**1. Introduction**

The aim of this chapter is to outline a constructivist account of the process of language acquisition, and to summarize the supporting evidence for this account, drawing on examples from some of the most intensively studied acquisition domains. Our goal is not to outline a generalized historical constructivist account, but rather to begin to sketch a new account that, in some small but significant ways, departs from previous proposals. In other words, while the account that we will outline here of course owes a considerable debt to earlier constructivist accounts (e.g., Bates & Macwhinney, 1982; Pine & Lieven, 1993; Langacker, 2000; Tomasello, 2003; Dąbrowska, 2004; Goldberg, 2006) we are speaking for no one but ourselves. We do not, in general, compare this account against rival theoretical approaches (c.f., Ambridge & Lieven, 2011; Ambridge, Pine & Lieven, in press), which we mention only very briefly, purely for comparative purposes.

 That said, the account that is presented here is probably best understood with the aid of just a little historical context. Since at least Chomsky (1957), the dominant view of language acquisition has been one under which children have innate knowledge of linguistic categories and phrases (e.g., [VERB], [NOUN], [VERB PHRASE], [NOUN PHRASE]) and some language-general rules for combining them into phrases (e.g., a [VERB PHRASE] contains either a [VERB] followed by a [NOUN PHRASE] or vice-versa - e.g., [*kick*] [*the ball*] / [*the ball*] [*kick*] – with each language committing itself exclusively to one of the two possible orders).

 The constructivist approach, which dates back to at least Braine (1963), arose primarily as a challenge to such claims. The basic idea is that children’s very earliest linguistic representations are not adultlike categories and rules (e.g., [VP] = [V, NP]), but rote-learned concrete holophrases (*I+want+it*) and low-level, lexically-specific slot-and-frame patterns or schemas (e.g., I’m [X]ing it). Only gradually do children abstract across these holophrases and lexical schemas to arrive at adultlike fully-abstract constructions. The constructivist approach is emergentist in two senses. First, it is emergentist in the sense that the generalizations that underlie linguistic competence emerge from the analysis of linguistic units stored in memory (initially, rote-learned holophrases), rather than being innately specified (as under many rival accounts). Second, the approach is emergentist in the sense that children’s language acquisition is emergent from – indeed, a byproduct of - their use of language as a social tool. Children are not “trying” to learn syntax; they are not conducting formal analyses of linguistic structure, combining content-free algebraic symbols, setting parameters, or building abstract linguistic categories for their own sake; they are *using* language, to cajole, to control and to communicate.

 Presumably as a reaction to the prevailing claim of very early abstract knowledge, most research conducted within the constructivist framework has focused on demonstrating that young children’s knowledge is lexically specific (see Tomasello, 2000; 2003 for reviews). As a consequence, the constructivist approach has often been interpreted – by both its critics and its advocates – as claiming that, until some relatively advanced age (perhaps around thee years) *all or most* of children’s knowledge consists of rote-learned holophrases and lexical schemas, with any demonstration of earlier abstract knowledge taken as evidence against the approach.

 In our view, this is a misinterpretation. The central claim of the constructivist approach relates not to age - “children do not have abstract knowledge until age X” - but to process: Children start out with holophrases, which develop, via a process of abstraction, first into lexical schemas, and, finally, into adultlike abstract constructions. Importantly, this process, whilst protracted and gradual, begins as soon as children have, in principle, two stored exemplars across which to abstract.

 Thus, early abstract knowledge does not falsify the constructivist account: Any abstract knowledge could, in principle, have been arrived at via a process of abstraction across stored exemplars, rather than having been present all along, regardless of the age of the child. Lest this claim seem too strong, it should be borne in mind that a child who can relate *teddy* to a picture of a teddy in a book, to her own teddy and to a bear in the zoo has already made an abstraction; and studies with newborn infants suggest that some phonological abstractions are formed *in utero* (e.g., Moon, Cooper & Fifer, 1993).

