the participants with SLI and their TD controls. The control groups were not compared with each other because for this study, each group's performance was only relevant in relation to that of the participants with SLI. Friedman's related samples test showed that the four groups differed significantly ($\chi^2(3) = 10.7$, $p = .01$). Planned comparisons between the participants with SLI and each control group using Wilcoxon signed ranks tests (with Bonferroni corrected $\alpha = 0.017$) showed the participants with SLI did not differ from their GM ($p = .019$), VM ($p = .42$) or CAM controls ($p = .26$).

Given that both the change-of-state and change-of-location constructions are correct with these alternating verbs, it is of interest whether the participants performed similarly to or differently from adults. Therefore a Friedman's related samples test compared five groups: the four previous groups and the adults. This showed that the five groups differed significantly ($\chi^2(4) = 15.2$, $p = .03$). Planned comparisons between the adults and each of the child/adolescent groups using Wilcoxon signed ranks tests (with Bonferroni corrected $\alpha = 0.012$) showed the adults differed significantly from the GM controls ($p = .005$), using significantly more change-of-state constructions. Once a Bonferroni correction was applied the adults did not differ significantly from the other three groups (SLI: $p = .019$; BPVS: $p = .012$; CAM controls: $p = .033$).

Inspection of the data for individual verbs showed that all groups used the verbs involving removal of an item from another item (*peel* and *wipe*) predominantly in the change-of-state construction. For *pack*, the SLI and GM groups seemed to prefer the change-of-location construction, while the VM and CAM controls and particularly the adults preferred the change-of-state construction. For *spread*, all groups preferred the change-of-location construction, but the adult preference was less strong. In general, the adults appeared to show a stronger preference for use of the change-of-state construction than all four child/adolescent groups.

Nonalternating verbs

First we checked the adult data to ensure that the nonalternating verbs had been correctly characterised as nonalternating change-of-state or change-of-location verbs. We found that with the verb *rob*, several adults made "errors". Inspection of individual "error" patterns showed that one adult used the change-of-location construction (e.g., "the man is robbing the bag from the lady") for both scenes. Five adults used the change-of-location construction for one scene and the change-of-state construction for the other, suggesting that they viewed *rob* as an alternating verb. Only four adults (three in the older and one in the younger age group) used the change-of-state construction exclusively. This calls into question its status in the local dialect as a verb which can only be used in the change-of-state construction (as suggested by Pinker, 1989 and Jackendoff, 1990). Therefore, we excluded the data for this verb from further analyses. The adults did not make any "errors" with any of the other verbs in the test, suggesting they viewed *pour*, *put*, *spill*, and *steal* as nonalternating change-of-location verbs and *fill*, *build*, and *cover* as nonalternating change-of-state verbs.

On change-of-location verbs, four participants (one SLI, one GM and two VM controls) each made one error[4]; all the rest achieved 100% correct. Due to the ceiling effects with virtually no variability on this group of verbs, we used nonparametric Kruskal-Wallis tests which revealed no significant difference in performance between the four groups of participants on this group of verbs ($\chi^2(3) = 2.04$, $p = .90$). All four participant groups made more errors on change-of-state verbs (producing errors such as "she was covering chocolate spread on the bread" and "the girl is filling orange juice"). Table 3 shows the mean proportion of participants from each group who used the correct construction for the change-of-state verbs. The SLI group had lower scores on change-of-state verbs than all three of the control groups.

Ceiling effects were evident in the three control groups, therefore nonparametric statistics were used to analyze any differences between the participant groups on the change-of-state verbs. A Kruskal-Wallis test revealed a significant difference between the groups ($\chi^2(3) = 14.02$, $p = .002$). Three planned comparisons compared the SLI group with each of the three control groups (with Bonferroni corrected $\alpha = 0.017$). Planned Wilcoxon signed ranks tests showed the participants with SLI differed significantly from their VM ($W = 155.5$, $n_1 = 15$, $n_2 = 15$, $p = .001$) and CAM controls ($W = 159.5$, $n_1 = 15$, $n_2 = 15$, $p = .001$), but the difference with their GM controls failed to reach significance when the Bonferroni correction was applied ($W = 179.5$, $n_1 = 15$, $n_2 = 15$, $p = .02$).

