The count-mass distinction in typically developing and grammatically specifically language impaired children: New evidence on the role of syntax and semantics

Karen Froud a, Heather K.J. van der Lely b,*

a Department of Biobehavioral Sciences, Teachers College, Columbia University, UK
b Centre for Developmental Language Disorders and Cognitive Neuroscience, University College London, 4th Floor, 123 Gray’s Inn Road, London WC1X 8WD, UK

Received 13 September 2006; received in revised form 13 September 2007; accepted 25 November 2007

Abstract

By the age of three, typically developing children can draw conceptual distinctions between “kinds of individual” and “kinds of stuff” on the basis of syntactic structures. They differ from adults only in the extent to which syntactic knowledge can be over-ridden by semantic properties of the referent. However, the relative roles of syntax and semantics in determining the nature of the count-mass distinction in language acquisition are still not well-understood. This paper contributes to this debate by studying novel noun acquisition in a subgroup of children, aged 8–15 years, with specific language impairment, whose core deficits are limited to within the grammatical system (G-SLI). We conducted two experiments: a production task and a word extension task. Such children might be expected to rely to a greater extent than their age-matched peers on semantic properties of referents in order to assign noun interpretations, since by hypothesis they have greater difficulty in accessing and utilizing syntactic category distinctions than typically developing children. In the production task, the Children with G-SLI demonstrated rigid over-application of a pluralization rule which masked even basic knowledge of semantic information about individuated objects versus non-individuated substances. Age-matched control children only performed in this way when all syntactic and conceptual/perceptual cues were neutralized. In the word extension task, which required a non-verbal response, the Children with G-SLI
showed evidence of only very limited abilities to use syntactic or semantic information for word-learning. Thus, developmental deficits in the grammatical system can be seen to impact on lexical acquisition as well as syntactic development.

Learning outcomes: As a result of this activity, the reader will be able to: (1) describe how syntactic (grammatical) impairment affects the ability to use syntactic cues for lexical acquisition, resulting in difficulties representing the structure of even simple phrases; (2) discuss the interaction between language components throughout development, and the cumulative impact of impairment in one or more aspect of language, which results in secondary impairments in other parts of the system; (3) consider the effects of an impairment in the ability to use syntactic cues for narrowing down word meanings, and how this can result in a much bigger problem affecting the subtle semantics of words and word classes.

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1. Introduction

Word learning is a complex phenomenon, which minimally involves interactions between children’s conceptual biases about the world and an appreciation of syntactic and semantic cues to word meaning (see Bloom & Markson, 1998 for an overview). However, children with specific language impairment (SLI) have difficulty acquiring new words (Rice, Oetting, Marquis, Bode, & Pae, 1994). This has been related to difficulties in mapping nonverbal semantic features onto lexical labels (Alt, Plante, & Creusere, 2004), representing semantic categories (McGregor, Newman, Reilly, & Capone, 2002), processing syntactic properties of words (Rice, Cleave, & Oetting, 2000), or with representing phonotactic properties of novel words (Alt & Plante, 2006). However, SLI is a heterogeneous disorder and subgroups of children with distinct types of specific language impairment might exist. The most widely-studied of these subgroups is G(rammatical)-SLI (Friedmann & Novogrodsky, 2007; van der Lely, 1998, 2005; van der Lely, Rosen, & McClelland, 1998). Children with G-SLI have a specific deficit in the computational grammatical system affecting hierarchically complex structures in syntax, morphology and phonology (Gallon, Harris, & van der Lely, 2007; Marshall & van der Lely, 2006; van der Lely, 2005). Thus, they exhibit effects of the language impairment in other language domains as a result of interactions between these and impaired development of the grammatical system. We focus on investigating word learning on the basis of syntactic and semantic cues in G-SLI. In this situation, it might be expected that children would have to rely solely on semantic information in order to assign interpretations to novel words. However, we hypothesize that children with G-SLI retain some ability to represent grammatical relations (see van der Lely, 2005), and to make use of these for lexical acquisition.

A continuing debate in the study of language acquisition concerns the extent to which development of knowledge in one linguistic domain might support development of knowledge in others. This has been applied especially to investigations of the interaction between syntactic and semantic knowledge, both of which are crucial for word learning. A widely-investigated instantiation of the syntax–semantics interaction is the mass-count distinction for nouns, which arises in many languages. In English, count nouns tend to have specific morphosyntactic properties: they have both singular and plural forms, and can be
modified by numbers and some quantifiers (e.g. *a pen/three pens/*some pen/every pen). Mass nouns, by contrast, cannot take a plural form, and cannot take cardinal determiners, though they may be modified by quantifiers such as some or much (e.g. *a water/*three waters/some water/*every water). Extensionally, count nouns typically refer to a “kind of individual”, whereas mass nouns usually refer to quantities of non-solid substances (and a number of food items—Gordon, 1985). Syntactic distinctions alone are not sufficient in language acquisition for a child reliably to distinguish between kinds of individuals (e.g. *pens) and kinds of stuff (e.g. water). The situation is still more complex for words which refer to collections of individual items. For example, furniture and its French equivalent meuble both denote a collection of individual items, but the English word is a mass noun, and the French word is a count noun (more similar syntactically to English collective nouns such as family or army). The nature of linguistic cues such as the count/mass distinction can be highly abstract and language specific.

Observations such as these have led psychologists to suggest that the mass-count distinction might be derived from pre-existing knowledge of non-linguistic ontological categories (e.g. Macnamara, 1972, 1982). This suggests that children acquiring their first language build on their knowledge of categories such as “object” and “substance” to derive related linguistic categories, “count noun” and “mass noun”. However, several studies show that acquisition of the count/mass distinction in language development is not straightforwardly based on a distinction between objects and substances. For example, Gordon (1985, 1988) found that children, from the age of 3;5, categorized words primarily on the basis of syntactic context, even when syntactic cues conflicted with semantic cues, suggesting that even very young children have an adult-like appreciation of the syntax of quantification.

Quine (1960) proposed that count nouns inherently provide information about how their referent can be divided, whereas mass nouns do not, implying that the acquisition of syntactic count-mass distinction is crucial for the development of object knowledge and individuation in the world. For example, pens are quantified in units of one pen, whereas water can be quantified arbitrarily; but words such as furniture have ‘divided reference’, in that they can be quantified either individually or arbitrarily. On this view, the child’s perception of items which have divided reference, and their association with particular (count or mass) syntactic constructions – which is language-specific – provide the child with generalizable preliminary information, which in turn provide the basis for finer observations about world-word mappings. However, a great deal of evidence suggests that children already possess information about the nature of objects and substances in the world before the finer points of count-mass syntax are fully available to them. For example, studies of infant perception have shown that they respond quite differently to objects than to non-solid substances (e.g. Huntley-Fenner, Carey, & Solimando, 2002), suggesting that knowledge of objects and individuation is not dependent on knowledge of the syntactic count-mass distinction.

Given this conflicting evidence, Bloom (2000) and others (e.g. Gordon, 1985, 1988; Macnamara, 1986; Xu & Carey, 1996) proposed that young children derive count and mass nouns from the input, based on the use of these terms to refer to individuated vs. non-individuated real-world referents. However, this cannot be the whole story. Straightforward mappings between syntax (mass/count) and perceptual properties (e.g. the object/substance distinction) do not exhaust the complexities of count-mass semantics. Bloom
(1994) argued that the relevant crucial mapping is not between syntactic representations and real world objects, but between grammatical classes and cognitive classes. This is supported by the existence of different classes of mass nouns: some have individual or atomic parts in their denotation (jewelry, furniture, etc.), whereas others do not individuate in this way (water and jelly). Gillon (1990) suggested that such contrasts indicate the extension of mass syntax into a more flexible cognitive schema than count syntax, whereby mass nouns simply remain underspecified for their properties of individuation. Building on these arguments, Barner and Snedeker (2005) proposed a modified account of Quinean mass-count semantics as a theory of how syntactic categories and cognitive categories are related. They point out that any evidence that can speak to the mapping between syntactic and conceptual knowledge “must address how speakers construe the referents of mass nouns, and how such construals relate to the quantification of mass-count syntax” (Barner & Snedeker, 2005, p. 47). This clearly draws a connection between interpretive processes and grammatical representations. In an attempt to operationalize the mass-count distinction and account for results from lexical priming experiments, Gillon, Kehayia, and Taler (1999) proposed that mass nouns are lexically marked whereas count nouns are morphosyntactically marked. In other words, the mass-count distinction involves lexical representation as well as syntactic operations; it is a phenomenon at the interface of grammar and lexicon, syntax and semantics.

