The semantics of syntactic structures

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Over the past 15 years, both linguists and psycholinguists have shown a growing interest in the idea that syntactic structures can carry meanings that are independent of the meanings of specific words. This article considers how this idea relates to traditional notions of compositionality in generative grammar, and examines two modern theories that, although based on different starting assumptions, both readily allow syntactic structures to bear independent meaning. We review work from psycholinguistics suggesting that observation alone is often insufficient to support the efficient learning of word meanings, and that some of the 'slack' left by observation can be picked up by the semantics of the syntactic structures in which words appear. We argue that this convergence between linguistic theory and psycholinguistic experimentation should be no surprise, because language must be learnable.

'*Twas brillig and the slithy toves / Did gyre and gimble in the wabe; / All mimsy were the borogoves, / And the mome raths outgrabe*'[1].

The nouns, verbs and adjectives in this famous piece of verse are all inventions, products of Lewis Carroll's febrile imagination. And yet as readers we have a sense – imprecise, perhaps, but real nonetheless – that we know what is going on in this poem. Take the first two lines. It is plain that two or more creatures of some kind (*the slithy toves*) are engaged in a couple of different activities (*gyring* and *gimbling*), while remaining in a fixed location (*in the wabe*). Why is Carroll's prose not utter gibberish? How are we able to extract meaning from it? The answer is that meaning can be inferred from the syntax of these lines, independent of the words that appear in those structures.

The past 15 years have seen a blossoming of interest in the semantics of syntactic structures. This interest has taken two related forms: among linguists, as an intensified examination of the role that syntactic structures play in the composition of sentence-level meaning; and among psycholinguists, as a proposal for how children might overcome some of the serious problems associated with word learning. This article aims to review these two lines of work and show how they relate. Although we are not the first to note this connection, we believe this article offers the first synthesis of this work grounded in both linguistics and psycholinguistics.

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What are the semantics of syntactic structures (TSOSS)?

By 'syntactic structures', we mean large units of syntax, in particular noun phrases (NPs) and verb phrases (VPs). By 'semantics' we mean abstract notions such as objecthood, substancehood, causation, motion and mental activity. TSOSS are carried independently of the open-class content words (nouns, verbs and adjectives) that inhabit these structures (although certain closed-class words such as prepositions and the plural marker '*s*' are also integral to TSOSS). For now, we offer some concrete examples of these structures and their semantics, deferring more-detailed discussion until the next section.

Mass nouns and count nouns, for example, characteristically appear in different NPs. The mass noun *milk* generally appears as a bare noun, as in '*Mary bought milk*'. The count noun *glass*, by contrast, typically appears with a determiner of some kind, as in '*Mary fetched three glasses*'. Critically, count nouns and mass nouns are not prohibited from syntactic cross-dressing; when such cross-dressing occurs, however, the resulting semantic interpretation is a function of the dress, not of the wearer. Compare '*Mary bought glass*' with '*Mary fetched three milks*'. Here, the structure of the NP acts as the engine of construal, guiding one to imagine either a non-individuated substance (*milk*, *glass*) or a countable entity (*three glasses*, *three milks*).

Much as NPs can guide the construal of objects, VPs can also guide the construal of events. Consider the effects of placing the verb *kick* in a variety of syntactic environments. In the sentence '*Susan kicked the ball*', the verb denotes an event involving contact or causation; in '*Susan kicked the ball to Bob*', it denotes an event of transfer; in '*Susan kicked her way out of the locked closet*', it denotes an event of motion by kicking. Where do these different construals of the kicking event come from? One answer is that each use of these uses of *kick* represents a different sense of the verb. Another answer – the one that we pursue in this article – is that the VP itself carries semantic content, and it is these semantics that effect the appropriate construal.