TABLE 3
Mean (SD) proportion of participants using the correct construction for change-of-state verbs

SLI	*GM*	*VM*	*CAM*
0.83 (0.12)	0.92 (0.13)	0.96 (0.05)	0.95 (0.05)

[4]The three control participants all made an error on the same scene; a girl pouring orange juice into a cup. Two used the change-of-state construction producing a sentence similar to "she poured the glass with orange". The other said "she's pouring a jug into a cup", using the correct position for the cup (in the prepositional phrase), but using the Source in the direct Object position. The SLI participant made an error

Thus, the participants with SLI achieved significantly lower scores on change-of-state verbs than their VM and CAM controls. They did not differ significantly from their GM controls once a Bonferroni correction was applied. However, they did not have any more difficulties with change-of-location verbs than any TD control group.

Developmental trajectories

We next considered the developmental trajectories for the change-of-state verbs for both the TD and SLI participants, as recommended by Thomas et al. (2009). Following Thomas et al. (2009), we first established whether a linear function provided a significantly good fit to the data. If it did not, we tried other functions. Then we used Akaike's information criterion and extra sum-of-squares test for comparing nested models (Motulsky & Christopoulos, 2004) to see which function provided the best fit and then used the line of best fit in the associated Figures.

The developmental trajectory for the TD participants for the proportion of change-of-state verbs used in the correct construction plotted against chronological age is shown in Figure 1. Twenty-eight of the 45 controls (62%) performed at ceiling, with another 13 (29%) performing near ceiling (above 0.88). Ceiling and near ceiling performance was found from 77 months upwards for some participants. Performance below 0.88 (between 0.5 and 0.86) was shown by six TD participants only. These ranged in age from 64 to 104 months. Thus, the TD data show variability (including some ceiling performance) from 64 to 104 months, followed by near ceiling performance for the remainder of the age range; however, ceiling performance is

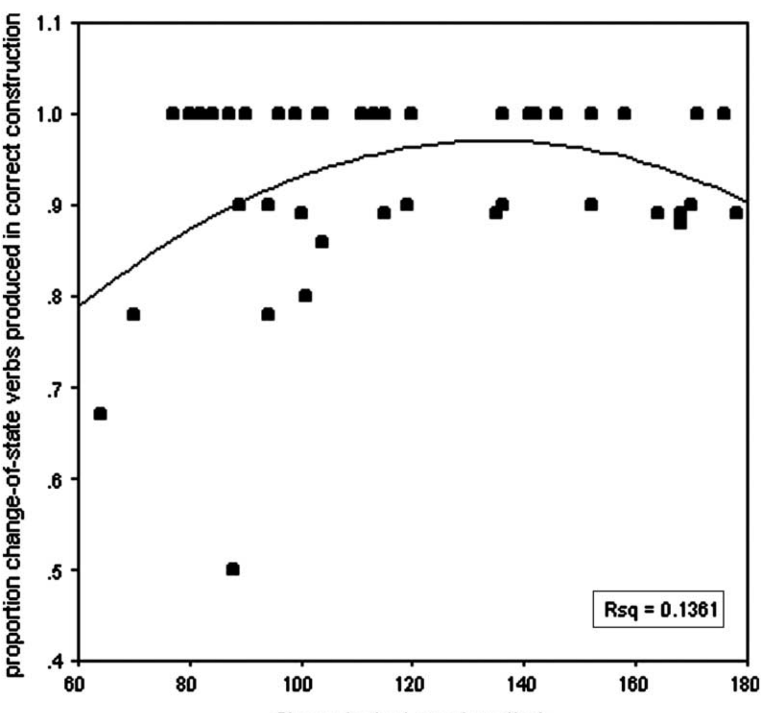

Figure 1. Developmental trajectory for proportion of change of state verbs produced with the correct construction by typically developing participants plotted against chronological age (in months).

never reached; some individuals at even the oldest ages still make errors. A linear equation did not fit the TD data: $R^2 = .046$, $F(2, 43) = 2.08$, $p = .16$. The most reliable model was the quadratic function, $R^2 = .136$, $F(3, 42) = 3.31$, $p = .046$. This is therefore shown in Figure 1.