This background makes the mass-count distinction a logical place to start an investigation of word learning in children who have grammar-specific language impairments. We add to the debate concerning the syntax–semantics interactions crucial for the acquisition of mass and count nouns, by investigating the extent to which a grammatical impairment impacts on the acquisition of novel nouns in standard noun-learning tasks. This approach has been helpful in disentangling effects of interacting but distinct knowledge systems to a greater extent than is possible via observations of the typically developing language system alone (see van der Lely, 2005, for a review), because specific language impairment can affect morphosyntactic, and phonological abilities in the absence of any apparent auditory, processing or neurological deficits (Menyuk, 1964; van der Lely, Rosen, & Adlard, 2004). The study also aims to further our understanding of the lexical acquisition difficulties found in children with specific language impairment.

SLI is a heterogeneous disorder affecting approximately 7% of children (Leonard, 1998; van der Lely, 2002). The late acquisition of first words is a prototypical characteristic of SLI in children (e.g. Bishop, 1997a,b; Leonard, 1998; Trauner, Wulfeck, Tallal, & Hesselink, 1995), and difficulties in vocabulary development have been reported (e.g. Dollaghan, 1987; Rice, Buhr, & Nemeth, 1990; Rice et al., 1994). Nevertheless, lexical acquisition difficulties in SLI are not well understood. It is apparent that children with SLI are able to manipulate abstract conceptual representations, as would be required for the utilization of ontological category knowledge in the acquisition of word meaning (e.g. Donlan, Bishop, & Hitch, 1998; Siegel, Lees, Allan, & Bolton, 1981), suggesting that the locus of the lexical impairment is unlikely to be extralinguistic. Van der Lely and colleagues proposed that some children with SLI have a deficit specifically affecting grammatical components of language-related representations (referred to as G-SLI), which may extend to the kinds of linguistic knowledge which are crucial for word learning (van
der Lely, 1994, 1999, 2004, 2005; van der Lely et al., 1998). The co-occurrence of grammatical and lexical deficits in G-SLI (and in SLI more generally) has led some researchers to suggest that grammar does not form a distinct subcomponent of the language faculty from the lexicon (Bates & Goodman, 1997; Norbury, Bishop, & Briscoe, 2002; Tomblin & Pandich, 1999). van der Lely (1999, 2004) has challenged such a perspective, observing that just one of the capacities known to underpin word learning is the ability to use syntactic representations to support the assignment of meaning; if this ability is deficient, as it is in G-SLI, then deficits in vocabulary acquisition are expected. Children with G-SLI, therefore, provide an ideal opportunity to examine the extent to which grammatical information is crucial for the acquisition of noun meaning.

1.1. Predictions

In order to evaluate the relative contributions of different kinds of knowledge to the interpretation of new words, we adopted paradigms in which semantic/perceptual cues (i.e., the type of referent—objects vs. substances) could be manipulated independently of syntactic cues (i.e., the syntactic frame used to introduce the novel word—count vs. mass syntax). The methods we used to elicit word extension and pluralization responses were based on those developed by Gordon (1985) and Soja, Carey, and Spelke (1991), and are detailed below.

We studied typically developing (TD) children who were older than previously reported in the word learning literature (e.g. Gordon (1985) and Soja et al. (1991) studied 2–5 year olds). Since developmental changes in word learning ability even in younger age groups have been reported – for example, Gordon’s (1985) children showed increasing reliance on semantic cues for word meaning by the age of five – we expected to see a continuation of this pattern in the older groups. Therefore, when both syntactic and semantic cues were made available, we predicted TD children to show (a) increasing ability to integrate the different kinds of information, and (b) an increasing ability to override syntactic cues on the basis of semantic information with age. In situations where only one type of cue was made available (syntactic or semantic), or where both types of cues point to a similar interpretation, we expected TD children to demonstrate an appropriate interpretive bias—so that count syntax cues and/or individuated object stimuli should yield more interpretations of novel nouns as having a ‘kind of individual’ interpretation, whereas mass syntax cues and/or non-individuated substance stimuli should bias the children towards a ‘kind of stuff’ interpretation. These predictions are in accordance with previous studies of word learning in much younger children (Gordon, 1985; Soja et al., 1991).

In contrast, we predicted that children with G-SLI would have difficulty integrating their (deficient) syntactic representations with semantic information to interpret and represent new lexical items (given that they show delays in lexical development despite normal non-verbal cognitive abilities). However, children with G-SLI may have fewer problems with learning new word meanings if they need not rely on syntactic cues to do so. For instance, they may find it easier to decide if a novel word refers to a ‘kind of stuff’ or to a ‘kind of individual’ when semantic/perceptual cues (the presence of an object or a substance) are more salient than syntactic (count/mass) distinctions.
Finally, neutralization of both syntactic and perceptual cues provided an opportunity to investigate what default interpretations are applied to novel nouns by typically developing and language-impaired children.

To summarize, our main research questions for this study were as follows:

- What are the relative roles of conceptual and linguistic cues for word learning, and how do these cues interact with each other?
- What is the impact of a grammatical deficit on the ability to utilize cues for word learning? Does a grammatical deficit have direct effects on lexical learning?

2. Method

2.1. Subjects

Four subject groups participated in the study: 17 children with G-SLI, two groups of younger children with typically developing language, and a group of chronologically age-matched controls (the CA group). The two younger groups were matched to the G-SLI group on tests tapping, among other language abilities, receptive and expressive syntactic abilities (the TD1 group) and on standardized test scores for receptive and expressive vocabulary (the TD2 group).

2.1.1. Children with grammatical (G)-SLI

All the children met the definition of SLI; that is, they showed significantly impaired language abilities alongside normal non-verbal performance IQ scores on standardized tests within 1 S.D. from the mean, no apparent neurological deficits, and no pragmatic or articulatory deficits on the report of speech-language pathologists and/or teaching staff. From this group of language-impaired children, subjects were selected on the basis of a battery of standardized language assessments: British Picture Vocabulary Scales (BPVS: Dunn, Dunn, Whetton, & Burley, 1997), a test of receptive vocabulary; Test of Word Finding (TWF: German, 1986), which uses various procedures to elicit expressive vocabulary; Test for the Reception of Grammar (TROG: Bishop, 1983), which assesses sentence understanding; and the Grammatical Closure subtest of the Illinois Test for Psycholinguistic Abilities (ITPA-GC: Kirk, McCarthy, & Kirk, 1968), an assessment of expressive morphosyntax. In addition, we administered two assessments of expressive verb morpho-syntax: the Verb Agreement and Tense Test (VATT: van der Lely, 2000) and the Test of Active and Passive Sentences (TAPS) (van der Lely, 1996b) which have been found to be reliable tests for identification of G-SLI. This range of assessments permitted evaluation of expressive and receptive skills in vocabulary and morphosyntax in relation to the children’s chronological ages. In addition, the SLI subjects’ non-verbal cognitive abilities were screened using the Raven’s Progressive Matrices (RPM: Raven, 1938) and the Block Design subtest from the British Ability Scales (BAS: Elliott, Murray, & Pearson, 1978). Subjects whose performance IQ on these assessments fell within the normal range for their age (i.e. IQ > 85), but whose scores on one or more of the language assessments fell more than one standard deviation below the level expected from their IQ scores, were considered specifically language impaired. Children who were more impaired on measures
of grammar than of vocabulary, and had >20% morpho-syntactic errors on the VATT and the TAPS (van der Lely, 1996a,b, 1999) (where virtually none would be expected for their age) were designated grammatical (G)-SLI (cf. van der Lely, 1996a,b), and were included in the present study. Only approximately 20% of children with a persisting language impairment and IQ > 85 met the criteria for the G-SLI subgroup (van der Lely & Stollwerck, 1996).

The 17 children with G-SLI (14 boys) had a mean age of 12;03 (range 8;0 to 15;06). Table 1 summarizes the overall performance scores of the G-SLI group. The appendix provides individual subjects' test scores on the four selection tests.