 Nevertheless, the constructivist account does make an eminently falsifiable prediction. Because the process outlined above is input driven, and because children’s input (and uptake) is uneven, so children’s knowledge is predicted to be uneven, in ways that correspond systematically to the language to which they are exposed. In more concrete terms, the prediction is that children will show better linguistic performance (in whatever task), when they are able to make use of a string (*I+want+it*) or lexical schema (e.g., *I’m* *[X]ing it*), that they have frequently encountered and thus stored in memory. Children will show worse performance on an equivalent utterance for which no stored string or template is available, even if that utterance is formally identical when analyzed at the level of adult linguistic categories (e.g., *John kissed Sue,* which – like *I want it* or *I’m eating it* – can be analyzed as having the structure [NPSUBJECT] [VP [V] [NPOBJECT]]). Furthermore, even when children have formed adultlike abstract constructions, they will show an advantage for utterances that constitute prototypical instances of those constructions.

 On our reading of the literature, these predictions have yet to be falsified, and, indeed, enjoy considerable empirical support. In this chapter, we summarize our constructivist account of development, and the current state of the empirical evidence, for each of four particularly well-studied domains: the acquisition of (i) determiners, (ii) inflectional morphology (iii) basic word order and (iv) more advanced constructions (datives, locatives, passives, questions, and relative-/complement-clause constructions).

**2. Determiners**

We by considering one of the smallest and most restricted linguistic domains: the English determiner system. Setting aside, for a moment, both the pragmatic aspects of the system and more borderline category members, all children have to learn is that English has two determiners, *the* and *a(n)*, and that – on the whole - if a particular noun has appeared with one determiner it can appear with the other (e.g., *the ball, a man; the book, a man* etc.). The highly restricted nature of this system means that it constitutes both an excellent example with which to illustrate the constructivist account, and a popular test case for this approach.

The constructivist account of the acquisition of this system runs as follows. Suppose a child hears, and stores, the following strings:

a ball the ball

a book the book

a doggie the rain

a man the pen

The child will schematize across the strings in the first column to form the lexically-specific slot-and-frame schema *a [X]* and across the strings in the second column to form the schema *the [Y]*. This process is outlined in detail later in this section. For now, the important point is simply that these schemas allow children to produce determiner+noun combinations that they have never heard before. For example, a child who had heard *a man* but not *the man* could produce this latter combination by inserting *man* into her *the [Y]* schema.

 Because the schematization process is slow and gradual, there will be a point early in development in which these slot-and-frame schemas are not yet fully formed, with children relying – at least some of the time – on the use of rote-learned strings (e.g., *a+man; the+rain*). Thus the constructivist account makes a simple prediction: If we can catch children at this very early stage, there will be some nouns that appear in their speech with *a* and not *the* – and vice-versa - because only the former has been stored as part of a rote-learned string (e.g., the child has stored *a+man* but not *the+man*), and a productive schema that could be used to generate it (e.g., *the [Y]*) has not yet been formed. Of course, in any given sample of adult speech, some nouns will be used with *a* and not *the*, or vice versa, simply for discourse reasons (e.g., the phrase *a drink* is used much more frequently - often with *Do you want…* - than *the drink*). So the prediction is not simply that children’s overlap between *the* and *a* uses of a particular noun will be low – the same is true for adults – but that this overlap will be significantly *lower* for children than adults (i.e., their caregivers).

 Precisely how to test this prediction fairly has been the subject of a long-running methodological debate (Pine & Martindale, 1996; Pine & Lieven, 1997; Valian, Solt and Stewart, 2009; Yang, 2010; Pine, Freudenthal, Krajewski & Gobet, 2013). The upshot is that it is important to restrict the analysis to nouns that (a) can combine grammatically with both *the* and *a(n)* (e.g., \**an advice*), (b) are used at least twice by a given speaker (hence giving the potential opportunity for overlap to be observed) and (c) are used by both a given child and his caregiver (otherwise, adult overlap rates are artificially depressed by low frequency nouns that have little opportunity to appear with both *the* and *a*, and which children do not use). When this is done (Pine et al, 2013), naturalistic data studies reveal a significantly lower overlap rate for children (31%) than their caregivers (47%); a finding that, incidentally, constitutes evidence against rival accounts under which both the determiner and noun categories, as well as some knowledge of how to combine them, are present from birth (e.g., Valian, 1986).