The developmental trajectory for the SLI participants for the proportion of change-of-state verbs used in the correct construction plotted against chronological age is shown in Figure 2. This shows a great variability with no obvious pattern. Of the three lowest scores, one was produced by the youngest and one by the oldest participant with SLI. One of the three ceiling scores was produced by the second youngest participant. Statistical analyses showed that no linear or nonlinear equations fit the SLI data significantly. A linear trendline is shown for illustrative purposes, $R^2 = .002$, $F(1, 13) = 0.02$, $p = .89$. Thus, it appears there is no systematic relationship between chronological age and the ability to produce change-of-state verbs in the correct construction in the participants with SLI.

The question then arises as to whether performance on change-of-state verbs is predicted more by semantic or grammatical knowledge than by chronological age, particularly in the participants with SLI. Therefore, we plotted performance on change-of-state verbs by age equivalent (as recommended by Thomas et al., 2009) first on the BPVS (which gives a broad indication of semantic knowledge) and then on the TROG (which gives a broad indication of grammatical knowledge).

Figures 3 and 4 show the proportion of change-of-state verbs used in the correct construction plotted against BPVS age equivalent for the TD and SLI participants respectively. All equations and curves fitted the TD data significantly, including the linear function, $R^2 = .16$, $F(1, 43) = 8.29$, $p = .006$. However, the quadratic model,

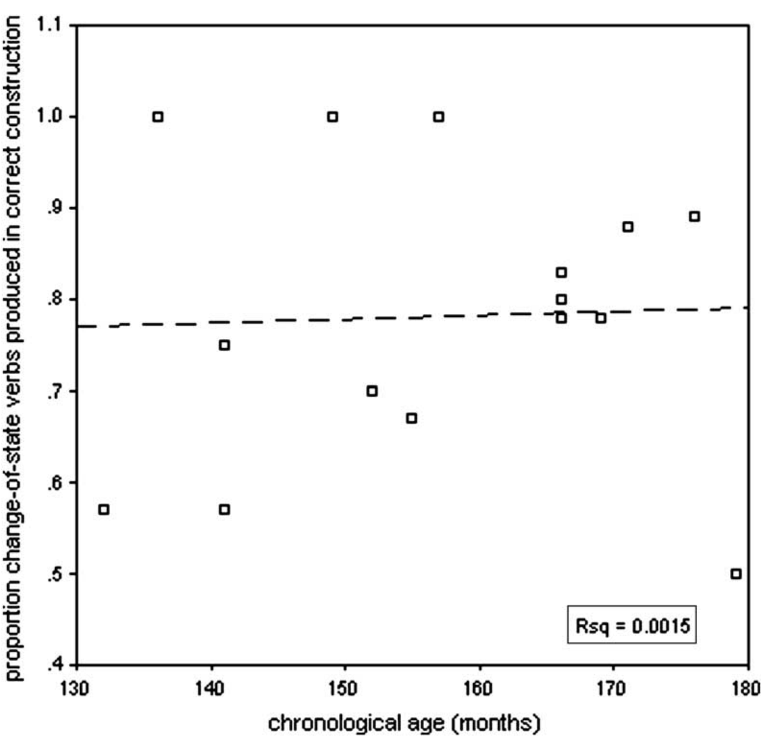

Figure 2. Developmental trajectory for proportion of change of state verbs produced with the correct construction by SLI participants plotted against chronological age (in months).