### Table 1

<table>
<thead>
<tr>
<th>Subject details: chronological ages and raw scores on the tests used for evaluating and matching language or non-verbal cognitive abilities</th>
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</thead>
<tbody>
<tr>
<td><strong>G-SLI (N = 17)</strong></td>
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<tr>
<td>Chronological age (yy:mm)</td>
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<td>Range</td>
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<td>RPM</td>
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<td>IQ (S.D.)</td>
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<td>z-Score (S.D.)</td>
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<td>Raw score (S.D.)</td>
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<td>z-Score (S.D.)</td>
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<td>Equivalent age (S.D.)</td>
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<td>Raw score (S.D.)</td>
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<td>z-Score (S.D.)</td>
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<td>TROG</td>
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<tr>
<td>Raw score (S.D.)</td>
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<tr>
<td>z-Score (S.D.)</td>
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<td>Equivalent age (S.D.)</td>
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<td>ITPA-GC</td>
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<tr>
<td>Raw score (S.D.)</td>
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<td>z-Score (S.D.)</td>
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<tr>
<td>Equivalent age (S.D.)</td>
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<tr>
<td>VATT</td>
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<tr>
<td>Raw score (S.D.)</td>
</tr>
</tbody>
</table>

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a RPM: Raven's progressive matrices; BPVS: British Picture Vocabulary Scales; TWF: Test for Word Finding; TROG: Test of Reception of Grammar; ITPA-GC: grammatical closure subtest from Illinois Test of Psycho-linguistic Abilities; VATT: Verb Agreement and Tense Test.

b Score not available for ages of subjects.
impairment will have different impacts on the language-disordered and control groups. The possibility of an extraneous age effect should also be taken into account, since language-matched children are typically much younger than the language-disordered children for whom they provide a control. In order to minimize these difficulties, we conducted multidimensional testing on the children in our control groups, examining different aspects of their linguistic abilities (receptive and expressive grammar and vocabulary). We have two language-matched groups, one matched on grammatical abilities, and one matched on vocabulary. We also included a group of age-matched controls, so that the performance of the language-disordered children could be compared directly to that of their peers.

The chronological age-matched (CA) group ($n = 17$) were matched pairwise to members of the G-SLI group (+/− no more than 2 months; all but three of the G-SLI group members shared the same birthday month with their CA control). Because they were not expected to match on any measure of language ability, the CA control group were given just two baseline language assessments, one of receptive vocabulary (BPVS) and one of receptive grammar (TROG). As expected, the CA group yielded significantly higher scores than the children with G-SLI on both these language assessments (BPVS: $t(32) = -5.715$, $p < 0.001$; TROG: $t(32) = -6.822$, $p < 0.001$).

There were 12 children in each of the typically developing (TD) control groups: the TD1 group was youngest, with a mean age of 6;2 (range 5;9 to 6;8); and the TD2 group had a mean age of 7;4 (range 6;6 to 8;0). The TD1 and TD2 groups were given all the same baseline assessments as the G-SLI group. The TD1 controls did not differ from the G-SLI subgroup on measures of morphosyntactic ability (TROG: $t(27) = -1.091$, $p = 0.285$; ITPA-GC: $t(27) = 0.234$, $p = 0.817$), nor on expressive vocabulary (TWF: $t(27) = 0.333$, $p = 0.742$), and although they achieved somewhat higher scores than the G-SLI subjects on the other three criterion assessments, the differences were either not significant or approaching significance (TROG: $t(27) = -2.038$, $p = 0.051$; ITPA-GC: $t(27) = -1.445$, $p = 0.160$; TWF: $t(26) = -1.944$, $p = 0.063$). The TD2 group, therefore, provided a matched control group for the G-SLI group on receptive vocabulary.

2.2. Experiment 1

2.2.1. Experimental design and methods: pluralization

The first series of experiments presented in this paper are replications and extensions of Gordon’s study (1985). The first experiment was designed to evaluate the relative importance of semantic or syntactic cues in interpreting novel nouns. The semantic cue was provided by the presentation of an object (a ‘kind of individual’) or a substance (a ‘kind of stuff’), and syntactic cues were provided by the use of determiners specific to either count or mass nouns. Thus, this $2 \times 2$ design resulted in four experimental conditions: objects or substances with count or mass syntax language cues. The children were asked to produce an appropriately pluralized (or non-pluralized) form of the novel noun in a sentence completion format (see below).
In the first version of the pluralization experiments, semantic information about the nature of the referent was either in accord or in conflict with the syntactic cues (the default assumption being that an object is associated with count syntax and a substance with mass syntax—Gordon, 1985). This manipulation allows us to evaluate whether children will respond primarily according to semantic or syntactic information when they are assigning names to novel referents. In the second version, we neutralized the semantic cue, to examine how children interpreted the count/mass distinction for novel nouns when they had to rely on syntactic cues alone. In the third version, the syntactic cues were neutralized, so that children had to rely solely on semantic features of the referent to decide between ‘kind of individual’ and ‘kind of stuff’ interpretations; in this instance, the syntactic count/mass distinction was not available to help interpret the novel nouns. Finally, we neutralized both the syntactic and the semantic cues to the nature of the novel noun referent, to see whether the children in our groups showed evidence of a ‘default’ mechanism for the interpretation of new nouns in the absence of salient cues.

2.2.2. Materials

The novel words used for the pluralization experiments had a simple CVC structure, to avoid problems with the repetition of the novel words. Thus, the vowel was always short (no diphthongs or long vowels), and there was always a word-final plosive consonant so that the plural marker would be clearly audible if pronounced.

Materials were novel objects (e.g., egg whisks, shower curtain hooks, electrical connectors, cocktail stirrers and so on) and novel substances (unusual-looking liquids such as glittery shower gel, colored hand creams, hair conditioner). We presented substances in test tubes, so that pluralization was pragmatically appropriate. As the substances were presented, the experimenter shook the test tube and pointed inside it, to ensure that the child recognized that it was the substance inside the test tube that was being referred to; the child was also reminded of this at the beginning and as necessary throughout the procedure. Each child was first shown one test tube half-full of a novel substance; then two more test tubes which were half-full of the same substance were presented to elicit a response. When the stimuli were objects, the child was shown one object followed by three more identical objects to elicit a response. Neutralization of the semantic cue for novel word count/mass subcategorization required referents that were indeterminate with respect to the object/substance distinction. Gordon (1985) discusses foodstuffs as the most common such referents—e.g. beans and rice, which differ in their count/mass subcategorization but are relatively similar in appearance. We used such neutral materials in this experiment (e.g. lentils, small pasta shapes, bath crystals and polystyrene chips). When neutral materials were used, the children were shown a tub containing the neutral substance and the experimenter extracted a piece of the referent – one lentil, one bath crystal, etc. – from the tub whilst discussing the referent with the child using count, mass or neutral syntax. The experimenter then showed the child the rest of the neutral substance, still in its tub, for response elicitation.

The sentence completion cues used to introduce and elicit (overtly or covertly) pluralized productions of the novel nouns utilized count, mass or neutral determiners. For example:
1. **Count syntax**: This is a rop. Can you say rop? Have you ever seen a rop before? So, here we have a rop, and over here we have more...what?

2. **Mass syntax**: This is some rop. Can you say rop? Have you ever seen some rop before? So, here we have some rop, and over here we have more...what?

3. **Neutral syntax**: This is my/the rop. Can you say rop? Have you ever seen my/the rop before? So, here we have my/the rop, and over here we have more...what?

In each experiment, children were shown the novel material, and encouraged to touch and play with it. The experimenter talked about the materials using novel nouns in the relevant syntactic context. Only following interactions of this kind were the children required to complete the elicitation sentence.

In each of the four versions of the pluralization experiment, the number of overt plurals produced in each condition was counted—that is, a score of 1 was allocated for each response which ended in the plural marker -s, and a score of 0 was allocated if the plural marker was omitted.

2.3. **Experiment 1a: conflict and accord between syntactic and semantic cues**

In this version of the experiment, we examined the interaction between the semantic object/substance distinction and the syntactic count/mass distinction. There were four experimental conditions (objects or substances with count or mass syntax cues) with four items in each condition. We also included a training phase, to ensure that the control children pluralized count nouns with an -s affix, but not mass nouns. In the training phase, a real count noun (*button*) and a real mass noun (*water*) were presented, and the child was asked to complete the sentence: *this is a button/some water, here we have more...*. Any child who failed to pluralize appropriately (*buttons; water*) would have been eliminated from the TD or CA control groups; however, every child completed this task appropriately. In the G-SLI group, five children (29.42%) incorrectly added an -s to form the plural of *water*.