 However, as we stressed in the introduction, abstract knowledge is not all-or-nothing, and these findings do not demonstrate that young children are relying entirely on rote-learned determiner+noun strings. Indeed, Pine and Martindale (1996) argued that children showed evidence of having acquired some low-level slot-and-frame schemas (e.g., *That’s a [THING]; On the [SURFACE]*) which, despite their rather contextually-specific nature, do enable at least some nouns (e.g., *table, chair*) to be used with both *a* and *the*.

***From rote-learned phrases to lexically-specific schemas***

As well as an important test case for the constructivist account, the English determiner system is useful as an example of the process of schematization assumed by this account. Returning to the example above, suppose that the child has stored the strings *a ball, a book, a doggie, a man, the ball, the book, the rain* and *the pen*. The child then schematizes across the first four strings to form an *a [X]* schema, and across the last four strings to form a *the [Y]* schema.

The use of *X* and *Y* to denote the slots is particularly important for two reasons. First, we have avoided using terms that relate to adult categories (e.g., [NOUN]) in order to emphasize the claim that children have not formed such categories (indeed, we suggest below that they may *never* do so). Second, we have avoided using a generic term to label both slots (e.g., [THING]), in order to emphasize the claim that the [X] and [Y] slots have different, though overlapping, properties.

 What does it mean for a slot to have a property? The property of a slot is a weighted average of all the items that have appeared in this position in the input utterances that gave rise to the schema. So, for this artificially restricted example, the property of the [X] slot will be a weighted average of the properties of *ball, book, doggie* and *man*, whilst the property of the [Y] slot will be a weighted average of *ball, book, rain* and *pen*.

But a weighted average of *which* properties[[1]](#endnote-1): their meanings, their sounds, their stress patterns? In principle, over any of these things; indeed, over any properties that the child can perceive. If the items that appear in a particular position in the source utterances are similar with respect to a given property (e.g., meaning), then the slot in the resultant schema will exhibit this property. So, for the present example, the [X] slot in the *a [X]* schema will have the semantic property of *discrete (“count”) entity*, whilst the [Y] slot in *the [Y]* schema will have the semantic property of *discrete or* *nondiscrete (“mass”) entity*. It is important to emphasize that these characterizations are approximate only; the actual meaning of the [X] slot in this example is no more or less than average of the meanings of *ball, book, doggie* and *man*; a notion that is captured only roughly by the description “discrete entity”. In other words, slot properties are fuzzy and probabilistic, as opposed to categorical.

If the items that appear in a particular position in the source utterances are dissimilar with respect to a given property (e.g., the sound of the first phoneme), then the slot in the resultant schema will not exhibit any particular property on this dimension. That is, if the source items exhibit heterogeneity with regard to a given property, the slot will also exhibit heterogeneity with regard to this property. So, for example, because the items that give rise to the slot in the *the [Y]* schema - *the ball, the book, the rain* and *the pen* – do not share any particular phonological properties, so the slot does not exhibit any particular phonological properties either (for discussion of the role of variability in slot formation see Bowerman & Choi, 2001; Bybee 1995; Janda, 1990; Barðdal 2009; Suttle & Goldberg, 2011; Dąbrowska & Szczerbinski, 2006).