TSOSS and linguistic theory

Modern notions of syntactic structure date back to Noam Chomsky's early work[2]. Within the framework of his *Aspects of the Theory of Syntax*[3], transformations served to map deep structures generated by the rules in the base of the grammar to surface structures that could then be pronounced by the phonetic–phonological system. To take an example, the basic structure 'Elvis shot the television' served as the deep structure for both the simple active sentence '*Elvis shot the television*' and the passive sentence '*The television was shot by Elvis*'. According to Chomsky, semantic interpretation took place on the configuration of 'deep structure'. The subject of a verb was interpreted as the 'doer' (later called the Agent), while its direct object was interpreted as the 'done-to' (later called the Patient). Transformations re-ordered elements and made essential structural modifications (for example, adding the preposition *by*

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to the passive), but did not affect the truth-conditional semantics of the sentence[4]. As a result, the NP *Elvis* assumed the same logical role in both the active and passive sentences cited above, despite occupying different surface positions in the two cases.

Faced with evidence that deep structure, as outlined in *Aspects of the Theory of Syntax*, could not yield a full semantic interpretation, syntacticians in the 1960s pursued two different tacks. Generative Semantics greatly enhanced deep structure so that it contained a large number of abstract elements not pronounced in surface structure (such as the meaning CAUSE); prior to pronunciation, these elements were replaced by words, although often not in a one-to-one fashion (CAUSE-DIE, for instance, would be replaced by *kill*)[5]. Interpretive Semantics, by contrast, posited additional levels of representation, each of which captured a different component of meaning[6]. Despite their differences, these two theories both adhered to a strict view of compositionality, wherein words (or unpronounced abstract elements) were the sole meaningful units in language. Some modern incarnations of Interpretive Semantics have incorporated the Generative-Semantic notion of abstract meaningful elements[7]. Importantly for our purposes, no theory descended from *Aspects of the Theory of Syntax* has posited rules that refer to syntactic structures as such. Instead, the descendants of this work derive complex structures from the interaction of a small set of universal principles and language-specific parameters[8,9]. To the extent that syntactic structures remain, they are seen as epiphenomenal products of these interactions, with no independent contribution to the composition of sentence-level meaning.

Some recent developments in linguistic theory have taken an altogether different approach, rethinking, among other things, the links between syntax and semantics, and the nature of compositionality. In what follows, two modern linguistic approaches consonant with our notion of TSOSS are examined in depth: that of Ray Jackendoff[10] and that of Adele Goldberg[11]. Many linguists would disagree strongly with the positions we review. Nonetheless, we think it striking that two linguists working from different starting points have come to similar conclusions about the meaningfulness of syntactic structures. This convergence, in our view, lends further credence to the notion that TSOSS have an important role to play in language interpretation.

Jackendoff's approach

Despite being one of the first proponents of Interpretive Semantics[6], Jackendoff has broken with that tradition in several ways. Nonetheless he continues to share its commitment to building a grammar around the minimum number of logically necessary components. In Jackendoff's theory of Representational Modularity, syntax is not the only, nor the most central, generative linguistic capacity[10]. Rather, the theory accords equal status to syntax and to its companion linguistic capacities, phonology and semantics. All three modules are generative, have their own unique principles of design and function, and are linked by sets of 'correspondence rules', which register information in one module with information in another. Words themselves are correspondence rules, linking the phonological, syntactic, and semantic modules. To take a simple case, the word *dog* is a triple of information: the phonological form /dog/, the syntactic category COUNT NOUN, and the semantic entity DOG. Each module has access only to its own type of information, and is blind to information in other modules. The word *dog* exists to link these three pieces of information.

'Theories of compositionality must take into account not only the meanings of words, but also the meanings of syntactic structures.'