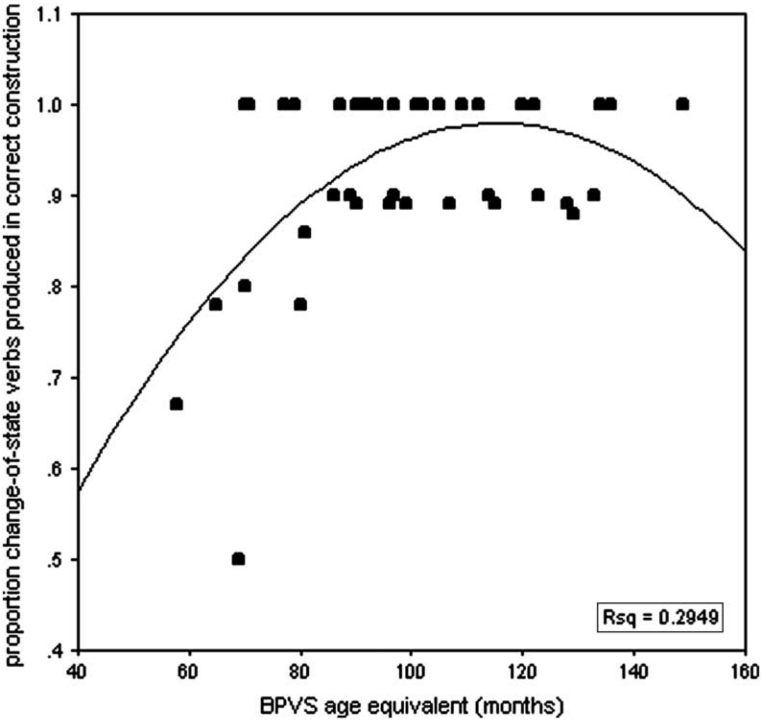

Figure 3. Developmental trajectory for proportion of change of state verbs produced with the correct construction by TD participants plotted against BPVS age equivalent (in months).

$R^2 = .295$, $F(3, 42) = 8.78$, $p = .001$, was the most reliable and is therefore shown in Figure 3.

For the SLI participants, no linear or nonlinear equations fitted the data significantly. However, the values of R^2 and F were higher and the p-values were lower than with the chronological age analyses, showing that vocabulary (rather than chronological) age has a closer (but still nonsignificant) relationship to the proportion of change-of-state verbs produced in the correct construction. A linear trendline is shown for illustrative purposes, $R^2 = .123$, $F(1, 13) = 1.82$, $p = .20$.

Figure 5 shows the proportion of change-of-state verbs used in the correct construction plotted against TROG age equivalent, for both the TD and SLI participants. All equations and curves fitted the TD data significantly, including the linear function, $R^2 = .32$, $F(1, 43) = 20.29$, $p < .001$. However, the cubic model, $R^2 = .50$, $F(3, 42) = 20.35$, $p < .001$, was the most reliable and is therefore shown in Figure 5.

For the participants with SLI, no linear or nonlinear equations fitted the data significantly. However, the values of R^2 and F were higher and the p-values were lower than with the chronological or vocabulary age analyses, showing that grammatical comprehension (rather than chronological or vocabulary) age produces a closer (but still nonsignificant) relationship with the proportion of change-of-state verbs produced in the correct construction. A cubic trendline is shown for illustrative purposes because it had the highest value of R^2 and F and also enabled comparison with the TD participant data, $R^2 = .35$, $F(2, 12) = 3.23$, $p = .075$. Visual inspection of the trajectories for the TD versus the SLI participants shows that the trajectories are very similar for the lower age equivalents (although the numbers are