The significance of slot properties is that only items whose properties overlap sufficiently with those of the slot may be inserted grammatically into this slot (e.g., Langacker, 2000: 17). This notion of overlap is also fuzzy and probabilistic, rather than deterministic. Consider, for example, our example schema *a [X]*, in which the slot has the approximate semantic property of *discreteness*. Words that exhibit this property to a sufficient degree can be inserted into this slot (e.g., *a cat*; *a table*). If a word that does not exhibit this property to a sufficient degree is inserted into this slot, a less than fully grammatical string results (e.g., \**a rain*). But if we insert a borderline case, something that has an intermediate degree of discreteness (e.g., *milk*, which is generally continuous, but could denote a discrete serving), an intermediately-grammatical string results (e.g., *?a milk*). Consider now our example schema *the [Y]*. Because this slot has broader semantic properties (“*discrete or nondiscrete entry*”), we can use pretty much any “entity” noun as a slot-filler (e.g., *the milk; the water*).

The reason for giving such a detailed account of the acquisition of the English determiner system is that, the account presented above is a microcosm of the constructivist account of language acquisition in general (or, at least, of rote phrases and schematization; a third stage – analogy - is outlined in the section on basic word order). The process by which rote-learned strings give rise to schemas whose slots exhibit probabilistic semantic, phonological and pragmatic properties is assumed to operate in all domains of language acquisition, and across all languages.

***Implications of the constructivist account of determiner acquisition***

 Before moving on to some of these other domains, we consider some broader implications of the account of determiner acquisition outlined above. The first is that, because slots take on whatever properties are shared by the items that appeared in the relevant position in the source utterances, ignoring dimensions along which these items do not share a particular property, there is no need to specify in advance which types of properties children will “look for” when forming grammatical generalizations. This is just as well, since the types of properties that slots exhibit vary hugely cross-linguistically, including – for example – humanness, animacy, and whether or not the speaker witnessed the event. That said, we would not wish to exclude the possibility of very general attentional or perceptual biases that make – say – humans, speech sounds, or the ends of utterances particularly salient.

 The second implication is that, because the slot-formation process is sensitive to commonalties along (in principle) any dimension, many slots exhibit constellations of properties of different types. Indeed, to find examples of slots that exhibit semantic, phonological and pragmatic properties at the same time, we need look no further than the English determiner system. Consider the fact that, before nouns that start with a vowel, speakers must use *an* instead of *a*. Whilst the traditional approach has been to posit pronunciation variations of “the same” word, this phenomenon falls naturally out of the present account, on the assumption that there are two indefinite constructions – *a [X]* and *an [Z]* that have the phonological properties of starting with consonant and vowel sound respectively.

The different pragmatic functions of *the* and *a/an* can be accommodated in the same way. The slots in the schemas *a [X]* / *an [Z]* and *the [Y]* have the functional-pragmatic properties of referring to discourse-old and discourse-new entities respectively. Thus, the slot in the schema *an [Z]* exhibits, at the same time, semantic (*discrete entity*), phonological (*starts with a vowel*) and pragmatic (*discourse-new*) properties. An infelicitous utterance results if the speaker uses a filler in a slot with which it does not share sufficient overlap on any one of these properties (e.g., *\*an advice* [semantic mismatch]; *\*an cat* [phonological mismatch]*; \*an orange* [a pragmatic mismatch, assuming that we have already been talking about this orange). Incidentally, we note in passing that accounts under which children have innate knowledge of a DETERMINER and NOUN category and a rule for combining them (e.g., Valian, 1986; Yang, 2010), will still need to posit something very like this type of probabilistic semantic, phonological and pragmatic learning to account for such cases anyway.

A final, and perhaps controversial, implication of this account is that there is no need for learners to construct either conventional Universal Grammar style grammatical categories such as [NOUN] and [DETERMINER], or even finer-grained language-specific, input-based categories such as [ENGLISH MASS NOUN] or [ENGLISH TRANSITIVE VERB]. The reason is that, provided that the child stores the semantic, phonological (etc.) properties of every word and every construction slot, which she will have to do anyway, she already knows which words can be used in any given construction: the words whose properties overlap sufficiently with those of the construction. There is nothing to be gained by grouping together the words that can act as fillers for the same slot, and calling them a “category”.