Correspondence rules do not always work so simply. For example, the preposition *of* in English is a pronounceable word and has a syntactic category, but it is not registered to anything in the semantic module. It exists merely to satisfy the requirement that all nouns be assigned case[8]. In order to explain how some words can have syntactic properties but no meaning, it is essential for Jackendoff that intermodular correspondence not be exhaustive. Once in place, the failure of total correspondence opens the door to TSOSS. For example, in the idiom '*kick the bucket*', neither the verb nor the NP is registered separately to a unit of semantics. Only the VP as a whole corresponds to the meaning DIE. In this example, the meaning of the idiom depends on the particular content words in the structure ('*kick the pail*' has a completely different meaning), but nothing in Jackendoff's theory requires that particular content words be present in order for a structure to be registered to something in semantics. The mechanism required to link the whole VP '*kick the bucket*' to the meaning DIE can just as easily link a more abstract VP such as '*verb the noun*' to a meaning like 'ACT on ENTITY so that it is AFFECTED'. In fact, the non-exhaustive nature of the correspondence rules predicts the existence of meaningful, but lexically 'poor' phrases and clauses – in other words, TSOSS. So while Jackendoff himself has not argued for the existence of TSOSS, we believe they follow quite naturally from the architecture he has proposed.

Goldberg's approach

Goldberg approaches the relation of syntax to semantics from a direction precisely opposite to that of Jackendoff. Whereas Jackendoff begins with a small number of necessary premises and derives from

them complex syntactic behaviors, Goldberg begins by analyzing some of the most complex syntactic behavior in all of language – idioms, metaphor and innovations – and from there deduces the underlying principles of the grammar.

The central element of Goldberg's theory is the 'construction'. A construction is a form–meaning pair, where the form can be a morpheme, a word or, most importantly for our purposes, a chunk of syntax. Goldberg takes as her starting point a dissatisfaction with the typical analysis of the syntactic flexibility of verbs. On the typical view, the fact that the verb *sneeze* can appear in both '*Sue sneezed*' and '*Sue sneezed the napkin off the table*' means that *sneeze* has two distinct senses – one denoting a bodily function, the other denoting caused motion with the body as the means of motion[12,13]. Goldberg points out that the meaning of the verb varies systematically with its structural frame. It is therefore at least as plausible to claim that the meaning of the verb remains constant, and to attribute the meaning change to the frames instead. Moreover, by attributing meaning to frames, we can eliminate much of the polysemy required by the alternative analysis, thereby achieving a more parsimonious lexicon.

What, then, is Goldberg's analysis of '*Sue sneezed the napkin off the table*'? Briefly, she posits three basic components: the verb *sneeze*, whose meaning remains invariant across syntactic environments; the construction, meaning 'caused motion'; and 'linking rules' to integrate them. The construction itself is a form, as defined by its syntax (NP V NP PP), paired with a meaning, as defined by the abstract semantics of caused motion (X CAUSE Y GO to Z). The linking rules constrain which verbs can appear in which constructions, as well as the interpretations they can receive there.

In English a verb can typically be used in a construction if it designates a subtype of the construction event-type (CET), the means of the CET, the result or precondition of the CET, or, in very limited cases, the manner, means of identifying, or intended result of the CET. Moreover, the verb's event type and the CET must share at least one participant. These constraints readily permit a wide range of verb–construction pairings, including '*sneeze the napkin off the table*', as sneezing is easily construed as the means of the caused motion. At the same time, these constraints also exclude odd sentences such as '*Sue thought the napkin off the table*', because '*think*', relative to the caused motion construction, satisfies none of the above constraints (unless, of course, one believes in telekinesis – see Outstanding questions).

Reflections of TSOSS in Jackendoff and Goldberg: a summary

Although Jackendoff and Goldberg begin from very different theoretical positions, each favors a relationship between syntax and semantics that resonates strongly with our own conception of TSOSS. We should emphasize, however, that neither linguist would fully endorse our particular conception of this relationship – nor we theirs. For Jackendoff, relations of syntax to semantics are too complex and language-particular for lexically poor units of syntax to contribute in any interesting way to sentence-level semantics. We believe that such relationships, while imperfect, are regular enough to be semantically potent. For Goldberg, our conception of TSOSS is too limited. In her view, every syntactic unit – words included – can be assigned semantics in a formally equivalent way. For a variety of reasons, we do not believe it makes sense to treat syntactic structures like words. And unlike Goldberg, we do not believe that verb–construction pairings are constrained only by cognitive factors such as whether an action can be construed as the means of caused motion. Indeed, we are convinced that formal lexical–syntactic properties (such as aspect[14]) play a fundamental role in determining which verbs can appear in which structures. Despite these differences, there is nonetheless a striking convergence of opinion on the relation of syntax to semantics, thus lending credence to the idea that theories of compositionality must take into account not only the meanings of words, but also the meanings of syntactic structures.