Each item in this experiment was presented with either a mass or count syntax cue. For substances, the mass syntax cue was in accord with the semantic object/substance distinction, whereas the count syntax cue was in conflict. This situation was reversed for object stimuli. For example:

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Cue</th>
<th>Condition</th>
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<tbody>
<tr>
<td>Object</td>
<td><em>Count syntax</em>: This is a rop. Can you say rop? Have you ever seen a rop before? So, here we have a rop, and over here we have more...what?</td>
<td>Accord</td>
</tr>
<tr>
<td>Substance</td>
<td><em>Mass syntax</em>: This is some kep. Can you say kep? Have you ever seen some kep before? So, here we have some kep, and over here we have more...what?</td>
<td>Accord</td>
</tr>
<tr>
<td>Object</td>
<td><em>Mass syntax</em>: This is some deg. Can you say deg? Have you ever seen some deg before? So, here we have some deg, and over here we have more...what?</td>
<td>Conflict</td>
</tr>
<tr>
<td>Substance</td>
<td><em>Count syntax</em>: This is a fip. Can you say fip? Have you ever seen a fip before? So, here we have a fip, and over here we have more...what?</td>
<td>Conflict</td>
</tr>
</tbody>
</table>

2.3.1. **Results and discussion**

The mean numbers of overtly pluralized responses for each group are presented in Table 2.
Table 2
Pluralization experiment 1a (conflict and accord between syntactic and semantic cues): mean percentages of overt pluralizations produced by each subject group

<table>
<thead>
<tr>
<th>Semantic Cue</th>
<th>Syntactic Cue</th>
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<tbody>
<tr>
<td></td>
<td>G-SL1</td>
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<tr>
<td></td>
<td>Mean %</td>
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<td>Objects</td>
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<td>Objects Total</td>
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<td>Substances</td>
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<td>Mass Syntax</td>
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</table>

Note: four items per condition were presented to each child.  
Shaded cells indicate accord between syntactic and semantic cues; unshaded cells indicate conflicting cues.
Repeated measures ANOVAs examined the effects of semantics (a two-level factor—objects vs. substances) and syntax (two levels: mass vs. count) on the dependent variable, numbers of overtly pluralized responses produced by the children in each group. All main effects and interactions were evaluated using Cohen’s $d$ statistic; $d$ greater than 0.4 indicates a medium effect size, and greater than 0.75 is considered to index a large effect (Cohen, 1988, 1992). These analyses were conducted twice: once comparing the G-SLI group with the two younger control groups (TD1 and TD2), and once comparing the G-SLI group with their chronologically age-matched peers. The ANOVAs revealed significant main effects of both semantics (G-SLI vs. CA controls: $F(1, 32) = 4.604$, $p = 0.04$, $d = 0.76$; G-SLI vs. TD controls: $F(1, 38) = 22.799$, $p > 0.001$, $d = 1.55$) and syntax (G-SLI vs. CA controls: $F(1,32) = 26.436, p > 0.001, d = 1.82$; G-SLI vs. TD controls: $F(1, 38) = 75.253, p > 0.001, d = 2.82$), with significant interactions for group $\times$ semantics (G-SLI vs. CA controls: $F(1, 32) = 6.877, p = 0.013, d = 0.93$; G-SLI vs. TD controls: $F(1, 38) = 8.002, p = 0.001, d = 0.92$), group $\times$ syntax (G-SLI vs. CA controls: $F(1, 32) = 10.925, p > 0.001, d = 1.17$; G-SLI vs. TD controls: $F(1, 38) = 10.027, p > 0.001, d = 1.03$) and, in the CA comparison, also semantics $\times$ syntax (G-SLI vs. CA controls: $F(1, 32) = 4.795, p = 0.036, d = 0.77$; G-SLI vs. TD controls: $F(1, 38) = 0.860, p = 0.360, n.s.$). Planned comparisons showed that the children with G-SLI produced significantly greater numbers of overt pluralizations in response to substance stimuli and to mass syntax cues than any of the control groups (for substances: G-SLI vs. TD1: $t(27) = 2.421$, $p = 0.022, d = 0.95$; G-SLI vs. TD2: $t(27) = 2.465, p = 0.020, d = 0.96$; G-SLI vs. CA: $t(32) = 4.728, p > 0.001, d = 1.67$; for mass syntax: G-SLI vs. TD1: $t(27) = 3.017, p = 0.006, d = 1.18$; G-SLI vs. TD2: $t(27) = 3.471, p = 0.002, d = 3.471$; G-SLI vs. CA: $t(32) = 5.192, p > 0.001, d = 1.84$). Both TD groups were discriminating between objects and substances, and between count and mass syntax, and the older CA children showed a complex response pattern, pluralizing more often in response to both objects and to substances when they heard a count syntax cue than when they heard a mass syntax cue (objects: $t(16) = 3.392, p = 0.004$; substances: $t(16) = 5.062, p < 0.001$). Within the count syntax condition, however, the CA group did not draw a significant distinction between objects and substances, suggesting that for these older children the presence of a count syntax cue can override semantic information about the nature of the referent. This finding is contrary to our prediction, which was based on observed patterns of increasing reliance on semantic cues in younger children (Gordon, 1985). Within the mass syntax condition, the CA group did attend to the semantic cue, suggesting that mass syntax cues did not override semantic information for these children, unlike the count syntax cues. This pattern of responses suggests that older children may be more sophisticated in their integration of different kinds of knowledge for the purposes of word learning than has been observed in younger age groups.

In contrast, the children with G-SLI did not show any evidence of attending to either semantic or syntactic cues, and even continued to produce overt pluralizations when both syntax and semantics were strongly biased against a ‘kind of individual’ interpretation. For instance, when mass syntax cues were accompanied by substance stimuli, there was a strong tendency for typically developing children to interpret the novel noun as referring to a ‘kind of stuff’. The children with G-SLI, however, continued to produce overt pluralizations in this condition, suggesting that they were impervious even to combinations of cues pointing to a particular interpretation.
To summarize, the children with G-SLI’s responses suggest that, for the purposes of lexical acquisition, they made no distinction between count and mass syntax cues in this task. More surprisingly, they also failed to take account of semantic properties of the referent, resulting in the production of overt pluralizations in all conditions—whether the semantic and syntactic cues were in accord or conflict with one another. This suggests the application of some over-learned ‘rule’ or strategy, and provides a stark contrast with the performance of age-matched and typically developing younger children. The control groups all produced significantly more overt pluralizations when the stimulus was an object than when it was a substance, and when the syntactic cue used count syntax than when it used mass syntax. They were sensitive to accord and conflict between syntactic and semantic cues, and showed evidence of the application of cognitive strategies to guide responses in the situation where the different cues were in conflict, suggesting a developmental trend towards increasing integration of different sources of knowledge for the purposes of word learning.

Clearly, semantic and syntactic cues interact and have different effects on the responses of typically developing children in this pluralization task. But does one kind of information take precedence over the other? There is some evidence from this first version of the pluralization experiment that children go through a stage of assigning precedence to semantic cues, later switching to giving syntactic cues more weight (e.g. the CA group produced 15% fewer substance name plurals than object name plurals, but 34% fewer plurals to mass syntax cues than to count syntax cues, suggesting that they found syntactic cues slightly more relevant; by contrast, the youngest TD group assigned somewhat more weight to the semantic cues, since they produced 21% fewer pluralized object names, but dropped only 31% of plural endings in response to mass syntax). If these children did rely primarily on syntactic cues to aid their subcategorization of novel nouns with respect to the count/mass distinction, neutralization of the semantic cues should not affect their ability to assign count/mass properties appropriately to novel nouns and their referents. And vice versa: if they rely on semantic cues, then neutralizing syntactic cues should have little effect. Therefore we investigated the effects of syntactic cues in isolation from semantic information, by utilizing materials which could not readily be categorized as either objects or substances (version 2 of the pluralization experiment).

2.4. Experiment 1b: neutralization of semantic cues

2.4.1. Materials

There were eight items in the neutral substance experiment—four were presented with count syntax cues, and four were presented with mass syntax cues. Other details of the procedure were identical to those described in experiment 1a. All referents (stimulus items) were indeterminate with respect to the object/substance distinction (lentils, bath crystals, etc.).

2.4.2. Results and discussion

The mean percentages of overtly pluralized responses given by the groups in this version of the pluralization experiment are shown in Table 3.
ANOVA revealed significant interactions between Group and Language Cue, once again suggesting that the different groups were responding to the count and mass syntax cues in different ways (SLI/TD: $F(3, 49) = 10.298, p < 0.001, d = 1.04$; SLI/CA: $F(1, 27) = 28.681, p < 0.001, d = 1.89$). Further investigation of the Group effects using one-way ANOVAs revealed that Group was a significant factor only when the Language Cue employed mass syntax (SLI/TD: $F(3, 52) = 6.366, p = 0.001, d = 0.82$; SLI/CA: $F(1, 28) = 17.339, p < 0.001, d = 1.47$), and planned comparisons (one-way ANOVAs) confirmed that the G-SLI group reliably produced more plurals overall than any of the control groups (G-SLI vs. TD1: $F(1, 28) = 5.175, p = 0.031, d = 0.89$; vs. TD2: $F(1, 28) = 5.533, p = 0.026, d = 0.92$; vs. CA: $F(1, 33) = 4.521, p = 0.041, d = 0.75$). Analysis of the simple effects using independent $t$-test showed that all the control groups, but not the children with G-SLI, significantly or marginally significantly differentiated between count and mass syntax language cues, producing greater numbers of overt plurals in response to the former (TD1: $t(11) = 2.028, p = 0.067$; TD2: $t(11) = 4.780, p = 0.001$; CA: $t(16) = 5.191, p < 0.001$; G-SLI: $t(16) = −0.566, p = 0.579$).