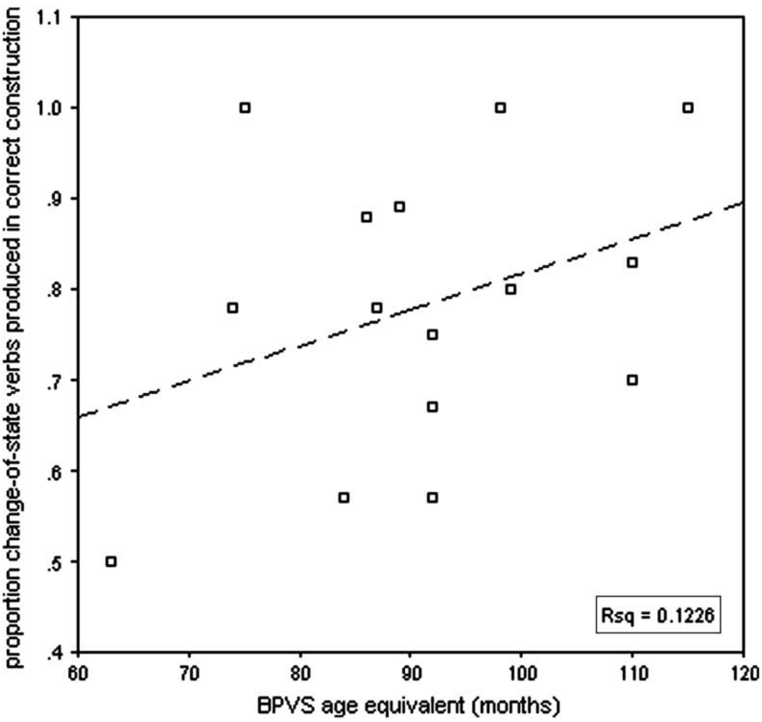

Figure 4. Developmental trajectory for proportion of change of state verbs produced with the correct construction by SLI participants plotted against BPVS age equivalent (in months).

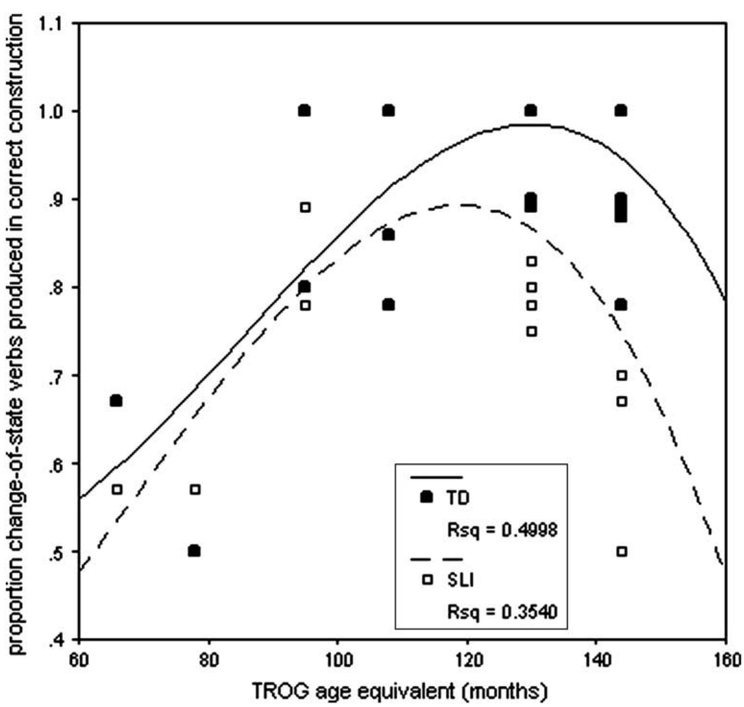

Figure 5. Developmental trajectory for proportion of change of state verbs produced with the correct construction by TD and SLI participants plotted against TROG age equivalent (in months).

very small). However, performance on change-of-state verbs seems to drop again with the higher age equivalents. This occurs more for the participants with SLI, although it must be borne in mind that while this curve fit the SLI data best, it was not a statistically significant fit, thus any conclusions must be tentative. Among the TD participants, this drop is due to only one participant and therefore must also be interpreted with caution. So in sum, the developmental trajectories indicate that grammar (TROG) abilities rather than chronological age or vocabulary are most closely related to performance on change-of-state verbs..

Individual response patterns

Table 4, showing the individual children who made errors on each video scene, reveals that none of the VM or CAM controls made more than one error in total on the six change-of-state scenes (once *rob* was excluded). However, three of the GM controls made two or more errors. These controls were those with the lowest raw and standard scores on the TROG, indicating once again that grammar knowledge plays an important role. Eight of the participants with SLI also made two or more errors.

Inspection of error patterns within the individual participants showed that approximately half of the participants (8 SLI, 53% and 19 controls from all groups, 42%) produced at least one change-of-state verb in both constructions (making an error on one of the two video scenes for a particular verb) indicating that they thought the verb could alternate. Such overgeneralisations of the locative alternation were produced by all groups across the age range including eight of the CAM controls. Inspection of individual verbs showed that for each verb, one video scene appeared to encourage errors more than the other.

