Argument Structure

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1. Introduction

The study of the acquisition of argument structure has long figured prominently in debates about learning and abstractness. In what follows, our goals are to highlight the major positions taken and to provide a much-needed synthesis of the evidence supporting them. Section 1 of this chapter introduces important terms and distinctions in the study of argument structure, addresses the balance of power between verbs and constructions with respect to the encoding of thematic relations, and briefly discusses various approaches to linking thematic relations with syntactic positions. In Section 2, competing theoretical approaches to argument structure are compared with an eye toward issues of learnability. Section 3 forms the heart of the chapter, presenting a comprehensive review of developmental research pertaining to argument structure organized chronologically and, within age group, by methodology and (where possible) language. Finally, Section 4 wraps up the current state of our understanding of argument structure and offers suggestions for future research.

1a. Terms and preliminaries

At an intuitive level, we think of verbs as labeling events in the world and verbal arguments, in turn, as naming individuals/entities that stand in some principled relation to an event. From this perspective, any account of the development of argument structure presupposes knowledge of event structure and its organization on the part of the learner. Indeed, our linguistic and conceptual representations of events are undoubtedly linked, though opinions vary as to how intimate the connection is between them. Levin & Rappaport Hovav (2005) rightly point out that the linguist's attention in this domain should naturally be drawn to those semantic properties of events that are grammatically relevant, i.e. potentially affecting subject and object selection, characterizing classes of verbs defined in part by distinctive morphosyntactic behavior, etc. They highlight three main approaches to the conceptualization of events that have been proposed in the literature concerning argument realization (p. 78). On the first, the localist approach, all events are thought of as being construed at some level of abstraction in terms of spatial motion and location (Jackendoff 1972, 1976, 1983, 1987, 1990). A second, aspectual approach places more emphasis on temporal properties such as telicity, measure, and incremental change (Dowty 1979, 1991, Jackendoff 1996, Tenny 1994, Vendler 1957). The third approach to event conceptualization takes causal notions to be central (Croft 1990, 1991, 1994, 1998, Talmy 1976, 1988).

Abstracting away from the details of how these approaches diverge, one finds general agreement among their proponents that certain broad classes of **events** (e.g. location-oriented/static vs. motion-oriented/dynamic, simple vs. complex) and **event participants** (roughly, agent/initiator vs. patient/theme vs. location/goal vs. instrument) are especially salient and often distinguished linguistically. Here, for the sake of concreteness, it may be helpful to pause and consider a scene involving a boy rolling a ball to his mother at a birthday party held outdoors. There are many sentences one might use to describe this dynamic event, including the following:

		Syntactic construction
(1)	a. The ball rolled (cf. #The boy rolled)[1]	*intransitive (unaccusative)*
	b. The boy rolled the ball	*transitive*
	c. The boy rolled the ball to his mother	*ditransitive*

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[1] The # symbol is used to mark sentences that, while grammatical, are incongruent with the event under consideration. In contrast, the * symbol indicates ungrammaticality.

Among the various entities that participate in this scene—including (but not limited to) the boy, the ball, the grass, the mother, the other party guests watching, and the various colorful decorations placed here and there—all bear some relation to the rolling event. However, only a few of these participants—agent, theme, goal/recipient—could ever qualify as **arguments**[2] of the manner-of-motion verb *roll*. To know which event participants may be encoded as arguments, and in which syntactic contexts, is to know the **argument structure** of *roll*, i.e. the requirements imposed by the verb *roll* (or its non-English equivalent) on those participants of a rolling event that the verb selects for the purpose of linguistic encoding in a given construction. More specifically, to know the argument structure of *roll* is to know that in an intransitive construction the verb takes the thing that gets rolled (the Theme) as its subject; in a transitive construction it takes the causer of the rolling action (the Agent) as its subject and the Theme as its object; and in a ditransitive construction, it maps the person or location that serves as the Recipient or Goal of the rolling action to a second post-verbal argument position (realized in (1c) as a prepositional phrase). Likewise, to know the argument structure of the instantaneously caused ballistic motion verb *kick* is to recognize that this verb is incompatible with the one-participant syntactic frame in (1a) unless its argument is the entity doing the kicking (the Agent), e.g. The *boy kicked / *The ball kicked*. Furthermore, some of the dimensions along which aspects of events like the one described above might conceivably vary, such as color (Grimshaw 1993) and volume of speech (Pesetsky 1995), consistently fail to matter for argument structure generalizations. Despite these and other examples of opacity in the relationship between event structure and argument structure, it is fairly common to find appeals in the literature to principles requiring features of each event (or each subevent in a complex event) to have some sort of syntactic realization (Grimshaw & Vikner 1993, van Hout 1996, Kaufmann & Wunderlich 1998, Pustejovsky 1991, Rappaport Hovav & Levin 1998, 2001). One consequence of such a requirement is that complex events must be expressed by dyadic (i.e. two-participant) predicates at a minimum, frequently by transitive verbs.

Speaking of transitivity, right off the bat we should take the opportunity to provide a few more examples of the various syntactic constructions to which we will often refer as we summarize what children know about argument structure in Section 3. The **intransitive,** one-participant construction shown in (1a) can be subdivided into two classes, **unaccusative** and **unergative**. **Unaccusative** verbs typically encode the result of a complex causative event and take the Patient of that event as their single argument (e.g. *The ball rolled*); unergative verbs encode an activity that an Agent is engaged in, and take that Agent as their single argument (e.g. *The boy kicked*).[3] The **transitive**, two-participant construction in (1b) is also compatible with verbs labeling several different event types; in particular, it is labeled **causative** when used to describe events in which an agent performs some action that gives rise to a change of state in another entity, the patient, (e.g. *The girl broke the glass*). Verbs encoding caused motion/possession are most often associated with the **ditransitive**, three-participant construction in (1c), which figures prominently in discussions of English object alternations, in particular

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[2] Throughout this chapter we rely on the definition of *argument* commonly used in mathematical logic, namely that of a variable relevant to a function. Since functions are inherently relational, it is only natural that we should largely concern ourselves with the argument structure of the most ubiquitous of relational concepts in natural language, verbs, as is standard in the literature. Still, it is important to remember that other lexical categories such as nouns and prepositions are also argument-taking, strictly speaking.

[3] See Levin & Rappaport Hovav (1995) for detailed discussion of the syntax and semantics of the unaccusative/unergative distinction, first made by Perlmutter (1978).

those referred to as **locatives** (e.g. *The farmer loaded {the truck with hay / hay onto the truck}*) and **datives** (e.g. *Kai gave {Zoe the guitar / the guitar to Zoe}*). More generally, the umbrella term **applicative** refers to a class of valency-augmenting constructions, encompassing transitives and ditransitives, studied most notably in the Bantu family but also in German, English, and other languages (Bosse 2011, Pylkkänen 2008). Constructions involving more than three participants are rare enough to merit no further attention in this chapter but are not unattested (e.g. *Sara traded her sandwich to Aidan for a slice of pizza*).