Indeed, there are at least two good reasons not to do so. The first is that the compatibility between particular words and constructions is a matter of degree; indeed many words can be coerced into constructions with which they are only marginally compatible (often to yield some special interpretation). The second, and more fundamental, reason for not maintaining offline categories of slot-fillers is that, in many cases, it is impossible to do so. Many properties, such as being discourse-old or discourse-new, which governs the relative compatibility between a noun and the *a [X]* and *the [Y]* constructions are not inherent properties of words at all. Hence it would not be possible to store a category of “*discourse-old nouns*” (or AGENTs or PATIENTs). To the extent that these are “categories” at all, they are ad-hoc categories (Barsalou, 1983), generated on the fly, emergent from the search for a suitable slot filler. If this search can turn up a filler whose *pragmatic* properties overlap sufficiently with those of the slot, it can presumably turn up a filler whose semantic and phonological properties overlap sufficient with those of the slot just as easily.

**3. Inflectional morphology**

The constructivist account of the acquisition of inflectional morphology is essentially the account of determiner acquisition outlined above, translated into a new domain. Consider, for example, the acquisition of the German present tense inflectional paradigm for a regular (*-en*) verb (e.g., *spiel****en***, ‘to play’).

1sg Ich spiel**e** (I play) 1pl Wir spiel**en** (We play)

2sg Du spiel**st** (You play) 2pl Ihr spiel**t** (You play)

3sg Er/Sie spiel**t** (He/She plays) 3pl Sie spiel**en** (They play)

The child begins by acquiring a number of rote-learned concrete holophrases, at both the level of individual verb forms and subject+verb combinations:

*spielt*  *Er+spielt*(He plays)

*bekommt* *Er+bekommt*(He gets)

*trinkt*  *Er+trinkt*(He drinks)

The child then abstracts across these stored strings to yield the following lexically-specific slot-and-frame schemas:

[X]t Er [Y]t

Again, we use [X] and [Y] rather than traditional linguistic category labels (e.g., [VERB] or [STEM]) to emphasize the fact that children are assumed not to be in possession of such categories. Exactly as for the determiner schemas discussed above, these slot-and-frame patterns are productive in that children may insert any filler whose properties overlap sufficiently with those of the slot. Thus, considering semantic properties, children may insert a word denoting an action, event or state-of-affairs (e.g., *Er [lieb]t*; He likes), but not one that denotes – for example – a concrete object. In this case, these slots do not exhibit any particular phonological properties, though will we subsequently discuss some that do.

 As for the determiner system, it is important to emphasize that the constructivist account does not claim that all of children’s early morphological knowledge consists of rote-learned strings. Although this schematization process is long and protracted, it begins as soon as children have, in principle, two stored forms across which to schematize. Thus, on the one hand, even very young children are likely to have acquired slot-and-frame schemas whose source forms are highly frequent in the input (e.g., 3sg, *Er [Y]t*). On the other hand, even relatively old children are unlikely to have acquired schemas whose source forms are extremely infrequent (e.g., 3pl, *Sie [Z]en*). Thus the constructivist prediction again relates not to age (“children’s knowledge of morphology is concrete until age X”) but to unevenness: Children will show good performance when they are able to use either (a) a rote-learned ready-inflected form or (b) a slot-and-frame schema formed on the basis of frequent exposure to suitable source utterances, but poor performance when they are not.