Among the control participants, only the two with the lowest raw and z-scores on the TROG used the (incorrect) change-of-location construction for both video scenes for any change-of-state verb. One child (ID code: 15, aged 7;4, TROG z-score -0.93) made errors on both scenes for *fill* (e.g., "the lady is filling the sweets into the jar") and *cover* (e.g., "the lady is covering the scarf on her head"), the other (ID code: 3, aged 5;4, TROG z-score -0.87) made errors on both scenes for *fill* only. However, this pattern of errors was more common among the participants with SLI; four participants (ID codes: 3,8,12,14) used the change-of-location construction for *fill* for both scenes while another two (ID codes: 9,15) did so for

TABLE 4
Individual children (shown by ID codes) who made errors on change-of-state video scenes. Controls were individually matched to children with SLI with the same ID code

Video scene	*SLI*	*GM*	*VM*	*CAM*
Lady filling a jar with sweets	1,3,6,8,9,12,14	3,15	N/A	N/A
Girl filling a cup with orange juice	3,5,7,8,12,14	3,11,12,15	2	3
Lady covering her hair with a scarf	9,15	15	N/A	N/A
Lady covering bread with chocolate spread	2,9,12,15	1,5,15	1,9,14	6
Man building a car out of lego	4	3	N/A	N/A
Girl building a tower out of bricks	1,7,12,14	1	10,15	2,7,8,10,12,14
Number of participants making				
0 errors	3	10	9	7
1 error	4	2	6	8
2 errors	5	1	0	0
3 errors	2	1	0	0
4 errors	1	1	0	0

cover. Thus in total, six of the 15 participants with SLI used the change-of-location construction for both video scenes with at least one change-of-state verb. This is a significantly higher proportion of the participants with SLI (40%) than of the control participants (4%), $\chi^2(1) = 12.3$, $p < .001$.

Summary of results

The participants with SLI did not differ from any TD group on use of the locative alternation or obligatory change-of-location verbs. In contrast, they did differ significantly from their CAM and VM controls on obligatory change-of-state verbs. In the TD participants, progress in the ability to use change-of-state verbs correctly was not linearly related to chronological age and adult-like performance was never quite reached. However, while the linear relationship between change-of-state verbs and both the BPVS and TROG was highly significant, nonlinear curves fitted better. No systematic relationship was found for the participants with SLI between correct production of change-of-state verbs and chronological age, BPVS or TROG age equivalents, although the relationship appeared stronger (but still nonsignificant) with the language measures. Individual response patterns showed some participants in all groups used obligatory change-of-state verbs as alternating verbs, but the participants with SLI were much more likely to use them as obligatory change-of-location verbs.

DISCUSSION

This study investigated the abilities of 15 participants with SLI and three TD control groups to use change-of-state and change-of-location verbs accurately in sentences. We found very few errors on change-of-location verbs, but all four groups made errors on change-of-state verbs. These findings support and extend previous findings (Bowerman, 1982; Gropen et al., 1991b) to older TD children and show that change-of-state verbs are more prone to linking errors. This study is the first (as far as we are aware) to directly investigate this area in children with SLI. This group was particularly affected and made more errors on change-of-state verbs than all three TD control groups, but this difference was only significant in comparison with their VM and CAM controls. Our results add to the evidence that children with SLI continue to have difficulties (well into their teenage years) in a variety of areas of language; in this case with the argument structure of change-of-state verbs. In contrast, the children with SLI did not differ significantly from any group, including adults, in their production of the change-of-state versus change-of-location construction with verbs which undergo the locative alternation.

The linking errors we found on change-of-state verbs are unlikely to be due to the task demands, or a general semantic difficulty with verbs, as this would affect all verbs to a similar extent. It is more likely that the linking errors on change-of-state verbs were due to inaccurate semantic representations for these verbs in particular (Gropen et al., 1991b). The particular difficulties with semantic representations of change-of-state verbs could be due to limited use of reverse linking to override the observational biases noted by Gentner (1978) and Gropen et al. (1991b). These biases would mean children are more likely to note changes of location than changes of state when both co-occur and the change of state is not particularly salient (see also Gropen, Pinker, Hollander, Goldberg, 1991a).