Finally, more detail is necessary concerning the range of roles, or **thematic relations**, that arguments are observed to play with respect to the events that verbs encode. Traditionally, these were thought of as composing a set of semantically unanalyzable roles defined independently of the verbs with which they were associated (Carter 1976, Fillmore 1968, Gruber 1965, Jackendoff 1972). Some of the most prominent roles have already been mentioned—**Agent** (the instigator/causer of an event), **Patient/Theme** (the entity affected by an event), **Location** (either source or goal in a motion event)—and to those we could add **Recipient**, **Beneficiary**, **Experiencer**, **Instrument**, and probably others. One issue that has arisen with respect to the list approach to thematic roles involves defining the proper grain size for argument-related generalizations. Attempts at addressing this issue have often appealed to either generalized roles labeling clusters of entailments imposed by predicates on their arguments (e.g. the Proto-Agent and Proto-Patient concepts in Dowty 1991) or some form of predicate decomposition into primitives instantiating basic meaning components in representations of verb lexical semantics (Jackendoff 1976, 1983, 1990, Rappaport Hovav & Levin 1998, Wunderlich 1997, 2000) or syntax (Hale & Keyser 1993, 2002, Harley & Noyer 2000, Marantz 1997). Still other approaches have argued that thematic roles must be built up gradually from verb-specific notions such as, e.g. Roller and Rollee, into verb-general categories like Agent and Patient (e.g. Tomasello 1992).

1b. Are thematic relations verb-specific or verb-general?
Decades of previous research have shown that, rather than varying arbitrarily in how they describe events, verbs with common semantic characteristics often have common syntactic characteristics. For example, *hit*-type verbs (e.g. *hit*, *kick*, *pound*) appear in the conative construction and the body-part possessor ascension construction but not in the middle construction, while *break*-type verbs (e.g. *break*, *crack*, *rip*, *shatter*) show the exact opposite pattern (Levin 1993: 6–7).

(2) a. Carla {hit/*broke} at the vase   *conative*
   cf. Carla {hit/broke} the vase*
 b. Carla {hit/*broke} Bill on the back *body-part possessor ascension*
   cf. Carla {hit/broke} Bill's back*
 c. The vase {*hit/broke} easily   *middle*
   cf. Carla {hit/broke} the vase easily*

Virtually all modern theories of lexical semantics have tried to account for this systematic aspect of verb behavior in some way, with results varying widely in terms of representational detail. Paraphrasing Pylkkänen (2008), the fundamental question that anyone in this research area must grapple with concerns the nature of lexical complexity. One influential position has been that argument relations project from the verb. This position, which we will refer to as **lexicalist** because it places the burden of explanation on the lexicon (e.g. Bresnan 1982,

Chomsky 1981, Dowty 1989, Jackendoff 1990, Joshi 2004, Rappaport Hovav & Levin 1998, Steedman 1997), requires—in addition to a precise theory of lexical representation—a theory of how the predicates and arguments in lexical semantic representations determine syntactic behavior and map onto a limited number of syntactic positions (the subject of Section (1c) below). Another equally important position, which we will call **constructionist** following Folli & Harley (2002), has favored a significant role for verb context (i.e. constructions) in argument realization (e.g. Borer 2003, Goldberg 1995, Hale & Keyser 1993, Harley 1995, Marantz 1984, 1997, Michaelis & Ruppenhofer 2001, Pietroski 2005, Williams 2005). In a constructionist account, the mapping (or *linking*) problem is often minimized as the syntax is further articulated and the number of positions available to link thematic roles with increases. Consequently, the explanatory burden falls on the grammar, which accordingly requires more complex machinery than it might otherwise. In particular, the issue of how to integrate core verb meaning (i.e. "root" meaning) with constructional meaning arises on this approach, whereas on a lexicalist approach a verb's compatibility with multiple constructions is typically seen as a function of its own polysemy (and not that of the construction). The strongest version of the constructionist approach holds that argument structure is purely syntactic, i.e. verbs have no arguments as part of their lexical representations (Pietroski 2005, Williams 2005).

An example of how proponents of the lexicalist and constructionist positions would represent the denotation of the verb *give* with respect to its arguments should clarify the general picture. From a lexicalist perspective, *give* projects an Agent, Goal, and Theme (3a), all of which are associated with their syntactic positions via the application of a linking rule or lexical event structure (not shown). In contrast, from a strong constructionist perspective, *give* doesn't project any arguments (3b); rather, basic thematic relations are introduced by the syntactic frame in which *give* occurs. There is also a weaker, intermediate constructionist position (associated in particular with Marantz 1997) according to which the Goal and Theme arguments are part of *give*'s lexical representation but the Agent argument is supplied by the syntax (3c).[4]

(3) a. Lexicalist lexical entry for *give*
$[[give]]: \lambda e.\lambda x.\lambda y.\lambda z. \; give(e) \wedge goal(e,x) \wedge theme\,(e,y) \wedge agent\,(e,z)$
   b. Strong constructionist lexical entry for *give*
$[[give]]: \lambda e. \; give(e)$
   c. Weak constructionist lexical entry for *give*
$[[give]]: \lambda e.\lambda x.\lambda y. \; give(e) \wedge goal(e,x) \wedge theme\,(e,y)$

Note that there is evidence for both verb-specific and construction-specific knowledge on the part of children throughout development, so we will need to return to this issue on several occasions.

1c. Mapping/linking

The mapping between thematic roles and syntactic positions is not one-to-one: a given thematic role category may appear in multiple syntactic positions (e.g. *Coffee spilled on my laptop* vs. *The barista spilled coffee on my laptop*), and multiple thematic roles can be mapped to a given syntactic position (e.g. *The chef {roasted chicken vs. visited Kitchen Stadium vs. gave us a free*

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[4] Kratzer (1996) first argued that Agents are not arguments of the verb based in part on the observation, attributed to Marantz (1984), that there are no idioms involving just the verb and its Agent. The argument holds if we assume along with Krazter that idiomatic meanings must be stated over lexical representations.

appetizer vs. intimidated <u>his apprentice</u>).[5] However, certain syntax-semantics correspondence patterns display considerable regularity across languages (e.g. Croft 1990, Dowty 1991, Grimshaw 1981, Jackendoff 1990) as well as in the "home sign" systems invented by deaf isolates (Feldman, Goldin-Meadow & Gleitman 1978, Goldin-Meadow & Mylander 1998), e.g. verbs like *give* that describe possession transfer consistently occur with three noun phrases. As a result, linguists have sought to bring semantics and syntax into formal correspondence (e.g. Randall 2010), thereby capturing crosslinguistic generalizations pertaining to argument structure and allowing one to make predictions in one direction or the other. As mentioned in Section (1a), researchers have explored various ways of either reducing the potential number of semantic distinctions to be made (through generalized thematic roles) or increasing the number of syntactic positions to link them to (through predicate decomposition) in order to simplify accounts of mapping. Another influential approach has focused on positing and aligning semantic and syntactic **prominence hierarchies**, with the former defined over thematic relations/semantic primitives (4a) and the latter defined over grammatical relations/syntactic positions (4b) (Baker 1988, 1997, Larson 1988, 1990).

(4) a. agent > theme > goal
    b. subject > object > indirect object/oblique

Given two such hierarchies, an algorithm along the lines of the one described in (5), a relativized version of Baker's 1988 Uniformity of Theta Assignment Hypothesis (UTAH), may be called into service to relate them.