In sum, this version of the pluralization experiment neutralized the semantic cue which differentiated between objects and substances, and we found that the children with G-SLI continued to produce overt pluralizations regardless of the syntactic cue (mass or count syntax) provided. Overall, children with G-SLI appeared to be using a response strategy such as ‘add -s to form a plural’ without regard for syntactic cues, whereas their age-matched and language-ability-matched peers were sensitive to the syntactic count/mass distinction, producing fewer overt pluralizations to mass syntax cues. One possibility is that these children with G-SLI cannot make use of syntactic information to inform their interpretations of novel nouns, precisely because of the nature of their impairment. However, they may be able to use semantic cues about the nature of the referent to help them decide on the meanings of novel words. The next logical step was therefore neutralization of the syntactic cues, to establish whether the children with G-SLI were attending to the semantic properties of the stimuli.

2.5. Experiment 1c: neutralization of syntactic cues

2.5.1. Materials

The semantic cues for categorization of a referent as a ‘kind of individual’ versus a ‘kind of stuff’ remained in place in this condition, but all syntactic cues were held neutral, using determiners such as my or the which are not associated with either mass or count syntax.
There were eight items in the neutral syntax version of the pluralization experiment (four objects and four substances). For example:

**Stimulus**

**Object**

*Neutral syntax*: This is my/the dap. Can you say dap? Have you ever seen my/the dap before? So, here we have my/the dap, and over here we have more...what?

**Substance**

*Neutral syntax*: This is my/the pag. Can you say pag? Have you ever seen my/the pag before? So, here we have my/the pag, and over here we have more...what?

### 2.5.2. Results and discussion

Table 4 shows the mean percentages of overtly pluralized responses given by the four groups in the neutral syntax condition of the pluralization experiment.

All three control groups produced significantly more overt pluralizations in response to objects than substances (TD1: $t(11) = 2.548$, $p = 0.027$; TD2: $t(11) = 4.000$, $p = 0.002$; TD3: $t(11) = 6.092$, $p < 0.001$). However, the children with G-SLI did not make any such distinction (G-SLI: $t(16) = -0.846$, $p = 0.410$). Therefore, semantic cues alone do not appear to inform these children’s interpretations of novel nouns in the same way as they do for typically developing children. This is true even when the typically developing children score within the same range as the children with G-SLI on various measures of linguistic ability (TD1 and TD2); and it is still true even when the typically developing children are matched to the children with G-SLI for chronological age, and could therefore be assumed to have similar world knowledge and life experiences to draw on. By assumption, this failure to attend to semantic cues does not occur because the children with G-SLI lack understanding of ontological categories such as “kind of individual” versus “kind of stuff”; they are not irrational, and most of them were able to distinguish between objects and substances appropriately in the practice items. Furthermore, the pattern of responses on the two practice items was not found to be a reliable indicator of how the individual children were likely to respond in the experimental conditions. Most likely these results were influenced by an overlearned ‘pluralization’ routine applied by the children with G-SLI. To further evaluate their performance, and to investigate whether their default interpretation of novel noun could really be the same as that assigned by typically developing children (as a ‘kind of individual’ unless there is information to the contrary), we carried out a further version of the pluralization experiment in which both syntactic and semantic cues to meaning were neutralized. This condition was expected to yield results indicative of the children’s default assumptions about novel words, since they would be able to rely on neither semantic nor syntactic information to aid their interpretation.

<table>
<thead>
<tr>
<th>Semantic cue</th>
<th>G-SLI, mean% (S.D.)</th>
<th>TD1, mean% (S.D.)</th>
<th>TD2, mean% (S.D.)</th>
<th>CA, mean% (S.D.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objects</td>
<td>78.00 (38.40)</td>
<td>75.00 (30.15)</td>
<td>93.75 (15.55)</td>
<td>94.00 (14.05)</td>
</tr>
<tr>
<td>Substances</td>
<td>83.75 (33.00)</td>
<td>60.50 (41.90)</td>
<td>60.50 (34.48)</td>
<td>70.50 (30.93)</td>
</tr>
</tbody>
</table>

*Note*: four items per condition were presented to each child.
2.6. Experiment 1d: neutralization of both semantic and syntactic cues

2.6.1. Materials

Substances perceptually neutral between objects and substances were used, such as those described for version 2 of this experiment. These were labeled using novel words which were introduced using neutral syntax, providing no mass/count cues for interpretation. There were four items altogether in the neutral semantics/neutral syntax experiment.

2.6.2. Results and discussion

As before, the number of overt pluralizations was counted (see Table 5), and two sets of analyses were conducted: SLI/TD and SLI/CA.

One-way ANOVAs on the numbers of overtly pluralized responses produced in response to neutral semantic and syntactic cues did not reveal any significant group effects. One-sample *t*-test were used to establish whether the groups pluralized more often than predicted by chance. The two youngest TD groups were not significantly different from chance, but the other two groups pluralized significantly above chance level (G-SLI: *t*(16) = 4.564, *p* < 0.001; CA: *t*(16) = 4.933, *p* < 0.001). This suggests that all the older children, in the absence of evidence to the contrary, adopted a ‘kind of individual’ interpretation as a default. This is in contrast to younger children, who under these circumstances simply guessed at an interpretation. In other words, the tendency of the G-SLI groups to assign a default count/object interpretation to a novel noun reflected a strategy which was also utilized by older typically developing children when no cues to word meaning are provided, either syntactically (count vs. mass) or semantically (objects vs. substances). This strategy does not appear to be used by the younger children. This suggests the strategy might become available to children as the result of developmental improvements in their ability to attend to and integrate interpretive cues (or the lack of them) in the environment. Thus, by removing all syntactic and semantic cues which would ostensibly support a particular interpretation, we were able to create conditions under which the older typically developing children (the CA group) behaved in the same way as the children with G-SLI have done in all the experiments so far.

The sentence completion format utilized in these experiments provides one way to evaluate the underlying knowledge which children at various stages of development bring to bear on the task of word learning. However, the requirement to produce pluralized noun additionally assumes that children are able to make use of morphosyntactic processes to reflect underlying knowledge. Especially in the case of very young children and children

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean% (S.D.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G-SLI</td>
<td>86.75 (33.20)</td>
</tr>
<tr>
<td>TD1</td>
<td>58.25 (41.75)</td>
</tr>
<tr>
<td>TD2</td>
<td>70.75 (39.65)</td>
</tr>
<tr>
<td>CA</td>
<td>81.00 (25.83)</td>
</tr>
</tbody>
</table>

Note: four items per condition were presented to each child.
with grammatically based language impairments, it is likely that there is interference between these two levels of representation. This could result in an apparent failure to take account of syntactic and semantic cues to determine word meaning, when the real difficulty lies with the pluralization rule itself. This possibility could account for aspects of the performance of the youngest TD group on the pluralization experiments (for example, they did not quite reach statistical significance when distinguishing between count and mass syntax in the neutral semantics condition), and certainly could account for the consistent performance of the G-SLI group. Experiment 2 was conducted to address this possibility by using a procedure (based on Soja et al., 1991) which does not require mapping between conceptual representations and morphosyntactic processes, to tap more directly into the children’s understanding of the ontological categories ‘kind of stuff’ and ‘kind of individual’.

2.7. Experiment 2

2.7.1. Materials

We prepared sets of unfamiliar objects (such as plumbing joints, picture hangers, tool clips and tile corners) and unfamiliar substances (combinations of more familiar substances – such as tile spacers mixed with hair gel, or cat litter mixed in with hand cream – with some colors changed to make them more unusual). Substances were presented in wooden blocks, in the center of which a shape had been hollowed out; in each case the hollow shape was filled with the substance.

2.7.2. Procedure

The children were presented with the unfamiliar objects and substances one at a time. Objects were handed to the child, and in the case of substances the child was handed the block with the hollow shape filled with a substance. The children were encouraged to handle the objects and substances before the experimenter named the object/substance using novel words in either (1) an informative syntactic context (determiners: a for objects, some for substances) or (2) a neutral syntactic context (determiners: the/my).