The developmental trajectory analyses also showed that both the TROG and BPVS were better predictors of correct production of change-of-state verbs than chronological age, but the TROG was the best, predicting 50% of the variance among TD participants. It also predicted the most variance (35%) among the participants with SLI, but not significantly so (although this could be due to the smaller numbers of SLI participants). Thus, the TROG seems to be most closely related to the production of change-of-state verbs. For this reason, it is unsurprising that the participants with SLI did not differ from their GM controls, who were matched to the SLI participants on the TROG. Thus, our results indicate that comprehension of sentences, as measured by the TROG, is reflected in expressive grammar for change-of-state verbs. This could be because both comprehension of sentences in the TROG and reverse linking (which we hypothesise is required for forming accurate semantic representations of change-of-state verbs and thus their accurate use in sentences) involve some similar skills, for example, the ability to hold a sentence in memory while identifying the different syntactic and thematic roles associated with the different participants in an event or picture.

For the TD participants, the BPVS was not as strongly related to the ability to correctly produce change-of-state verbs as the TROG. However, this does not exclude the hypothesis that poor semantic representations for verbs (that we hypothesise are caused by difficulties with reverse linking when learning verb meanings) could underlie these errors. The BPVS is a forced choice single word-picture matching task where the pictures are rarely strongly semantically related and thus children could use guessing strategies with some very broad semantic knowledge of the word. It also includes few verbs and for those verbs which are included, it does not require children to make fine semantic distinctions, such as the difference between *pouring* and *filling*, which we hypothesise underlie the linking errors we found. Thus, it assesses the breadth rather than the depth of a child's vocabulary knowledge (Ouellette, 2006).

Individual analyses of the errors revealed a pattern for six of our participants with SLI which was displayed only by the two TD controls with the lowest TROG scores. These six SLI and two GM control participants used at least one change-of-state verb in the incorrect change-of-location construction for both video scenes. With limited data on each verb, it is difficult to draw strong conclusions. However, it is possible that these participants viewed these verbs as obligatory change-of-location verbs (in common with Bowerman's daughters for *fill* and *touch*, reported in Bowerman, 1982). Thus, the errors found in our study could be explained by inaccurate or under-specified semantic representations for these verbs in terms of which argument is assigned to the Patient role. This finding is consistent with a failure to use reverse linking to note that the Goal appears in the direct Object position and hence is affected in a specified way (i.e., is the Patient).

However, a much more common error pattern for all participant groups was overgeneralisation of the locative alternation to some change-of-state verbs. Bowerman (1982) also reported that this type of error was more frequent in her diary data, but she did not report it after the age of 7;2. Gropen et al. (1991b) reported that this error was still common in TD children aged 6 years but did not investigate older children. Our study used a wide age range of TD children (up to 15 years), but still was unable to establish at what age the children adopt the adult pattern and stop overgeneralising the locative alternation. The developmental trajectory analyses showed asymptote below ceiling for the TD participants. Surprisingly, even some of the oldest control participants persisted in using some change-of-state verbs in change-of-location constructions on occasion. This was more common for some video scenes than for others, indicating that some scenes encouraged use of the change-of-location construction. However, this was not so for the adult participants.

One possibility is that these overgeneralisation errors were due to the general demands of the task. However, if this were the case, we would expect a similar number of errors on change-of-location verbs; a pattern which we did not find. Alternatively, they could be evidence of a developmental change, which, in some young people, has not yet reached the adult state even by the mid-teenage years. However, the asymptote below ceiling shown on the developmental trajectories argues against this hypothesis. A further possibility is that the semantic representations and hence argument structures of these verbs may be in a state of flux within the language (among young people) and in the future, when these young people become adults, they will be used more widely as alternating verbs. Our finding that some of the adults (particularly the younger ones) used *rob* as an alternating verb lends weight to this possibility. However, even within the alternating verbs, differences were found between the adults and the child/adolescent groups; the adults tended to use the change-of-state construction more than the child/adolescent participants. Variation in verb use of this kind may well vary by region and local dialect, thus it is important to collect local adult data when studying verb argument structure in children and adolescents. We also showed that some video scenes seemed to encourage errors more than others in all groups. Therefore, it is important that studies do not assume because participants have used a particular construction for a particular verb for one scene, they will use the same construction for another.