 There is considerable support for this prediction. For example, highlighting the role of rote-learned ready-inflected forms, a naturalistic-data study of child Spanish (Aguado-Orea, 2004) found that an error rate of 5% for 1sg forms doubled to 10% when just the two most frequent – and hence potentially rote-learned – forms (*quiero*, ‘I want’ and *puedo*, ‘I can’) were excluded. This study also found that both children studied used significantly fewer different forms of each verb than their caregivers. Importantly, this finding is not simply a consequence of adults having a larger repertoire of verbs or morphemes; it holds even when restricting the analysis to verbs and morphemes used by both children and their caregivers. Krajewski (2008) reported very similar findings for Polish (though similar studies of English, Spanish and Italian – Pine, Lieven & Rowland, 1998; Gathercole, Sebastian & Soto, 1999; Pizzuto & Caselli – failed to include these crucial vocabulary controls).

Considering the role of morphological slot-and-frame schemas, Aguado-Orea (2004) found an error rate of close to zero for 3sg forms, but 34-58% (depending on the child) for 3pl forms; exactly the finding that is expected, given that source forms for a 3sg *[X]a* schema are considerably more frequent in the input that source forms for a 3pl *[X]an* schema. Similar findings were reported in a naturalistic data study of Brazilian Portuguese (Rubino & Pine, 1998), and an elicited production study of Finnish (Rasanen, Ambridge & Pine, submitted).

Although its impoverished morphology makes translating such studies into English less than straightforward, when this is done, similar findings are obtained (e.g., Theakston, Lieven & Tomsello, 2003; Theakston & Lieven, 2005; Theakston, Lieven, Pine & Rowland, 2005; Theakston & Rowland, 2009; Rowland & Theakston, 2009; Wilson, 2003; Pine, Conti-Ramsden, Joseph, Lieven & Serratrice, 2008; Rasenen, Ambridge & Pine, in press). Neither are such findings restricted to verb morphology. Similar findings for noun morphology were reported by Leonard, Caselli and Devescovi (2002) for Italian, and by Dąbrowska (2001; 2004; 2005; 2008a; 2008b), Dąbrowska & Szczerbinski (2006) and Krajewski, Lieven and Theakston (2012) for Polish (though again, there is some evidence of the beginnings of abstraction from an early age; Dąbrowska & Tomasello, 2008; Krajewski, Theakston, Lieven and Tomasello, 2011).

***The role of phonology***

The morphological systems discussed in this section so far do not have any particular phonological restrictions. Many systems, however, do exhibit such restrictions, two particularly well-studied examples being the Arabic and German noun-plural systems (Forrester & Plunkett, 1994; Hare, Elman & Daugherty; Plunkett & Nakisa, 1997; Kopcke, 1998; Hahn & Nakisa, 2000; Kauschke, Kurth & Domahs, 2011; Behrens, 2002, 2011). Such restrictions are incorporated into the present framework by an assumption already introduced above; that slots exhibit phonological properties which derive from a weighted average of the items that appeared in this position in the source utterances. For example, the German *–s* plural marker appears with a wide variety of phonologically heterogeneous nouns. Consequently the [X] slot in the morphological *[X]s* slot-and-frame schema has no particular phonological properties, and can readily accommodate all-comers (including, for example, foreign borrowings with non-nativelike phonology). Other markers, such as *–e* appear with a smaller set of phonologically homogenous nouns (the vast majority end in *t/d*, with a much smaller number ending in *–s/-r/-k*). Consequently, the [Y] slot in the morphological *[Y]e* slot-and-frame pattern probabilistically exhibits the phonological property of ending in *–t > -d > -s/-r/-k*, and the greater the extent to which a novel noun is compatible with this property, the more likely it is to receive the *–e* plural marker, as opposed to one of the alternatives (e.g., Kopcke, 1998; Hahn & Nakisa, 2000). The same holds for any other dimensions along which slot-fillers share a particular property (e.g., gender and animacy are two such dimensions for some German noun classes).