TSOSS and word learning

Word learners must solve numerous problems. One key problem is knowing what to pay attention to in a world that frequently provides complex scenes open to multiple construals, some more salient than others. Another is learning words whose referents cannot be observed. In this section, these problems are considered as they apply to nouns and verbs, and how TSOSS might help learners to overcome them is discussed.

Learning the meanings of nouns

Languages have three types of nouns: proper, count and mass. These nouns can be distinguished according to their distributional properties. In English, count nouns appear with determiners such as *a* and *every*, and they pluralize. Mass nouns, by contrast, appear bare, with determiners like *some* and *much*, and they do not pluralize. Both count and mass nouns can appear with the determiner *the*, and the latter can be converted into the former by the use of classifying phrases such as '*a bottle of X*' and '*a grain of Y*'. Proper nouns are names and appear with no determiners at all.

This section focuses on experiments that explore the mass–count distinction, although equivalent experiments have been conducted with proper nouns and show similar results[15,16]. The fundamental question for these noun-types is which noun appears in which syntax. On the face of things, it seems plausible to say that the world determines how a

Box 1. Roger Brown's classic study

The notion that syntax might assist the language learner was first explored by Roger Brown in his now classic study of word learning[a]. Brown showed children ranging from three to five years old a scene that depicted a woman kneading confetti in a striped bowl. As he showed the picture, he said, '*In this picture, you can see sibbing/some sib/a sib*'. Brown then showed the children three additional pictures, each of which reproduced a separate component of the original scene – the substance, the container and the motion – and asked them to show him '*another picture of sibbing/some sib/a sib*'. Children's responses varied with the form of the question: asked to show *sibbing*, children pointed to the hands; asked to show *some sib*, they pointed to the confetti; and asked to show *a sib*, they pointed to the bowl. Thus, the syntactic context of the novel word influenced the interpretation children gave to it.

At the time, Brown was not explicitly interested in the relation of syntax to semantics, or in the role that syntax plays in lexical acquisition. Rather, he took the study as evidence for an effect of language on thought – the form of language that children heard influenced their conception of the complex scene. Indeed, the title of Brown's paper – 'Linguistic determinism and the part of speech' – makes plain his interpretation of this work. Whether these results should be seen as Whorfian in nature remains unclear. What is clear, however, is that Brown uncovered a powerful phenomenon, which, over the past decade, has achieved great prominence among researchers studying lexical acquisition.

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noun is treated syntactically: objects get count syntax, and substances get mass syntax. This simple story cannot be correct, however, because the syntactic assignment of nouns is inconsistent both within and across languages. Witness the English words *fruit* and *vegetable*. The former is treated as a mass noun, and the latter as a count noun. Moreover, the word *hair* in English is a mass noun, while its counterpart in Italian, *cappelini*, is a count noun.

Alternatively, it is possible that the assignment to count or mass is arbitrary and strictly syntactic, and languages dictate on a case-by-case basis whether a noun is to be treated as mass or count. This view, however, misses a massive correlation, both within and across the world's languages, between perceptual properties and syntactic assignment. In point of fact, nearly all objects are treated as count nouns, and nearly all substances are treated as mass nouns.