Summary and future directions

This study compared four change-of-state verbs with four change-of-location verbs and found the change-of-state verbs to be more prone to errors for all groups. The participants with SLI made significantly more errors with these verbs than their VM and CAM controls. However, the participants with SLI did not differ significantly from any TD group in their use of verbs which undergo the locative alternation.

In terms of change-of-state verbs, whereas TD and SLI participants used them as alternating verbs, some SLI participants used them as if they were change-of-location verbs. This pattern of verb use in sentences could be due to difficulties using reverse linking (O'Hara & Johnston, 1997; Shulman & Gudeman, 2007; van der Lely, 1994) which may well be needed to refine the semantic representations of change-of-state verbs. Future studies could investigate this finding further by studying a wider range of verbs with many more opportunities to use each individual verb. This would allow stronger conclusions to be drawn regarding the consistency of the children's errors.

Intervention studies could investigate whether making clear which argument is "affected" by the action represented by the verb improves performance. Indeed, a study subsequent to this one, which included 11 of the participants with SLI in this study (Ebbels, van der Lely, & Dockrell, 2007), showed that explicit instruction focused on the Patient role can increase the accuracy of change-of-state verbs in older children and adolescents with SLI.

In addition, future studies could tease apart more directly the use of abstract syntactic cues; the complexity of the syntactic structure versus reverse linking per se versus the interface between different levels of linguistic representation (van der Lely & Marshall, 2011) as well as explicitly investigate the interaction between reverse linking, observation, and use of change-of-state verbs in TD children and children with SLI. One means of doing this could be teaching participants the meanings of novel verbs using events involving changes of state and location, such as those in

Gropen et al. (1991a), where the salience of the changes of state and location vary. These events could be paired with sentences using the novel verbs in the change-of-location versus change-of-state construction. Thus, for some events there would be a mismatch between observational and syntactic cues. For example, the change of location of the Theme may be most salient, but the Goal may appear in the direct Object position and vice versa. Then, similar events could be acted out using new objects and the participants asked to describe the event. By examining participants' use of constructions for those verbs where observational and syntactic cues conflict, it would be possible to establish whether they use syntactic cues to override observational cues. Interestingly, a recent study (Froud & van der Lely, 2008) found that children with Grammatical-SLI had only limited use of syntactic cues even in simple determiner phrases to distinguish between novel count or mass nouns. It is possible that the use of syntactic structure requires an abstract level of syntactic representation that is impaired in many children with SLI. This suggestion warrants further study. Such studies would reveal if our data constitute a more general phenomenon in the SLI population.

CONCLUSIONS

All participants, but particularly those with SLI had more difficulties using change-of-state verbs accurately than change-of-location verbs. These findings extend those of Gropen et al. (1991b) to older TD children and children with language impairments. Our results indicate that the difficulty with change-of-state verbs was not due to a general bias against use of the change-of-state construction, as the overall use of this construction with the alternating verbs was greater than 50% among all groups. Our findings support the view that errors in production of verb argument structure for change-of-state verbs could arise due to inaccurate semantic representations for verbs, which could in turn arise due to difficulties with reverse linking.

This study adds to evidence that young people with SLI continue into their adolescence to have language difficulties, in this case with the verb argument structure of change-of-state verbs. Thus, verb argument structure should be considered alongside other areas of language when evaluating theories of SLI and when assessing and planning intervention for children with SLI of all ages.

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APPENDIX 1
Video scenes

Change of state verbs	*Change of location verbs*	*Alternating verbs*
man buildling a car out of lego	girl pouring orange juice into a cup	man packing clothes in a suitcase
girl building a tower out of bricks	lady pouring sweets onto a table	girl packing bag with jumpers
lady covering her hair with a scarf	lady putting an apple in a bowl	man spreading butter on toast
lady covering bread with chocolate spread	lady putting a vase on a table	lady spreading bread with chocolate spread
lady filling a jar with sweets	lady spilling water on a surface	lady peeling skin off apple
girl filling a cup with orange juice	lady spilling rice krispies on a table	man peeling a banana
man robbing a lady of her mobile phone	lady stealing a camera from a man	man wiping crumbs off table
man robbing a lady of her handbag	man stealing a lady's purse	man wiping his face with a flannel