(5) If a verb α determines θ-roles θ_1, θ_2, ..., θ_n, then the lowest role on the Thematic Hierarchy is assigned to the lowest argument in constituent structure, the next lowest role to the next lowest argument, and so on. (Larson 1988: 388, ex. P2)

Importantly, the grammatical relations invoked in (4b) can be recast in terms of morphological case-marking (Carrier-Duncan 1985), topicality (Givon 1984), or otherwise such that the notion of syntactic prominence does not necessarily presuppose configurationally represented syntactic structure. Within the monostratal Construction Grammar (CG) framework, apparent idiosyncracies of linking—such as the different syntactic positions in which the Theme argument *the ball* appears in (1a-b)—are traditionally encoded in construction-specific ways, where constructions amount to conventionalized pairings of form and meaning stored, like words, in the lexicon. Broader linking generalizations are captured in this framework by prominence hierarchies among constructions; for instance, a skeletal transitive construction specifying that Agents map to subject position and Patients to object position is argued to dominate and extend its mapping scheme to more specific instances (or senses) of this construction (e.g. causative, non-causative) (Goldberg 1995, ch. 4).

2. Theories of argument structure and learnability
Summarizing the range of theoretical approaches to argument structure from a developmental perspective is a challenge, but our task is simplified somewhat by the fact that the two most active research traditions stake out fairly opposite positions along the nature-nurture continuum. Of course, this sort of terminology is misleading in the sense that no serious researchers argue

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[5] See Levin & Rappaport Hovav (2005), ch. 5, for more detailed discussion.

for either extreme. Instead, bodies of work typically vary in terms of the *degree* to which linguistic input is argued to play a decisive role in the formation of categories/representations relevant to argument structure and the generalizations made over them.

On "**early abstraction**" (or, alternatively, "**nativist**") approaches, the causal role of the input in structure building is downplayed, and relatively more emphasis is given to the learner's use of the input in testing an innately constrained set of hypotheses about the relationship between form and meaning (Baker 1979, Chomsky 1959, 1975, 1980, 1981, Crain 1991, Fodor 1966, Pinker 1984, *inter alia*). Importantly, positing innate abstract knowledge does not solve the learning problem. Rather, it shapes the learning mechanism to be a selective one rather than a strictly inductive one (Fodor 1966, Lightfoot 1982, Pinker 1979, Viau & Lidz in press). For example, even if learners come fully loaded with innate knowledge about the range of abstract structures that are possibly utilized in language, they must still use evidence from the surface form of language to identify which particular abstract structures underlie any given sentence in the language to which they are exposed (Fodor 1966, Pinker 1979, Tomasello 2000). This problem is made even more severe when we recognize that the very same aspect of syntactic representation may manifest itself differently in the surface form of different languages (Baker 1988, Clark 1992, Dresher & Kaye 1990, Rizzi 1982, Sakas and Fodor 2001). Thus, a selective learning mechanism cannot comprise a simple triggering mechanism in which the learner is endowed with knowledge of which cues must be sought out in order to identify a particular syntactic structure in the exposure language (Fodor 1998, Gibson & Wexler 1992, Lightfoot 1993, 1999, Tomasello 2000).

Of course, the nativist's conclusion that the acquisition of syntactic forms relevant to argument structure is achieved in large measure by some sort of selective learning mechanism is valid only to the extent that the arguments for abstract representation are themselves valid. Alternatives to the "early abstraction" view come in two related varieties, which we will lump together under the "**emergentist**" (or "**usage-based**") rubric.[6] One approach recognizes that syntactic representations in adult grammars are abstract, but posits that this abstractness is the result of a learning mechanism that drives the learner from concrete representations of particular experiences to increasingly abstract generalizations over those experiences (Bybee 1998, Elman et al. 1996, Tomasello 2000, *inter alia*). A second approach posits that adults' syntactic representations are less abstract, moving the explanatory burden of seemingly abstract phenomena to other areas of linguistic knowledge (Culicover & Jackendoff 2005). A growing body of research reflects a convergence of these alternatives, attributing less abstractness to syntactic representations and deriving what abstractness there is from domain-general processes of induction and categorization (e.g. Goldberg 2006, Goldberg, Casenhiser & Sethuraman 2004, 2005, Tomasello 1992, 2003).

As a way of focusing in on the empirical findings in Section 3 that might allow us to confirm or falsify aspects of the above theories, we find it useful to reflect on **Baker's Paradox** (Baker 1979), as summarized by Pinker (1989). Pinker describes the acquisition of argument structure as a logical problem; since language is an open-ended set, but input is finite, the child learner must generalize on the basis of whatever hypothesis concerning argument structure seems to make the most accurate predictions. With respect to ditransitives, children learning English hear many verbs like *give* and *tell* that alternate between prepositional dative (*X gave Y to Z*) and double-object dative (*X gave Z Y*) structures. Children also hear verbs like *say* and *whisper* that only

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[6] Certainly there are hybrid approaches combining elements of the early abstraction and emergentist approaches in various ways as well (e.g. Ninio 2011).

appear in one of those structures, the prepositional dative, and it is perhaps only natural for them to assume that these two verbs alternate just as *give* and *tell* do, leading to non-adultlike utterances like *say/whisper Sophie the secret*. Given that children are not taught the dative alternation explicitly, and further that they are not systematically corrected or miscomprehended when they speak ungrammatically (e.g. Brown & Hanlon 1970), how is it that they manage to avoid or retreat from such overgeneralization errors?

Three aspects of this problem contribute to its paradoxical status: (a) the apparent lack of negative evidence, (b) children's relative productivity, i.e. their willingness to go beyond the input, and (c) the arbitrariness of argument structure, as illustrated by *whisper*'s failure to participate in the dative alternation. The only way out of the paradox is to question one or more of these three assumptions; conveniently, proponents of the two broad theoretical approaches sketched above make different choices. Early abstractionists typically take issue with (c), pointing out systematic regularities that exist in the mapping between verb meaning and verb syntax and positing that children readily apprehend and take advantage of them in acquiring verbal argument structure. Indeed, there is much evidence supporting this idea in its various incarnations, whether we take syntax or semantics as the starting point. **Syntactic bootstrapping** (e.g. Fisher 1994, Fisher, Gleitman, & Gleitman 1991, Gleitman 1990, Landau & Gleitman 1985, Snedeker & Gleitman 2004) involves using syntactic cues such as the number of arguments and general subcategorization patterns to constrain one's hypotheses about verb meaning. In comparison, **semantic bootstrapping** (Grimshaw 1990, Pinker 1984, 1989) involves using cues about verb meaning (extracted in part from analysis of situations in the world) to make aspects of the syntax predictable. Note that these heuristics, while often discussed independently, are not mutually exclusive and have increasingly been thought of as working in tandem (e.g. Hochmann et al. 2010). On the other hand, proponents of more emergentist, usage-based approaches commonly object to (b) and (a), emphasizing children's well-documented **conservativity** (i.e. relative unwillingness to generalize) in language production under certain circumstances (e.g. Ahktar & Tomasello 1997, Lieven, Pine & Baldwin 1997, MacWhinney 1982, Olguin & Tomasello 1993, Tomasello 1992) and the potential influence of forms of indirect negative evidence such as **entrenchment** (Ambridge et al. 2008) / **statistical preemption**[7] (Boyd & Goldberg 2011), respectively.