***Type frequency versus heterogeneity***

The account outlined above raises an interesting question: Is a particular slot more productive (more open to new fillers) when it has higher “type frequency” - i.e., when more different items have appeared in this position in the source utterances (Bybee, 1995; 2001) – or is type frequency simply functioning as a proxy for heterogeneity? Certainly, all other things being equal, the greater the number of unique items that appear in a particular position, the greater the likelihood that these items will be heterogeneous (in terms of phonology, semantics, gender etc.), thus giving rise to a slot that exhibits no particular properties, and hence no particular restrictions. Findings from investigations into the German noun plural suggest the latter possibility: the *[X]s* schema appears to be one of the most productive schemas (see also Behrens, 2011, on *–en*), although it has considerably lower type frequency than many others, presumably due to its diversity.

 Although the findings from an adult study (Suttle & Goldberg, 2011) suggest unique roles for type frequency and (here, semantic) heterogeneity, we are aware of only one child study that has attempted to unpack these two factors. In a novel-noun elicited-production study of the Polish case-marking system, Dąbrowska and Szczerbinski (2006) found that phonological heterogeneity was a better predictor of productivity than type frequency for 4-year-olds and adults, whilst the opposite was true for 2-year-olds. For three-year-olds, the two predictors were similar. However, these results should be interpreted with caution, given the extremely high correlation between these authors’ measures of type frequency and phonological heterogeneity (*r*=0.91, *p*<0.001). Future research should focus on morphological systems that better allow these predictors to be unconfounded.

***The effect of phonological neighbourhood density***

 In the meantime, a related finding that warrants explanation is the apparent importance of phonological analogy, even for slots that do not place phonological restrictions on the fillers that may appear therein. Consider, for example, the Finnish present-tense 1sg morpheme *–n*. Due to the highly regular nature of Finnish morphology, all verbs, regardless of their phonology, take *–n* in 1sg form. Why, then, are children more likely to supply the correct form for verbs with a large number of phonological neighbours (*kerää-n* ‘*I pick up’*, *herää-n* ‘*I wake up’*) than for verbs that do not (Rasanen, Ambridge & Pine, in press; see also Kirjavainen, Nikolaev & Kidd, 2012, for a similar finding for the Finnish past-tense system)? Why, in a similar vein, are English children more likely to supply a regular *–t* (orthographically, *-ed*) past-tense form for real and novel verbs that are similar to several existing regular verbs (*kiss/kissed, miss/missed, hiss/hissed, wish/wished*) than those that are not (e.g., *match*) even though all are compatible with the *[X]t* schema (Marchman, 1997; Marchman, Wulfeck, & Weismer, 1999; Ambridge, 2010)?

 One possible explanation for these *phonological neighbourhood density* effects is that, rather than using slot-and-frame schemas, children sometimes arrive at an inflected form by direct phonological analogy with one or more stored rote-learned, ready-inflected forms. However, this explanation seems a little *ad hoc*; why should children rely on one-shot analogies more in the domain of morphology than elsewhere? An explanation that is more consistent with the general approach that we are outlining here emphasizes that the property of a slot is a weighted average of the properties of all the items that have appeared in the relevant position in the source utterances. Thus even when these items are sufficiently heterogeneous as to mean that a slot exhibits no *restrictive* phonological properties, it nevertheless retains a preference for fillers that share the “flavor” of its source items, in the form of a weighted average (much as we propose for sentence-level categories in the following section). For example, to put some crude numbers on it, the [X] slot in the English past-tense *[X]t* schema might have the phonological properties 30% *iss* (*kiss, miss, hiss*), 20% *ish* (e.g., *wish, dish*), 50% miscellaneous (e.g., *clip, bake* etc.); sufficiently variable that any novel verb can be accommodated, sufficiently weighted that a novel verb such as *wiss* or *biss* feels most at home (i.e., is rated as a particularly “good sounding” regular past-tense form; see Albright & Hayes, 2003; Ambridge, 2010).