It is clear that the syntax of noun phrases carries semantic content, because the syntax determines which construal is appropriate. What, exactly, is that content? It is tempting to conclude that count syntax means 'object' and mass syntax means 'substance'. However, it cannot be this simple, because things that are not objects are marked with count syntax (*a noise*, *a belief*, *a party*), just as things that are not substances are marked with mass syntax (*thunder*, *knowledge*, *music*). Although the precise semantics have not yet been identified, it is generally agreed that count syntax marks individuals, whereas mass syntax marks non-individuated elements[17,18]. Although these semantics are abstract, they are concrete enough to serve the learner well. In the proper context – for example, in the noun-learning experiments described below – they cash out, for all practical purposes, as object and substance.

Previous research has indicated that learners privilege whole objects of the same shape as the referents for newly encountered nouns[19,20]. Despite this bias, it is possible to arrange the world so that it encourages less attention to whole objects and more attention to their substances. For example, children are influenced by the extent to which an entity (such as a block of wood) was created with intent by human hands, as opposed to by a natural process or by accident. Entities of the former type evoke the whole object bias, whereas entities of the latter type do so much less. But the world is not arranged for the learner's convenience. Solid substances are rarely encountered in a configuration that affords the substance construal, as solid substances almost always compose objects. The world contains more cars than piles of metal, more windows than shards of glass and more animals than balls of fur.

Given the learner's biases towards objects and shapes, and given the nature of the world, the acquisition of count nouns seems straightforward. But mass nouns are far more vexing. Fortunately for the child, the syntax of NPs provides information about noun type. Indeed, experimental evidence from several laboratories indicates that children as young as two years old can exploit syntactic cues to arrive at the proper construal of an entity[18,21,22]. A typical experiment closely resembles the seminal work of Brown[23] (see Box 1). Children are introduced to a novel entity, either with count syntax (*a dax*) or with mass syntax (*some dax*). Later they are shown additional novel entities that match the teaching entity either on shape or on substance, and are asked which of the test items is also *the dax* (a form neutral between count and mass syntax). Children's choices vary as a function of the syntax used to introduce the novel noun: count syntax produces shape-based object choices, whereas mass syntax produces substance-based object choices. Syntactic form thus drives construal of a novel entity.

This finding is especially striking in light of results from a control condition often conducted in these studies, in which the child is introduced to the novel noun with no syntax at all. Under these circumstances, construal is shaped by the inherent properties of the entity: entities apparently shaped with intent (for example, Nivea with gravel shaped into an L) evoke more shape-based responses than do entities whose shape reflects no obvious intent (for example, a blob of Nivea with gravel)[24]. Regardless of which construal an entity affords without syntax, its construal can be shifted by the appropriate syntax[22]. Syntax can thus help to overcome the shape–object bias as well as what might be called the 'blob–substance' bias.

In summary, we have laid out the behavior of count and mass syntax, and the problems faced by the learner. Distributionally, a massive correlation holds between count syntax and objecthood, on the one hand, and mass syntax and substancehood, on the other. And indeed, entities in the world usually afford a single construal based upon (for example) whether they appear to have been assembled with intent. These two facts together on the face of things equip the learner to acquire nouns readily. In fact, syntax seems to be an unnecessary cue in the acquisition of many nouns[25,26]. However, speakers often talk about aspects of an entity that contradict the perceptually salient construal (the substance of artifacts, the shapes of substances). To acquire words whose meanings contradict the most perceptually natural interpretation, learners must have an escape from the 'trap of salience'[27]. TSOSS provide that escape.

Learning the meanings of verbs

One of the most striking facts about word learning is that verbs are learned later than nouns[28,29]. This delay is not surprising when we consider the many problems that confront the child[30]. For example, verbs and the events that they describe do not line up particularly well in time. In one corpus, the verb *open* was uttered in the presence of opening only 37% of the time; more often than not, *open* occurred with no opening in sight[31]. In principle, this problem could be overcome with sufficient opportunity for cross-situational observation. It is probably the case that the event most frequently associated with the verb *open* is, in fact, opening. Other problems, however, cannot readily be solved no matter how many observational opportunities the learner has. Consider that events frequently afford multiple construals. Every event of giving is equally an event of taking; likewise, every event of buying is equally an event of selling. Because of this entailment, the learner will never (or nearly never) witness them decoupled, and so will be unable to disentangle one construal from another. Even more seriously, the referents of verbs are generally more abstract than those of nouns, especially in the early input to children[26]. Indeed, many common verbs (for example, *think* and *believe*) refer to events that cannot be observed at all. On top of all these problems, learners also show a bias in verb learning parallel to the object bias in noun learning. Given an event, learners prefer an agentive interpretation, where the most active participant is assigned to the thematic role of Agent and, consequently, to subject position[32]. It would seem a daunting task for learners to overcome these various obstacles to successful verb learning. TSOSS provide the support necessary to do just that.