As we will see below, one issue in critically evaluating the early abstraction and emergentist approaches to argument structure is that work done in these traditions tends not to focus on the same tasks or age groups. Generally speaking, the former relies more on comprehension-based methods with younger populations, while the latter skews toward production-based methods with older populations. To the extent possible, we will attempt to correct for this asymmetry in reviewing the developmental literature.[8]

3. Review of developmental findings
Our approach below is to let the child's chronological progression through stages relevant to the acquisition of argument structure guide us in organizing the literature review. Section 3a covers

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[7] By entrenchment we mean the phenomenon whereby repeated presentation of a verb in one attested construction discourages or suppresses use of that verb in unattested constructions (e.g. Braine & Brooks 1995, Clark 1987). Statistical preemption, whereby speakers learn not to use a construction with a particular verb if an alternative construction with the same function is consistently witnessed, differs from entrenchment primarily in that the frequency of a verb in functionally comparable constructions (as opposed to in any alternative construction) is considered predictive of the strength of the negative evidence provided (see Boyd & Goldberg 2011, p. 61).

[8] See also Ambridge & Lieven (2011) for an even-handed literature review along these lines.

the period between birth and 18 months of age, ending roughly at the onset of the two-word stage. The cut-off for Section 3b is 3 years, approximately when we begin to see abundant evidence of children using verbs productively. In Section 3c, we focus on what is known about 3- and 4-year-olds' increasingly sophisticated language skills in this domain. Finally, in Section 3d we take the rise of children's verb-compliant behavior as a milestone, dealing with lexical learning (or unlearning) at 5 years and beyond.

3a. Infancy to 18 mo.
In the earliest stages of language acquisition, prior to the two-word stage, children are unable to demonstrate knowledge of argument structure in production. Nevertheless, there is evidence from comprehension-based methods that they are sensitive to certain aspects of argument structure.

Representative findings:
In some respects, event representation in young children parallels argument structure, suggesting that early conceptual representations may provide a foundation for emerging linguistic representations. Gordon (2004), in work replicating and extending Scherf & Gordon (1998, 2000),[9] habituated 6-, 8-, and 10-month-old infants to videos depicting three entities (a boy, a girl, and a stuffed camel) engaged in one of two events, giving or hugging. At test, participants were shown two trials of the same (habituated) video and two trials of a novel (altered) video in alternating order. In the altered videos, the camel had been removed, but the motions of the girl and the boy remained the same. Looking time data revealed that by 10 months of age, infants discriminated between the familiar and novel test events for giving events only, i.e. they discriminated between giving something and not giving something, but not between hugging while holding something and hugging while not holding anything. Thus, well before they are able to describe giving and hugging events, 10-month-old infants arguably form nonlinguistic representations of these events that encode the number of grammatically relevant event participants.

The findings of Brandone and colleagues (2006) suggest that by 17 months, children have taken the next step and begun to make use of these similarities between event structure and linguistic structure to predict the subcategorization frame of a novel verb. In a habituation study, Brandone and colleagues demonstrated that 17-month-olds expect a novel verb associated with a one-participant event to be used in an intransitive frame. Brandone et al.'s findings are consistent with the idea that toddlers at this age are already able to bootstrap from semantics to syntax, inferring the syntactic frame(s) with which a novel verb is compatible on the basis of the structure of the event the verb describes.

In addition, there is suggestive evidence that 17.5-month-olds can bootstrap in the other direction, using their knowledge of the transitive frame to guide their interpretation of the event described. For instance, Hirsh-Pasek and Golinkoff (1996), replicating and extending Golinkoff et al. (1987), used the intermodal preferential looking paradigm to demonstrate that toddlers at this age can interpret word order appropriately in sentences with familiar transitive verbs such as "Big Bird is tickling Cookie Monster." The Agent and Patient roles that these two Sesame Street characters played in their test events were manipulated such that participants had to choose (by directing their eyes) which of two versions of the events matched each linguistic stimulus at test. Participants attended significantly more often to matching events regardless of their ability to

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[9] See also Scherf (2005).

produce multiword utterances, indicating that they recognize not only the order of phrases or entities in a given sentence, but also the semantic significance of this ordering.

Along these lines, White, Baier and Lidz (2011) have recently shown an effect of syntactic bootstrapping even earlier using the same experimental paradigm. Presented with events depicting, e.g. a hand using a truck to push a block during familiarization, 16-month-old toddlers were then observed to look significantly more often at the Patient (the block) than at the Instrument (the truck) when told to find the novel noun phrase "the tiv*"* if they had previously heard the pushing event described transitively (e.g. "She's pushing the tiv"). Those who heard the same event described using a different syntactic frame (e.g. "She's pushing with the tiv") instead looked more often at the Instrument, provided that they had no productive verb vocabulary.[10] We can conclude on the basis of these results that 16-month-olds are able to use their knowledge about the range of syntactic positions a novel noun phrase might occur in to infer the thematic role borne by the noun phrase.

3b. 18 mo. to 3 years
From the two-word stage through approximately the end of the second year, child learners typically evince what's known as a grammar explosion. This burst in linguistic sophistication brings with it an embarrassment of riches in terms of empirical research. Much of the work targeting this developmental stage—concerning language comprehension and also, increasingly, production—suggests considerable knowledge on the part of the child with respect to argument structure. However, there is a great deal of disagreement over the nature and origin of this knowledge.

Representative findings:
In comprehension, studies have shown that children in this age range can extract quite a bit of information about the meaning of a novel verb from the context in which it occurs. For instance, the number of noun phrases cooccurring with a verb is apparently informative quite early in development. One piece of evidence for this comes from Yuan and colleagues (2007), who demonstrated that 21-month-olds hearing a novel verb in the transitive frame (e.g. "He's gorping him") looked reliably longer at a two-participant event depicting one boy causing another to bend than did those hearing the same novel verb in the intransitive frame (e.g. "He's gorping"); the latter were more likely to look at a simultaneously presented one-participant event involving a boy moving his arms (see also Fisher 2002 for similar results using pointing as a dependent measure with 28-month-olds). In addition, knowledge of the semantic significance of word order appears abstract enough to be recruited in the interpretation of novel verbs presented in transitive frames by 21 months (Fisher 2000, Gertner, Fisher & Eisengart 2005; preferential looking) and in both transitive and intransitive frames by 28 months (Fernandes et al. 2006; forced-choice pointing). Note, however, that evidence for children's comprehension of word order in sentences containing novel verbs used transitively is not found until after age 3 in act-out tasks (e.g. "Make Mickey dack Ernie") (Akhtar & Tomasello 1997).

Within months, children can use the transitive/intransitive frame distinction to guide the meanings they posit for novel verbs in choosing among events with equal numbers of participants. For example, 26-month-olds are able to determine whether a verb taking two noun phrase arguments refers to a causative scene (e.g. a duck forcing a rabbit to squat by pushing down its head) or a non-causative scene (e.g. a duck and bunny each twirling one arm in circles)

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[10] See Section 4 for more details.

by noting whether the verb appears in a transitive (e.g. "The duck is gorping the bunny") or intransitive frame (e.g. "The duck and the bunny are gorping") (Naigles 1990; see also Fisher 2002, Naigles & Kako 1993). Thus, toddlers use the syntactic structures in which two noun phrases occur to infer the relation between two event participants that is encoded by the novel verb.