As each item was presented, the experimenter also placed two additional stimuli on the table in front of the child. In the case of objects, the two new items were (a) an object of the same shape and size, made of a different material; and (b) several small pieces of the same material that the original object was made from. In the case of substances, the two new items were also hollowed out blocks with (a) the same shape as the original carved into it, but containing a different substance; and (b) three small, randomly shaped hollows,

```
<table>
<thead>
<tr>
<th>Named stimulus</th>
<th>Object trial</th>
<th>Substance trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test stimuli</td>
<td><img src="image1.png" alt="Object trial" /></td>
<td><img src="image2.png" alt="Substance trial" /></td>
</tr>
</tbody>
</table>
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Fig. 1. An example of an object trial and a substance trial. Different patterns indicate different substances.
containing the same substance as the original (see Fig. 1). The experimenter then asked the child a question, using the same determiners as in the original language cues (e.g. *which is my dop over here?*). The child was thus required to point to the object, shape or substance which they believed matched the intended referent of a novel word.

2.7.3. Coding of responses

The children’s responses were recorded and scored according to whether they picked out the object or substance which matched the original for *shape*. That is, shape matches scored 1, but substance matches scored 0. For example, in the case of object stimuli, if they chose the same object made of a different substance they scored 1; but if they chose the same substance in pieces they scored 0. In the case of substance stimuli, choosing the wooden block with the same shape hollowed out but a different substance inside was allocated a score of 1; choosing the same substance in three randomly shaped hollows was scored as 0. We therefore expected different scoring patterns for each condition: object stimuli with informative syntactic cues, for example, should score higher than substance stimuli with informative syntactic cues, because the former condition was expected to yield more object/shape match responses than the latter.

2.7.4. Results and discussion

Mean percentages of object/shape-match responses for each group are presented in Table 6.

Qualitative differences were found between the children with G-SLI and the TD groups. Analyses revealed that all of the children were attending to the semantic cues, making significantly more object/shape match responses to object stimuli than to substance stimuli (G-SLI: \( t(16) = 2.742, p = 0.014 \); TD1: \( t(11) = 3.009, p = 0.012 \); TD2: \( t(11) = 2.890, p = 0.015 \); CA: \( t(16) = 4.928, p = 0.021 \)). There was no such effect associated with the syntactic distinctions, although ANOVAs for the G-SLI and CA groups showed significant interactions between semantic and syntactic cues (G-SLI: \( F(1, 16) = 6.896, p = 0.018 \); CA: \( F(1, 16) = 4.765, p = 0.013 \)) demonstrating that children in these two groups were responding differently to the two types of syntactic cue for the objects and the substances. Analysis of the simple effects showed that the interaction for the CA children was due to effects of the syntactic cue when stimuli were *substances only*; the CA group chose the object/shape matched item significantly less often when the syntax was informative, showing that they were attending to syntactic information when the stimuli were not clearly

<table>
<thead>
<tr>
<th>Material</th>
<th>Language cue</th>
<th>G-SLI, mean % (S.D.)</th>
<th>TD1, mean % (S.D.)</th>
<th>TD2, mean % (S.D.)</th>
<th>CA, mean % (S.D.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objects</td>
<td>Neutral</td>
<td>48.50 (44.60)</td>
<td>77.0 (41.90)</td>
<td>75.0 (35.35)</td>
<td>70.50 (37.75)</td>
</tr>
<tr>
<td></td>
<td>Informative</td>
<td>66.25 (45.88)</td>
<td>73.0 (44.55)</td>
<td>73.0 (41.90)</td>
<td>73.50 (35.88)</td>
</tr>
<tr>
<td>Substances</td>
<td>Neutral</td>
<td>42.75 (43.98)</td>
<td>37.5 (43.3)</td>
<td>31.25 (38.63)</td>
<td>42.75 (43.98)</td>
</tr>
<tr>
<td></td>
<td>Informative</td>
<td>36.75 (46.03)</td>
<td>43.75 (44.13)</td>
<td>23.00 (37.63)</td>
<td>19.00 (30.00)</td>
</tr>
</tbody>
</table>

*Note: four items per condition were presented to each child.*
semantically biased towards a ‘kind of individual’ interpretation \( t (16) = -2.554, p = 0.021 \). However, the children with G-SLI reliably distinguished neutral from informative language cues for object stimuli only \( t (16) = 2.400, p = 0.029 \). The informative syntax apparently provided children with G-SLI with additional support for the object match response, so that an informative cue such as ‘a bip’ signaled to them an individuated singular object. This is a much more limited kind of syntactic knowledge than ‘knowing’ the mass/count distinction, but nevertheless the performance of the children with G-SLI on this task supports our conjecture that they do draw a distinction between ontological categories such as ‘kind of stuff’ and ‘kind of individual’, despite their apparent inability to reflect such distinctions in morpho-syntactic constructs such as pluralization. When the stimuli were substances, and/or the syntactic cues were neutral, the effects of this distinction were no longer seen; children with G-SLI did not reliably distinguish between the different types of syntax across the board (e.g. a paired-samples comparison between G-SLI responses to all informative vs. all neutral syntactic cues was not significant). This pattern of responses suggests that these children with G-SLI can use (limited) syntactic cues to aid in novel word interpretation, but they do so only when syntactic information accords with semantic cues. Note that we cannot claim on the basis of these results that children with G-SLI make ontological distinctions on the basis of syntactic cues; rather, we consider it a possibility that they have access to some awareness of syntactic cues as a corroboration of evidence from other modalities when they are assigning interpretations to novel words.

3. Summary of results

In these investigations of interacting sources of knowledge for assigning interpretations to novel nouns, we have observed some striking similarities and differences between G-SLI and typically developing children. Typically developing children (aged 5–15 years, across the control groups) demonstrated maturational effects, showing evidence of an increasing ability to integrate different kinds of information for noun interpretation. They attended in particular to semantic information about the nature of the intended referent, showing secondary effects of syntactic cue—a pattern which replicates and extends the findings of Gordon (1985) with respect to younger children. In addition, the youngest control groups were found to respond at chance when all interpretive cues were removed from the experimental paradigm (i.e. neutral semantics and neutral syntax), whereas under the same conditions older children demonstrated a bias towards interpreting novel nouns as referring to a ‘kind of individual’ rather than a ‘kind of stuff’. This suggests that application of a default interpretation under such circumstances is a developmental effect. No such maturational effects were apparent within the G-SLI group. Overall the effects of different kinds of cues for the interpretation of novel nouns were always more limited for the children with G-SLI than for the control children, no matter how the experimental paradigm was varied. However, the children with G-SLI demonstrated some minimal ability to make use of words within a syntactic context to support a ‘kind of individual’ interpretation.
4. General discussion

Since lexical acquisition is one kind of linguistic learning which continues throughout life, it is of interest to investigate age differences with respect to interpretation of novel words in typically developing children. The results of these experiments showed that older children continue to make use of both semantic and syntactic knowledge in tasks designed to tap into aspects of lexical representation. This series of experiments manipulated only two basic kinds of information: mass versus count syntactic cues, and semantic distinctions between objects and substances. The existence of a developmental trend towards increasing integration of these two kinds of information was particularly evident across the three control groups in the situations where children were presented with conflicting semantic and syntactic information (experiment 1a). Although our data are cross-sectional and not longitudinal, the results from experiment 1a (Table 2) show that the youngest typically developing children (TD1) seem to be guessing at an object/substance interpretation in the conflict conditions. The next oldest groups (TD2 then CA) are progressively more influenced by the semantic cue when the mismatch involves object stimuli, and by the syntactic cue when the mismatch involves substance stimuli. One possibility is that this reflects a fallback position, whereby the default interpretation is “individuated object”; however, it is clear from our other results that children are quite able to depart from this default. For instance, in experiment 1c, where semantic cues are unavailable, these children do not simply revert to the “object” interpretation; rather – and in sharp contrast to the children with G-SLI – they respond to the syntactic cues they are provided with. In the condition where substances were presented with neutral syntax (providing a semantic bias towards a ‘kind of stuff’ interpretation, but no supporting syntactic information). Neither the semantic nor the syntactic cue supported a ‘kind of individual’ interpretation. The TD1 controls randomly allocated ‘kind of individual’ or ‘kind of stuff’ interpretations to the novel nouns in these conditions, but the TD2 and CA children showed a significant tendency towards ‘kind of stuff’ interpretations which increased with age. These patterns suggest that children do not shift from reliance on semantic category knowledge to reliance on syntactic information to inform novel word interpretations, because such a shift should be reflected by greater numbers of ‘kind of stuff’ interpretations allocated by younger children than by older children, in the substance/neutral conditions. Rather, as they get older, typically developing children apply increasingly sophisticated integrative operations over different knowledge sources, permitting the interpretation of novel words within a complex linguistic and communicative context.