How might TSOSS help learners to overcome these problems – the ambiguity of the world, abstract referents and the agency bias? First of all, the syntax of a VP must systematically reflect the meaning of the verb. And indeed, work in both linguistics[12,13,33] and psycholinguistics[34,35] indicates that abstract semantic properties such as causation, motion, transfer, and mental activity 'project' systematically from a verb's lexical–semantic structure into the syntax[8].

Second, children must actually make use of TSOSS. In one experiment roughly parallel to the NP experiments discussed above, three- and four-year-olds were shown an event ambiguous between two interpretations (for example, chasing and fleeing)[32]. The event was described either with a lone nonsense verb ('*Look! Gorping!')* or with a full sentence containing a nonsense verb ('*The bunny is gorping the skunk / The skunk is gorping the bunny*'). The task was to paraphrase these novel verbs. When the verbs were presented with no syntax or with a syntax that supported the agency bias (with the more active participant named in subject position), participants consistently offered an Agent-oriented construal ('*chasing*'). However, when the syntax opposed the agency bias (with the less active participant named in subject position), children provided Patient-oriented construals ('*running away from*'). Here again, TSOSS provide an escape from the trap of salience, resolving both the ambiguity of the world and overcoming a bias that can interfere with successful word learning.

In a different experimental setting, two year-olds were shown a videotape of two actions performed at the same time[36]. One action was causal (a person costumed as a duck made a person costumed as a bunny squat down by pushing on his shoulders) and the other was non-causal (both the duck and the bunny twirled their arms in synchrony). At the same time, they heard either a transitive sentence ('*The duck is gorping the bunny*') or an intransitive sentence ('*The duck and the bunny are gorping*'). The events were then separated, one to a screen, and the children were asked to 'find gorping'. Children looked reliably longer at the causal event after hearing the transitive sentence, and at the non-causal event after hearing the intransitive sentence. Since the verb was unfamiliar, these preferences must have

Box 2. TSOSS and language impairment

Recent research has linked an inability to use TSOSS (the semantics of syntactic structures) and language impairment in children with specific language impairment (SLI). SLI is characterized by sub-normal language abilities in combination with relatively preserved non-language cognition[a]. In terms of verb vocabulary size (as measured by a type:token ratio), children with SLI lag behind both age-matched peers as well as language-matched peers[b]. These children tend to rely on a relatively small set of general purpose verbs, such as *go* and *do*[b,c]. Given the paucity of verbs and the crucial link between verb learning and access to TSOSS (Refs d,e), researchers have considered the possibility that SLI children lack at least some of the rules that relate syntax to semantics. Indeed, investigations have found that SLI children cannot reliably infer the basic semantics of a nonsense verb from its syntax[f]. Thus, asked to act out the sentence, '*The girl zivved the boy*', SLI children (unlike non-impaired children) are equally likely to make the boy and the girl the agent of the action. Moreover, SLI children are more likely to omit the subject in cases of unusual syntax–semantics mappings, such as the so-called 'unaccusative' structure, in which the subject NP (noun phrase) is assigned the role of Theme (roughly, 'affected object'), as in '*The boat sank*'[g]. More research needs to be done to establish exactly what about TSOSS these children are unable to understand or use, but it appears that failing to appreciate TSOSS has detrimental effects on vocabulary development, particularly in the domain of verbs.