Recently, it has become clear that children can make similar inferences about novel verb meaning on the basis of syntactic context—i.e. the number, identity, and syntactic position of accompanying arguments—even in the absence of accompanying information from visual scenes. Yuan and Fisher (2009) exposed 28-month-olds to dialogues in which a novel verb was mentioned eight times in either an intransitive frame (e.g. "The boy blicked") or a transitive frame (e.g. "The boy blicked the girl"). Participants then viewed two scenes, one depicting an event with one actor, the other an event with two actors. When asked to ''Find blicking," 28-month-olds looked reliably longer at the two-actor events in the transitive condition. Thus, even in non-referential contexts, 28-month-olds are able to glean the number of noun phrases occurring in sentences containing a novel verb and use this information to choose among subsequently presented visual scenes differing chiefly in terms of the number of participants. Arunachalam and Waxman (2010) presented converging evidence in 27-month-olds using a similar procedure (with pointing as their dependent measure), and there are signs of the same ability to take advantage of multiple syntactic frame cues without concurrent events at 22 months in the work of Messenger and colleagues (unpublished manuscript).

There is evidence, moreover, that children in this age range can use semantic information about the arguments of a novel verb to infer the argument structure of that verb. Scott and Fisher (2009) revealed that unaccusative and unergative intransitive verbs can be distinguished in a corpus of child-directed speech by the animacy of the event participants appearing as their subjects and the degree of lexical overlap between the nouns used as subjects and objects in their transitive variants. Specifically, unergative verbs (e.g. "Anne dusted") were more likely to occur with animate subjects than unaccusative verbs (e.g. "The lamp broke"), and unaccusative verbs were more likely to exhibit lexical overlap between subjects and objects in their transitive variant than unergative verbs ("Anne broke the lamp" vs. "Anne dusted the lamp"). Scott and Fisher demonstrated, moreover, that 28-month-old children can use their knowledge of the distribution of these semantic features in the input to guide their interpretation of a novel verb. Similarly, Bunger (2006) showed that that 24-month-old children can use semantic combinatorial information to determine which of the subparts of a causative event (means vs. result) a novel verb labels. In a preferential looking study, both adults and 24-month-olds preferred to map novel verbs presented in the presence of a causative event (e.g. a girl bouncing a ball by hitting it repeatedly with a tennis racquet) onto the result of the causative event if they had been presented in an intransitive syntactic frame with an inanimate subject (e.g. "The ball is pimming") and onto the agent's activity if they had been presented in intransitive frame with an animate subject (e.g. "The girl is pimming").

At this early stage in the acquisition of argument structure, what children seem to know about the meanings associated with verbal frames is in some sense more impressive than what they know about verb-specific meanings. One set of experimental findings highlighting this asymmetry has relied on pitting frames and familiar verbs against one another directly in act-out tasks. For instance, Naigles, Gleitman and Gleitman (1993) found that 2-year-old English speakers interpreted transitives causatively and intransitives non-causatively even with verbs that do not occur grammatically in these frames. Thus, children hearing "Noah comes the elephant to

the ark" have been shown to interpret this as meaning that Noah *brings* the elephant to the ark, i.e. that Noah causes the elephant to come to the ark. These findings have been replicated in French at age 5 (Naigles & Lehrer 2002) and extended to Kannada, in which early 3-year-old speakers ignore causative verb morphology and instead rely on argument number (a probabilistic cue to transitivity) in acting out the meanings of familiar verbs in unfamiliar syntactic environments (Lidz, Gleitman & Gleitman 2003); in addition, Mandarin speakers show a similar pattern at 32 months (Lee & Naigles 2008; but cf. Göksun, Küntay & Naigles 2008 for complications in Turkish child data).

Relative to the comprehension-based findings that we have just summarized—which are by and large friendly to the idea that early learners make note of universal tendencies existing in the mapping between form and meaning across languages and possess relatively abstract knowledge of argument structure from the beginning—results from production studies in this age range paint a more mixed picture with respect to the degree of abstraction evident in children's argument structure representations.

Many researchers have noted children's relative unwillingness to generalize verbs (familiar or novel) in spontaneous speech and elicited production before age 3. Concerning the former, some data from corpus and diary studies suggest that children's early language is organized and structured entirely around individual verbs and other predicative terms, with argument structure initially consisting of little other than verb-specific constructions with open nominal slots, or so-called "verb islands." For example, building on work by Bowerman (1976), Braine (1976), and MacWhinney (1978) that emphasizes the item-specific nature of constructional knowledge, Tomasello (1992, 2000) observed that his daughter's verb usage up to 24 months was characterized by impoverished verb morphology (e.g. tense/aspect marking), conservativity (with each verb typically limited to one or two constructions), and unevenness with respect both to how verbs were distributed across various constructional types and to how arguments were marked across verbs within a construction (e.g. Instruments were preceded by *with* or *by* inconsistently and Agents were sometimes omitted). Similar results have been reported for broader samples of English-speaking children up to approximately 3 years (Lieven, Pine & Baldwin 1997; see also Goldberg, Casenhiser & Sethuraman 2004, Pine & Lieven 1993, 1997, Pine, Lieven & Rowland 1998) as well as for child learners of Italian (Pizzutto & Caselli 1994), Hebrew (Ninio 1999), Inuktitut (Allen 1996), and various other languages (see, e.g. Tomasello 2000, p. 214). Furthermore, verb overgeneralization errors (e.g. "Don't giggle me;" "Mommy, I poured you…yeah, with water;" "Jay said me no") appear to be much more frequent after age 3 than before, generally speaking (e.g. Bowerman 1982, 1988, Pinker 1989).

Especially in the longitudinal research summarized above, a potentially causal role for input frequency in caregiver speech throughout children's subsequent development has often been touted[11]; however, data from select cross-sectional studies relying on first use as a dependent measure should give us pause. For a microcosmic glimpse of this sort of general dispute with respect to the importance of input frequency in the acquisition of the English dative alternation,

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[11] About the issue of input richness, a few researchers have argued from production data that the construction of argument structure knowledge gets off the ground in various ways via observation of the input, which apparently contains a number of highly frequent and/or salient general-purpose light verbs—e.g. *do*, *give*, *go*, *make*, *put*—that happen to be among those acquired earliest (e.g. Goldberg, Casenhiser & Sethuraman 2004 on English-speaking 28-month-olds, Ninio 1999 on Hebrew-speaking 18-month-olds). However, Brown (1998) discusses early production data from Tzeltal Mayan children that cast doubt on the crosslinguistic validity of the correlation between ease of acquisition and semantic lightness.

readers are encouraged to compare Campbell & Tomasello (2001) on the one hand to Gropen et al. (1989), Snyder & Stromswold (1997), and Viau (2007) on the other.

Finally, contra the observed verb-specificity in children's early production mentioned briefly above, a few corpus studies have revealed what look like verb-general effects in the acquisition of argument structure at age 2—notably Snyder's (2001) work on a syntactic parameter argued to determine the availability of both compounding and a range of syntactic constructions and Viau's (2007) work on the acquisition of possessional and locational semantic primitives, upon which the representations of datives and other verbs arguably depend. From a crosslinguistic perspective, Demuth (1998) observed that Sesotho-speaking children use applicative constructions (6) productively (and with few errors) by 30 months.

(6) Mosadi o-rek-**el**-a ngwana dijo[12]
    woman AGR-buy-**APL**-FV child food
    'The woman is buying food for the child'

Applicatives can apparently be derived from most (but not all) intransitive and transitive verbs, so the child learner must eventually learn to avoid overgeneralizing. Additionally, in Sesotho the learning task is complicated by the fact that the applicative argument may bear a number of different thematic roles and may appear either before or after the other internal object depending on animacy (see Demuth 2010 for a demonstration that 4-year-old Sesotho speakers are sensitive to the latter).