This view of maturational interpretive strategies developing over time and having increasing influence on word learning is supported by the different performance patterns of older and younger children when both syntactic and semantic cues were neutralized. We demonstrated that this situation induced older typically developing children to rely on a strategy such as that used by the children with G-SLI, resulting in more overt pluralizations (and hence presumably more “kind of individual” interpretations) than when additional linguistic information was made available. Under the same circumstances, the younger typically developing children performed at chance, suggesting that interpretive strategies emerge as the result of experience and increasing problem-solving abilities—abilities which, such as lexical learning itself, continue to develop throughout life.
The G-SLI group showed some ability to make use of grammatical knowledge for the purposes of lexical acquisition, counter to the possibility that children selected for their difficulties in the syntactic domain would remain insensitive to any syntactic cues. This performance does not support a view of SLI as a disorder with a single underlying cause. In particular, input-processing deficit accounts of SLI (e.g., Joanisse & Seidenberg, 1998; Leonard, 1998) cannot capture the performance of our G-SLI group, because they demonstrated effects of informative syntactic cues (in particular the count determiner *a*, despite its low perceptual salience). Further, because the children with G-SLI did not perform in the same way as younger typically developing controls, we cannot argue for a delayed-but-normal view of their word learning abilities, as has been suggested with respect to grammatical abilities (e.g., Rice & Wexler, 1996). In this study the older typically developing children only performed similarly to the G-SLI group when syntactic and semantic cues were neutralized, and younger control children performed at chance in this situation—a pattern of performance not evinced by the children with G-SLI in any of the experimental manipulations reported here. These data are difficult to interpret without recourse to a well-articulated theoretical account of the nature of the underlying deficit in G-SLI, since children with a grammatically based language disorder could be expected to have particular difficulties in accessing information which is dependent on a syntactic distinction such as count/mass. However, van der Lely’s (2004, 2005) Computational Grammatical Complexity (CGC) account holds that children with G-SLI do not have a total linguistic deficit, but are impaired in structures requiring particular kinds of syntactic dependencies (including, for example, passives, tense marking, pronominal reference, question formation) (van der Lely, 1998, 2004, 2005).

The CGC maintains a distinction between hierarchical structural complexity in the domains of syntax, morphology and phonology. The CGC claims that with respect to the syntactic component, children with G-SLI are impaired in syntactic dependencies involving feature checking. Checking is a process of deleting uninterpretable features from a syntactic representation before it reaches the interfaces between language and other cognitive mechanisms (Chomsky, 1995). To be deleted, features must be in particular structural relations with syntactic heads or operators. Checking therefore requires a well-developed structure-building mechanism which is sensitive to all constraints and dependency requirements within a language. According to the CGC, children with G-SLI are specifically impaired in representing checking relations which incur what linguists call “movement” (Chomsky, 1995)—for example, the structural relations between a wh-word in a question and the object Noun, to which the wh-word is related, but which is overtly absent in questions (Who_ did you see _ to). However, consider nouns within the determiner phrase (nouns appear as the complements to determiners—Abney, 1987). Here, dependencies are also established through feature-checking. However in contrast to questions, this checking is carried out via what linguists call AGREE (roughly speaking, a more local checking domain). Checking via Movement is considered more complex and is acquired later than checking via AGREE (Friedmann & Lavi, 2006). Some languages, however, have no checking requirements within certain syntactic domains, and it has been proposed that English determiner phrases could be one such domain (Rappaport, 2001). Under such a view, it is not difficult to see how children with grammatical impairments could retain some understanding of the syntactic properties of determiners, especially in
English and other languages which lack feature-checking (and, by hypothesis, also lack associated structural complexity) within the determiner phrase.

Cross-linguistic studies have shown that access to syntactic properties of determiners can be problematic in SLI (e.g. German: Roberts & Leonard, 1997; French: Jakubowicz, Nash, Rigaut, & Gérard, 1998; Greek: Tsimpli & Stavrakaki, 1999). Even so, and remaining theory-neutral with respect to the nature of the underlying deficit in G-SLI, it is nevertheless clear that the word learning tasks discussed here require access to only limited syntactic knowledge. It may be the case that awareness of (some of) the semantic and phonological characteristics of even a limited set of determiners may suffice for the allocation of an interpretation to a novel noun. Our present results indicate that the G-SLI subgroup have access to this kind of information about some determiners—though it could be as limited as understanding that a, for instance, can function as a non-specific singular marker. This hypothesis is supported by the G-SLI group’s overall selection of more object/shape matched stimuli in experiment 2 when they were presented with an object introduced by the determiner a. Because the array included an object of a different substance but the same shape, and three pieces of the same substance but with different shapes, their more frequent selections of the former could minimally indicate knowledge of the singularity inherent in the determiner a rather than any underlying knowledge about semantic (object/substance) or syntactic (count/mass) distinctions. This may or may not constitute semantic, rather than syntactic, knowledge about the construal of determiners (e.g. Longobardi, 1994). Note that the informative syntax cue in experiment 2 only helped the children with G-SLI when concordant semantic cues were also present. The rest of the time, the children with G-SLI seemed to be responding according to a strategy, dictating that they interpret novel nouns as referring to ’kinds of individual’ unless there is good evidence to the contrary.

4.1. Theoretical and clinical implications

Our results provide support for the view that word learning crucially involves interactions between syntax and semantics. Additionally, we have preliminary evidence to suggest that children’s strategies for assigning relative weight to syntactic and semantic properties of referents change over time, so that it may not make sense to think in terms of an ongoing bias towards one particular kind of representation. The performance of the children with G-SLI indicates that they are able to access and make use of some syntactic knowledge in the acquisition of novel words, which speaks to the existence of a partial (not total) deficit in the grammatical system. The CGC account proposed by van der Lely (2004) provides one way to understand which aspects of the grammatical system are impaired, and which may be developing normally. Cross-linguistic research would shed additional light on these questions (see Friedmann & Novogrodsky, 2004, 2007; Stavrakaki, 2006).

Intervention approaches are not typically based directly on research of this nature. However, it seems possible that there could be some direct clinical implications of our findings, especially in context of previous findings which support the view that children with SLI have difficulties in many domains, and that all of these can interact to make word learning more difficult. Children could be provided with additional strategies for retaining information about the meanings of new words, particularly in educational environments.
Reinforcement of lexical learning using a variety of input modalities, similar to the semantic enrichment approaches often taken to cases of acquired language disorder (e.g. Boyle, 2004), or semantic feature approaches like those used in literacy development (e.g. Anders & Bos, 1986) may aid in (a) providing additional exposures to novel terms, resulting in improved retention; and (b) enhancing the representation of semantic features associated with novel terms. Such work is of course already being undertaken by speech-language pathologists who work with these populations. Furthermore, a clinical trial using such an approach has been conducted, where children with G-SLI were provided with either enriched semantic therapy, or syntax and semantic therapy together (Ebbels, van der Lely, & Dockrell, 2007). Crucially, this study followed clear identification of the precise syntactic deficits in the children, prior to directing meta-syntactic and meta-semantic therapy. It would be of interest to see if such an approach could be used to address word-learning problems in SLI.

4.2. Study limitations and future avenues for research

It is clear that there are several limitations of this study. We were able to identify 17 children presenting with a profile compatible with G-SLI. However, this is still a low n, and the participants represented children across a wide spread of ages. Therefore, generalizability of these results, even to other children with G-SLI, is necessarily limited. The number of items in each condition was likewise very small, due to constraints of the amount of time we could work with each child, and the number of conditions being concurrently presented. The set of experiments reported here was embedded in a set of other activities, which served to disguise the aim of the study, but which also meant that very many unrelated and distractor items were presented in one testing session. Under these circumstances it was not possible to have a higher number of trials per condition. This limitation of the experimental design could be addressed in future work.

There are difficulties in diagnosing grammar-specific language impairments, and it is clear from the assessment results (Appendix A) that there remained some variability in performance within our G-SLI group. This serves to illustrate a point often made in the literature concerning the heterogeneity of language impairment and whether the G-SLI subgroup are qualitatively different from other children with SLI. After some 20 years of behavioral data, perhaps current imaging or genetic evidence will eventually provide us with a definitive answer. Whatever the answer, however, clear characterization across multiple domains of language is essential. There were also problems in identifying an appropriate control group for the children with language impairment, as with all studies of disordered populations—and there is no perfect solution. We attempted to address these issues by using three different control groups, matched to our G-SLI group on different variables: test scores in vocabulary, test scores in grammar, and chronological age. Nevertheless, possible confounds remain: variability in performance on various assessments and on experimental tasks, both within and between the groups; different ages and experiences for the children in the TD1 and TD2 groups; and very different educational experiences for the children in the CA group, all contribute to the difficulty of obtaining a realistic match with the children in the G-SLI group.