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been driven by the structures of the sentences. In a related experiment, three- and five-year-old children were able to match a novel verb to one of two scenes based on the kind of sentence frame the verb had appeared in, even when all the NPs were pronouns ('*She's pilking her*' versus '*She's pilking*')[37]. These experiments show that TSOSS can guide the attention of children to the scene most likely to correspond to the meaning of a novel verb.

In a test of the degree to which observation can support word learning, adults were shown videotaped clips of mothers interacting with their young children. With the sound turned off, participants had to guess the meanings of nouns and verbs uttered during those interactions. Participants saw six instances of each word, with beeps placed at the appropriate spots. Although participants successfully guessed many nouns, they failed to guess most of the verbs (an effect of concreteness rather than of syntactic class). Those verbs that were difficult to learn from observation (for example, *think*) were far more easily learned by participants who were shown transcripts of the syntactic contexts in which the mothers uttered them. Thus TSOSS can 'pick up the slack' left by observation, making it possible to learn verbs that would otherwise be difficult if not impossible to acquire.

In summary, there is an ever-growing wealth of evidence that TSOSS are widely used in acquisition[15,38,39]. What's more, recent work with specific language impairment children suggests that an inability to take advantage of TSOSS might lead to difficulties in word learning (see Box 2).

Conclusions

Two recent linguistic theories, beginning from rather different starting assumptions, both readily permit syntactic structures to carry meanings apart from the words that appear in them. Work on the acquisition of word meanings suggests that meaningful structures are frequently helpful – and sometimes indispensable – for the learning of words, especially those that cannot easily be learned from observation. In our view, this convergence between theoretical and experimental work should not be surprising. One of the most profound insights of the Chomskian program is that grammars must be learnable. We might extend this observation further: language, in general, must be learnable, and if the world by itself does not provide sufficient support, then help must come from elsewhere. On this view, language has its particular properties not just so that learners can acquire syntax, but also – just as importantly – so that they can acquire words. We have focused on TSOSS because there is substantial evidence for their existence and for their usefulness in language acquisition. More generally, this article can be seen as an effort to link the domains of linguistic theory and language acquisition. Language structure and language acquisition are two halves of the same whole: each reflects the other, and neither can be properly understood alone.

Outstanding questions

- To what extent are verb–structure pairings constrained by formal properties of language, and to what extent are they constrained by conceptual factors? The sentence 'Susan thought the book to John' strikes most people as highly peculiar at best. One explanation for the oddity of this sentence is that the verb *think*, because of its formal, linguistic properties, is not permitted in a structure that is typically reserved for verbs of transfer. Another is that the event that it describes is not possible in the world as we know it. But if this sentence is preceded by a sort of science-fiction context specifying that Susan has the power to move objects with her mind, its acceptability improves considerably. How easily can judgments of acceptability be manipulated with context?
- There are good reasons to believe that the mappings between meaning and form are at least partially innate, but there is also a good deal of cross-linguistic variability in the details of these mappings. How, then, do early learners exploit these mappings when they have not yet mastered the surface properties of their native language (such as how the subjects of sentences are grammatically marked)?
- When do children acquire enough syntactic knowledge to be able to exploit it for word learning? Can we predict what words will enter a child's vocabulary by knowing what words can be learned without TSOSS, what words require it, and how children's knowledge of TSOSS develops?
- The syntax of noun phrases is more variable cross-linguistically than that of verb phrases: while there are languages that do not make the mass–count distinction, there are no languages that do not have different morpho-syntactic structures for transitive and intransitive verbs. Similarly, TSOSS appear to be more crucial for acquiring verbs than for acquiring nouns. What is the relationship between these two facts? Is the first a cause of the second?
- How are TSOSS represented and accessed? One possibility is that their semantics are computed in real time by applying in reverse the rules that link the semantics of lexical items to their associated syntax. Alternatively, syntactic forms might come to bear meanings directly, such that listeners can look up the semantics of a syntactic structure much as they would the semantics of a word. What kind of evidence would help to distinguish these two representational models?

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