Concerning elicited production, as a rule, children under 3 years of age tend to hew closely to the syntactic frames in which they have heard each verb used. Experimenters modeling novel verbs in intransitive frames (Tomasello & Brooks 1998; see Berman 1993 for Hebrew data), as passives (Brooks & Tomasello 1999), or as simple gerunds ("Tamming!"; Akhtar & Tomasello 1997, Olguin & Tomasello 1993), have found that children in this age range were reliably unlikely to use the novel verbs in active transitive frames. A related finding is that 32-month-old English-speaking children asked to describe novel events using novel verbs modeled in sentences with non-canonical word order—e.g. either SOV ("Ernie the cow tamming") or VSO ("Tamming Ernie the cow")—were significantly less likely than older children to "correct" these odd forms by using canonical SVO word order in their own productions (Abbot-Smith, Lieven & Tomasello 2001, Akhtar 1999; for similar studies with French-speaking children, see Matthews et al. 2005, 2007). However, Franck and colleagues (2011) argue that this "Weird Word Order" paradigm is problematic for various reasons and underestimates 2-year-olds' competence (see also Franck & Lassotta 2011). Their own experiment using the same method with a few modifications showed no difference between 35-month-olds and older children in terms of corrections.

3c. 3 years to 5 years
Proponents of both main approaches to the development of argument structure typically agree that by age 3 a certain level of linguistic abstraction has been achieved. On average, learners are more willing and able to demonstrate productive knowledge of argument structure than in previous stages and thus are more tolerant of a variety of additional research methods used to assess the character of this knowledge. The preponderance of work on language production

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[12] Ex. (3b) from Demuth (2005); glosses are as follows: AGR: subject-verb agreement, APL: applicative, FV: final vowel (mood).

relative to comprehension in this age range may reflect researchers' focus on 3-year-olds' newfound ability to express themselves, coupled with the fact that some comprehension-based methods used with younger populations are not appropriate for older children.

Representative findings:

A few studies have explored priming—the effect that the use of a particular construction or structure has on subsequent uses of the same structure (Bock 1986)—during online sentence comprehension at this stage. In the first to do so, Thothathiri and Snedeker (2008), 3- and 4-year-old children heard unambiguous double-object (e.g. "Give the lion the ball") or prepositional datives (e.g. "Give the ball to the lion") before encountering temporarily ambiguous dative utterances ("Bring the **mon**key the hat" / "Bring the **mon**ey to the bear"). During the ambiguous interval, participants who had been primed with double-object datives were more likely to look at the potential Recipient (monkey), while those who were primed with prepositional datives were more likely to look to the potential Theme (money); this effect was observed both when the same verb was used in prime and target sentences and when different verbs were used. As Thothathiri and Snedeker themselves note, the data are agnostic as to the locus of priming effects, with possibilities including (a) syntax alone, (b) the mapping between syntax and semantics (thematic roles), and (c) the mapping between syntax and conceptual structure (animacy or lack thereof). In subsequent work, these authors have found evidence supporting (b) with 4-year-olds in work priming datives with locatives, either Goal-first (e.g. "They loaded the truck with the hay") or Theme-first (e.g. "They loaded the hay on the truck") (Thothathiri & Snedeker unpublished manuscript).

In comparison, the literature on production priming is somewhat more extensive. Generally speaking, these studies have relied on the picture description paradigm, in which children either repeat a prime sentence uttered by the experimenter or simply listen to it and then describe a target picture. On the negative side of the ledger, two studies by Savage and colleagues explored the role of lexical overlap on priming in children from ages 3 to 6 using the active-passive alternation for transitive verbs (Savage et al. 2003, 2006). They found that children in all age groups showed priming when the prime sentence used pronouns that could be repeated in the target utterance: i.e. "It is catching it" or "It got caught by it" facilitated the subsequent production of similar active and passive sentences, e.g. "It is closing it" or "It got closed by it," respectively. In contrast, when non-overlapping lexical nouns were used (e.g. "The ball was caught by the net") only the 6-year-olds (and not the 3- and 4-year-olds) showed priming. All other production studies have demonstrated robust structural priming across verbs in children as young as 3 years in the absence of overlapping content words. For instance, Huttenlocher and colleagues found priming of both passive and dative constructions in 3-, 4-, and 5-year-olds (Huttenlocher, Vasilyeva & Shimpi 2004; Shimpi et al. 2007). Bencini & Valian (2008) observed a similar pattern with 3-year-olds who were given either active or passive primes and then asked to describe pictures of transitive actions with inanimate agents and patients.

Turning to spontaneous production, perhaps most notable is a burst in the number of overgeneralization errors produced by children that begins approximately after age 3. Such errors are generally interpreted as a tell-tale sign of abstract knowledge of argument structure. Causative overgeneralizations of intransitive verbs and adjectives (e.g. uttering "Can I glow him?" with the intended meaning "make the toy glow") have been particularly well-studied, thanks in no small part to Bowerman's careful diary studies (Bowerman 1974, 1982, 1988, 2008). In addition, we find extensive discussion of locative (e.g. "Can I fill some salt into the

bear?") and dative (e.g. "Button me the rest") overgeneralizations in Pinker (1989). Pinker's account of how children retreat from such overgeneralizations has been influential and merits close attention, since we will need to presuppose some familiarity with it in the next section. Briefly, he argues that the rules for argument structure alternations apply to (and so must be sensitive to) the semantic properties of verbs; in particular, if a verb's meaning is not compatible with the semantic change the rule brings about, then the verb will fall outside its scope and fail to participate in the alternation (Pinker 1989). Broad-range rules are thought of as defining necessary conditions for alternating verbs, while narrow-range rules provide sufficient conditions and serve to constrain overapplication of the broad-range rules by picking out classes of verbs that actually alternate. Learning is predicated on the assumption that knowledge of the mapping between meaning and form is innate; thus, arguments project correctly provided that verb meanings and the rules manipulating them come to be represented properly. On Pinker's view, retreating from overgeneralizations amounts to cautiously nailing down verb meanings and refining narrow-range rules. To the extent that overgeneralizations on the part of the child appear constrained rather than random and/or prolific, then we have support for Pinker-style criteria-governed productivity in the acquisition of argument structure. Indeed, children's overgeneralizations do appear to be rare relative to grammatical uses based on available estimates (see Gropen et al. 1989 for a discussion of overgeneralization in datives and Kim, Landau & Phillips 1999 for overgeneralization of Korean locatives; see also Maratsos et al. 1987 for a discussion of Bowerman's causatives, though cf. Bowerman 2008, pp. 288–289). Problematic for Pinker's account, however, are data of the sort Bowerman (2008) discusses showing that causativization errors appear to cross-cut or fall outside of the broad- and narrow-range verb classes described above.