Additionally, we were interested in addressing questions concerning the relative importance of syntactic and semantic cues for word learning in children across a range of ages. Cross-sectional data provide only a limited glimpse into developmental changes. Longitudinal data obtained for the same children over a long period of time would provide greater insight into these questions.

There may be other methods of tapping more directly into the children’s understanding of novel nouns without adding a layer of morphosyntactic complexity to the task. For instance, interesting work has demonstrated that gesture can be a useful index of learning state, even in very young children (Capone, 2007). As we demonstrated, experimental approaches to language impairment need to carefully evaluate the response modalities made available to the participants, since these may be interacting in interesting ways with the source of the impairment itself.

The study conclusions, as well as the limitations, lead to some future avenues for research to extend our understanding of the issues addressed here. Our experiments manipulated only one perceptual/semantic cue (objects vs. substances) and one syntactic cue (mass vs. count syntax). To gain greater insight into the relative roles of conceptual and linguistic cues for word learning, and how they interact, it is necessary to identify and experiment with additional semantic and syntactic properties of novel words. For instance, semantic properties like animate/inanimate certainly interact with mass/count syntax; and syntactic properties not directly associated with the noun itself, such as verb subcategorizations, interact with noun interpretation. An interesting case would be the acquisition of collective nouns, since these are individuated terms for collections of objects; this situation provides an interesting intersection between the mass and count properties we have examined here, and could be very valuable in shedding further light on our research question (Bloom, 1996; Bloom & Kelemen, 1995).

We used two different indices of understanding: one involving overt morphosyntactic marking, and one involving a non-verbal response. Future research may focus on the effects of other response modalities and indices of cognitive state, such as observations of children’s use of novel terms after a period of assimilation.

In order to more directly address our question about the impact of grammatical disability on word learning, it would be of interest to conduct detailed language assessments on a wider range of children with language impairment with the aim of identifying any who have a differentially greater difficulty in the lexical domain. A comparison between children with a lexical specific language impairment and those with a grammar specific impairment could be most illuminating in terms of the particular pattern of deficits which would interact with word learning tasks like these. It is difficult to identify such children, since the highly interactive nature of the grammar and lexicon means that a deficit in one will affect the other, especially by the ages we have examined here. However, as we become more adept at identifying specific language impairment in younger and younger children, it may become possible to examine the effects of such specific impairments at very early stages, which in turn could present a window into the nature of the grammar-lexicon interaction itself.

In closing, we have shown that children with a primarily grammatical developmental language disorder, who do not have cognitive or sensory deficits in other domains (van der Lely et al., 2004), are under certain circumstances able to assign interpretations to a novel
word. This corroborates a view of lexical development as a robust process which will proceed on the basis of even very limited syntactic representations. Word learning is a dynamic process, which changes throughout development, and is based not only on the linguistic capacity to distinguish between grammatical forms, but also on conceptual and other abilities: at least, the capacity to apprehend relations between objects, and the expectation of a link between the conceptual and linguistic representations (Waxman, 2004; Waxman & Booth, 2003). In G-SLI, as we have shown, there is a marked deficit in grammatical representations, and an attendant impact on the ability to associate novel words with their denotations. Nevertheless, lexical learning does proceed under conditions of G-SLI, and access to limited grammatical representations for the purposes of lexical acquisition is possible. Thus, this investigation of word learning in grammatical impairment could be interpreted as providing support for a view of lexical acquisition as independent from – though still related to – processes underpinning grammatical development.

Acknowledgements

We would such as to thank all the children who took part in this study. We also thank the parents, teaching staff and speech and language therapists at Moor House School, Hurst Green; Dawn House School, Nottingham; St. Mary’s Primary School, Islington; Bishop Winnington-Ingram School, West Ruislip; and Stoke Newington Secondary School, London. Shannon Connair, Pat Davis, Nichola Gallon, Joe Green, Alexandra Perovic and Andrew Simpson carried out testing and coding of results, Steve Long helped with statistical analysis, and Sue Nicholas and Harish Patel helped to make the experimental materials; we are very grateful to all of them. Special thanks also to Jackie Battell for invaluable help and support at every stage of this study, from preparation of materials to reading of drafts. Thanks also to Jessica Young, for her help and for many valuable discussions, and to Melissa Randazzo for work on the manuscript. This study and the two authors were supported by Wellcome Trust Grants (no. 059876/2/99/063713) awarded to the second author.

Appendix A. Individual performance on criterion assessments

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<th>IQ (BAS)</th>
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<th>BPVS z-score</th>
<th>TWF Raw score</th>
<th>TWF z-score</th>
<th>TROG Raw score</th>
<th>TROG z-score</th>
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<th>VATT Raw score</th>
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<th>TWF z-Score</th>
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<th>TROG z-Score</th>
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a  z-Score not available for age of subject.
b  Note, this subject had participated for a number of years (8+) in our studies, and his scores on TROG now fell within normal limits. However correct scores on some items on this test can be achieved with only semantic/lexical knowledge, and the test does not target items we know that Children with G-SLI are particularly impaired on. On those that do (e.g. VATT, or assigning theta roles to active and passive sentences, as well as on other measures of syntax requiring non-local dependencies), he showed the same grammatical deficit as the other Children with G-SLI.

Appendix B. Continuing education

1. Children with specific learning impairment have difficulties acquiring the meanings of new words, most likely because
   a. they have reduced problem-solving abilities
   b. they have difficulties representing syntactic information about individual lexical items
   c. their phonotactic representations of new words are impacted
   d. it is difficult for them to integrate semantic and syntactic information
   e. all of (b), (c) and (d) above

2. Children with grammatical specific language impairment form a subgroup of children with SLI, because they
   a. have impairments primarily in grammatical components of language (syntax, morphology, phonology)
   b. have impairments in language which are heterogeneous in nature
   c. have impairments with general cognitive processing which impact primarily on linguistic processing but can also be found in other processing tasks
   d. have difficulties with rapid auditory processing of linguistic cues to word meaning
   e. have fewer difficulties with language development than children with SLI

3. Which three of the following statements accurately reflect current opinion on the status of the count/mass distinction in cognitive development?
   a. Development of the syntactic count/mass distinction is based on the real-world distinction between objects and substances.
   b. The count/mass distinction is stable across languages, so that mass or count syntax used in one language accurately predicts its appropriate use in other languages.
c. Knowledge of objects and individuation develops earlier than knowledge of the syntactic count/mass distinction.

d. The syntactic mass/count distinction probably maps onto cognitive categories, rather than classes of objects and substances in the real world.

e. Mass nouns are lexically marked, and count nouns are syntactically marked, showing that the mass/count distinction is a phenomenon at the interface of multiple linguistic systems.

4. When all cues to novel noun interpretation were removed from the experimental paradigm, how did the youngest control children respond?

a. They interpreted all novel nouns as referring to objects rather than substances, suggesting reliance on a default object-biased interpretation strategy.

b. They interpreted all novel nouns as referring to substances, suggesting a preference for the most tactiley appealing referents.

c. They were unable to select any response to the experimental task, and the results could not be coded.

d. They performed at chance, selecting object and substance interpretations in roughly equal measure.

e. They behaved in exactly the same way as the children with grammatical SLI.

5. Which of the following is not an accurate statement about the study findings?

a. Control children showed primary effects of semantic cues, with secondary syntactic effects, and an increasing ability to integrate different kinds of information over time.

b. Children with G-SLI did not show evidence of maturational effects, and seemed to rely on learned strategies such as overt marking of the plural rather than having recourse to linguistic knowledge about the count/mass distinction.

c. Children with G-SLI cannot make the syntactic mass/count distinction, and this severely impacts their ability to distinguish objects from substances in the real world.

d. Children with G-SLI can make limited use of syntactic cues to aid in novel noun interpretation, but not when there is any conflict between syntactic and semantic information.

e. Effects of different kinds of cues for novel noun interpretation were more limited across the board for children with G-SLI than for children in the control groups.

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