Potentially complicating the learning process is the fact that arguments are often omitted in caregiver speech in many languages, including (but not limited to) Japanese (Rispoli 1995), Hindi (Narasinham, Budwig & Murty 2005), and Inuktitut (Skarabela 2006). How do children determine the argument structure of verbs with elided arguments? Helpful strategies could include attending to multiple utterances per verb to gather information on argument number (Korean: Clancy 1996; English: Medina 2007), noting contingencies in the input concerning argument number and verb class (Mandarin: Lee & Naigles 2005) or animacy of the Patient (Japanese: Rispoli 1987, 1995), and looking for other cues such as the likelihood of adverbial modification (Wittek 2008). An additional strategy with crosslinguistic support involves attending to discourse factors affecting argument realization. For instance, Allen (2000, 2008) found that Inuktitut-speaking 3-year-olds were more likely to omit arguments in their own speech when their referents had been previously mentioned in the discourse (but cf. Brown's 2008 results with Tzeltal-speaking 3.5-year-olds). Given this tendency, Allen speculates that learners of Inuktitut can infer the existence of missing verbal arguments in caregiver speech from their understanding of the discourse context of an utterance. In any case, it certainly seems to be true that children's omission of arguments from their own speech at this age is not the result of limited underlying conceptual capacity. For example, Bunger, Trueswell and Papafragou (in press) observed that 4.5-year-old English-speaking children, unlike adults, tend to omit Goal information from their descriptions of motion events (e.g. "The boy was skating [into a soccer net]"). However, children's eyegaze patterns during event viewing and performance on a subsequent change detection task suggested that, like adults, they had encoded goals as part of their conceptual representations of the events.

Concerning elicited production in this age range, relatively little work seems to have been done using novel verbs, with at least one notable exception: Conwell and Demuth (2007) assessed 3-year-olds' ability to generalize across dative frames in English after teaching them novel verbs of transfer. Children did generalize, but they showed a strong preference for doing so in one particular direction, from the double-object dative frame to the prepositional dative frame (e.g. "Kim norped Petey the ball" > "Kim norped the ball to Petey;" 52%), rather than the other way around (9%). Interestingly, the double-object dative frame shows more semantic restrictions than its prepositional dative counterpart in the adult grammar (Green 1974, Oehrle 1976, Pinker 1989), so this asymmetry in extension could conceivably be due to children's sensitivity to the relevant meaning differences between the frames.

In contrast, evidence of the effect of syntactic context on children's identification of novel verbs is easier to come by in this age range than it is before age 3, particularly with respect to potentially difficult verbs encoding alternate perspectives on events (e.g. *give/get*, *chase/flee*) or belief (e.g. *think, know*). Fisher and colleagues (1994) showed 3- and 4-year-olds videotaped scenes described by a puppet using novel verbs and then asked participants to paraphrase these puppet words. Importantly, the syntactic contexts in which the novel verbs were presented ranged from neutral (e.g. "Look! Ziking!") to biased toward one perspective (e.g. "The elephant is ziking the ball to the bunny") or the other (e.g. "The bunny is ziking the ball from the elephant"). In neutral contexts, children showed an agency bias, preferring to paraphrase with verbs whose subjects mapped to the agent in the videotaped event (e.g. *give*); this bias was enhanced in contexts with goal prepositions (*to*) taking the agent's perspective and reversed in contexts with source prepositions (*from*) taking the recipient's perspective. It seems clear that structural properties of the sentence children heard influenced their perception of a single scene and even led them to override their default goal bias in event representation. The value of syntactic cues to meaning becomes even more critical in the case of abstract verbs describing mental states, like *want* or *think*, for which the extralinguistic context provides very few cues to meaning but which occur in a tightly restricted and highly predictive set of syntactic frames (e.g. Gleitman, Cassidy, Nappa, Papafragou & Trueswell 2005, Kako 1998, Papafragou, Cassidy & Gleitman 2007, Snedeker & Gleitman 2004). Papafragou, Cassidy, and Gleitman (2007) demonstrated, for example, that 4.5-year-old children were more likely to interpret a novel verb as a label for a mental state if it occurred in a sentence with a sentential complement (e.g. "Matt gorps that his grandmother is under the covers") than if it occurred in a transitive sentence (e.g. "Matt gorps a basket of food"). Thus, children of this age use not only the semantic type of an argument (e.g. Goal vs. Source) but also its syntactic type (e.g. sentence vs. noun phrase) to refine their hypotheses about the meaning of a novel verb.

3d. Beyond 5 years
By age five, what is left to discover with respect to argument structure? Primarily verb-specific lexical information, including exceptions to the generalizations made in previous stages, consideration of which brings issues of abstraction and the role of the input once again to the forefront.

Representative findings:
Children in this age range have typically begun to move away from predominantly frame-compliant behavior, as discussed in Section 3b, and toward a more nuanced, adultlike, verb-compliant stance that is responsive to the particulars of the exposure language. Trueswell and

colleagues provide abundant evidence of this shift in their studies of 5-year-olds' parsing preferences with respect to locative verbs. In the first study of this kind, upon hearing sentences like "Put the frog on the napkin in the box" in which the prepositional phrase *on the napkin* is temporarily ambiguous between modifier and Goal interpretations, 5-year-olds were shown to strongly prefer to interpret the ambiguous PP as the Goal of *put*—as indicated by eye movements and act-outs—even when the accompanying referential scene provided disambiguating evidence (e.g. two frogs, only one of which was on a napkin) (Trueswell et al. 1999). Coupled with the fact that children's observed Goal bias for *put* reflects how that verb is used in child-directed speech, these data suggest that the information that children gather on the number and types of phrases that probabilistically occur with verbs as they acquire them is not jettisoned after the verb meanings are learned. Instead, this information is retained and deployed on the fly as a sentence unfolds and particular verbs are encountered to assist in recognizing the intended structures of utterances. Indeed, the influence of this knowledge of argument structure on children's parsing commitments outweighs that of countervailing discourse factors for several years (Trueswell et al. 1999, but cf. Choi & Trueswell in press for complications in Korean, a verb-final language). Snedeker and Trueswell (2004) replicated and extended these findings, confirming that 5-year-olds demonstrate considerable sensitivity to the argument structure of known verbs and rely on this information in making parsing decisions. Specifically, they found that when interpreting ambiguous *with*-PPs, children are sensitive to the argument structure biases of particular verbs, interpreting them as Instruments for verbs that typically occur with Instruments (e.g. "Tickle the frog with the feather") and as direct object modifiers for verbs that typically do not occur with Instruments (e.g. "Choose the frog with the feather").

Returning to Pinker's criteria-governed productivity hypothesis (Pinker 1989), a number of studies have examined older children with an eye toward assessing the psychological reality of the narrow-range verb classes that are posited to constrain children's overgeneralization errors. For example, Ambridge and colleagues had 5- to 6-year-olds, 9- to 10-year-olds, and adults rate the grammatical acceptability of causativized intransitive verbs (both familiar and novel) from three of Pinker's semantic classes using a 5-point scale (Ambridge et al. 2008). In support of Pinker's general approach, participants in all age groups showed the strongest dispreference for causative overgeneralizations with verbs belonging to the class associated with the lowest degree of direct external causation, i.e. the class that is furthest in meaning from the transitive causative prototype (namely, "semivoluntary expression of emotion" verbs such as *laugh* and *giggle*). However, consistent with the entrenchment hypothesis mentioned toward the end of Section 2, they also found that participants' willingness to overgeneralize seemed to be conditioned by frequency, with high-frequency familiar verbs most likely to be used conservatively, low-frequency familiar verbs somewhat less so, and novel verbs least of all. Ambridge et al. (2009) replicated this pattern of results with slightly different stimuli, leading the authors (and Ambridge et al. in press) to argue for a hybrid approach to solving Baker's Paradox in which both verb semantics and entrenchment/pre-emption play a role.

If only to highlight the need for more work on how children retreat from argument structure overgeneralizations, it is interesting to juxtapose two sets of results from studies focusing on datives in this age range. On the one hand, Gropen and colleagues (1989) had relative success in eliciting double-object dative tokens of four novel verbs taught to older children (mean age 7;4). Children produced novel verbs in the double-object dative frame 50% of the time when the novel verbs had been taught in that construction, and 44% of the time when the novel verbs had been taught in the prepositional dative. Children also showed sensitivity to a morphophonological

constraint argued elsewhere to govern the dative alternation in English by producing novel verbs in the double-object dative frame 54.7 % of the time for monosyllabic verbs and 39.1% of the time for polysyllabic verbs. In a follow-up experiment, Gropen and colleagues tried to elicit double-object dative uses of novel verbs more naturally, i.e. by modeling the novel verb using a syntactically neutral gerund form (*"This is norping"*). Production was elicited with sentences like "Can you tell me, using the word 'norp,' what I'm doing with you?" Results again indicated success in eliciting double-object datives in general. Children produced unmodeled double-object datives with novel verbs in response to 41% of questions, with 75% of children producing at least one double-object dative. Children were significantly more likely to produce double-object datives if the recipient was a prospective possessor than if it was an inanimate location, with the highest rate of double-object dative responses occurring when the child was the recipient, followed by when toy animals were recipients. Gropen and colleagues concluded on the basis of their results that children were productive in their use of double-object datives by virtue of respecting semantic and morphophonological constraints on the permissible bounds of extension in English—all this against a background of relative conservatism, whereby children preferred to use argument structures that they had heard a verb used in. On the other hand, Mazurkewich and White (1984) investigated 9-, 12-, and 15-year-old English speakers' knowledge of dative extension patterns using a grammaticality judgment task and found relatively widespread overgeneralization late in linguistic development. For instance, 46.7% of the 9-year-olds accepted utterances like "Tom reported the police the accident" as grammatical. At 12 years, 33% of participants accepted them, and at 15 years the acceptance rate was still measurable at 11%. It is not immediately obvious how one can square this sort of finding, if robust, with Gropen et al.'s results.[13]

4. Analysis

On balance, do the results summarized above favor one theoretical approach to argument structure over another? In our view, there is currently no definitive answer to this question. Moreover, as stressed in Section 2, the early abstraction and emergentist approaches are best thought of not as diametrically opposed but rather as positions along a continuum with respect to the potential role of the input in building/constraining generalizations related to argument structure. We can see at least two constructive ways forward, which we discuss in turn. The first involves highlighting how each approach advances our understanding of the process by which children master verbal argument structure as well as what issues each approach raises. The second involves considering the potential benefits and risks of a shift in focus away from *what* is acquired by a given stage in this domain and toward *how* that knowledge is acquired. Indeed, there are signs that the field might already be progressing in this direction.

Fisher (2002) comments on the complementary (as opposed to contradictory) nature of work emphasizing either the role of abstraction in driving the learning process on the one hand or item-based learning about verbs and their arguments on the other, asserting that "to achieve a complete picture of how children learn their native languages, we must explore the interactions of lexical and more abstract syntactic knowledge in language acquisition (p. 275)." What then do the two main approaches to argument structure contribute to that picture? To start with, it would be difficult to underestimate the significance of early abstraction work probing young children's developing comprehension of argument structure through the second year of life. Positive

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[13] Though see Fodor (1985) for discussion of possible methodological problems with the experimental work in Mazurkewich & White (1984).

findings early in development such as the ones reviewed in Sections 3a-b help to motivate a meaningful distinction between competence and performance, which in turn should suggest that caution is in order when interpreting null results in production in these stages and later on. Overall, however, the early abstraction approach to argument structure (with a few notable exceptions) has neglected to adequately address thorny learnability issues posed by overgeneralization errors past age three as well as challenges to universals of argument linking raised by crosslinguistic data. In comparison, emergentists (using production-based methods in particular) have quite successfully highlighted the importance of the type of lexical learning older children must do in order to arrive at an adultlike understanding of argument structure. That said, their investigations of younger children's competence have yielded more mixed results. While the healthy skepticism toward the necessity of positing innate knowledge on the part of early learners that emergentists tend to emphasize is certainly valuable, one might find fault with the (at times) overly broad strokes in which their proposals of alternative explanations are sketched. Whether or not the domain-general learning strategies frequently attributed to children—intention reading, analogical structure mapping, and/or pragmatic (i.e. Gricean) reasoning (e.g. Goldberg 2006, Tomasello 2000), to name a few—are relevant to the acquisition of argument structure is an empirical question; however, valid empirical tests require the sort of predictions that only more explicit formal accounts of learning can generate. On that note, we close with a brief discussion of mechanisms of learning.

As alluded to above, we perceive a trend in work on the acquisition of argument structure toward focusing on *how* the process unfolds. Three papers serve to illustrate this trend. First, recall from Section 3a that White et al. (2011) demonstrated syntactic bootstrapping by as early as 16 months in English-speaking children who knew few verbs. More specifically, these authors described a U-shaped curve along which 16-month-olds without verbs and 28-month-olds behaved as expected in the experiment outlined earlier, but 16-month-old verb users and 19-month-olds did not. They argued that learners' developing verb knowledge, combined with the maturation of their ability to parse syntactic structure, accounts for the observed dip in performance. Abstracting away from the details of this particular study, we note the surprisingly early influence of verb-specific knowledge that it seems to reveal and its focus on early sentence processing. Second, Wonnacott, Newport and Tannenhaus (2008) explored language learners' ability to acquire knowledge of argument structure when Pinker-style semantic bootstrapping was not an option. In a series of artificial language learning experiments with adult participants, they showed that even without semantic cues to verb distribution, learners could acquire both verb-specific and verb-general constraints based on distributional information in the input. Concerning methodology, Wonnacott and colleagues found that participants' production and online comprehension data reflected either probabilistic knowledge or knowledge of absolute constraints, while their grammaticality judgment data reflected only knowledge of absolute constraints, e.g. a verb was only judged to be more grammatical in one construction than the other when participants were convinced that the verb could *never* occur in the other. Thus, participants appeared to distinguish grammaticality from other factors potentially affecting verb usage. Planned follow-ups are reported to include taking a closer look at spoken corpora in order to gauge the relative naturalness of the statistical regularities that participants were able to track and adapting the artificial language learning paradigm for use with children. Third, Alishahi and Stevenson (2008) recently discussed a computational model for the representation, acquisition, and use of verbs and constructions. In the Bayesian framework they adopted, constructions were viewed as probabilistic associations between syntactic and semantic features. The authors found

that the behavior of their model throughout acquisition largely mirrored the stages of learning through which children have been observed to progress. Of course, it is always important to closely examine what types of knowledge are assumed by/built into models of this type, and Alishahi and Stevenson's is no exception—though in more recent work (Alishahi & Stevenson 2010) they claim to have managed to remove semantic role information from the "assumed knowledge" column. Regardless, we are encouraged to observe the mini-renaissance that these studies and others have begun to form in terms of attention to learning mechanisms in this domain. A proper weighing of the twin roles of input and abstraction with respect to the development of knowledge of argument structure will no doubt continue to preoccupy researchers of all theoretical persuasions for years to come.

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