 There is also a third, and perhaps most satisfactory, possibility[[2]](#endnote-2); one that we have already touched upon in the section on determiner acquisition. Perhaps what constructivist theorists call schemas or constructions are no more than helpful mnemonics for particularly frequent kinds of generalizations. Perhaps, in fact, all generalizations are formed on the fly on the basis of stored strings, with schemas merely “immanent in their instantiations” (Langacker, 2000: 7). On this account, there is no difference between generating *wiss*🡪*wissed* (a) by phonological analogy with *kissed, missed* and *hissed* or (b) by inserting *wiss* into a *[X]t* slot-and-frame schema, with which – by virtue of the occurrence of *kiss*, *miss* and *hiss* in its source utterances – it is particularly compatible. In fact, although rarely discussed in relation to child language acquisition (notable exceptions are Ninio, 1993 and Abbot-Smith & Tomasello, 2006[[3]](#endnote-3)), such *exemplar-based* models of linguistic knowledge are well established in the adult psycholinguistics literature (e.g., Skousen, 1992; Nosofsky, 1992; Chandler, 2002; Daelemans, Zavrel, Van der Sloot & Van den Bosch, 2010).

**4. Optional Infinitives and pronoun case-marking errors**

Finally, it would be remiss of us to end this section without touching upon a phenomenon that has proved particularly central to the development of constructivist theory: so-called “optional infinitives”. The phenomenon is that, across many different languages (e.g., English, German, Dutch, Russian, Swedish) children produce utterances that lack tense and agreement marking such as \**He eat cake* (c.f., *He eat****s****/****is*** *eating cake*) or \**Er Kuchen essen* (‘He cake to eat’; c.f., *Er* ***isst*** *Kuchen*, ‘He eats/is eating cake’). Many different non-constructivist accounts of the phenomenon have been proposed, all of which share the assumption that children are failing to mark tense and/or agreement in some formal grammatical sense (e.g., Rizzi, 1994; Radford, 1996; Wexler, 1998; Legate & Yang, 2007). However, none of these accounts can explain the simple finding that the rate of such errors varies dramatically across verbs within a given language (e.g., Freudenthal, Pine, Aguado-Orea & Gobet, 2010; Rasenen, Ambridge & Pine, in press; Ambridge & Lieven, 2011: 152). The constructivist account explains this phenomenon as the result of children rote-learning input strings, and omitting material from the start of utterances (e.g., *~~Does~~ he eat cake?; He ~~can~~ eat cake; Er ~~kann~~ Kuchen essen*), due to a large recency effect and a smaller primacy effect in memory (Ebbinghaus, 1885/1913). A computer model that instantiates this account (MOSAIC) explains the observed variation in error rates both within and across languages (Freudenthal, Pine, Aguado-Orea & Gobet, 2007; Freudenthal et al, 2010), as well as children’s performance in experimental elicitation tasks (e.g., Theakston, Lieven & Tomasello, 2003).

 It is important to note that this account cannot explain the very high rates of such errors observed in English (and perhaps other Germanic languages). Rasenen et al (in press) provided evidence that this is due to a “defaulting” effect whereby children who cannot retrieve a rote-learned 3sg form (e.g., *eats*) or schema (e.g., *[X]s*) instead default to the lexical form of the relevant verb with the highest surface frequency; in every case, the “bare” form (e.g., *eat*). Rasenen et al showed that, across verbs, the higher the proportion of bare vs 3sg *–s* forms in a representative input corpus, the higher the rate of “OI” errors vs correct 3sg –s inflection for that verb.

What unites the MOSAIC and defaulting explanations is its assumption of children’s early reliance on stored strings (here, ready-inflected verb forms and subject+verb combinations). Thus this central assumption of the constructivist account offers a ready explanation for a phenomenon that has eluded formal linguistic accounts. This assumption also explains a related phenomenon: children’s non-nominative-subject errors (e.g., *Me do it; Her eat cake*), which are seen as deriving from a combination of truncating input strings (e.g., *~~Let~~ me do it*) and defaulting to the form with the highest surface frequency in the input (e.g., *Her* > *She*) (Kirjavainen, Theakston & Lieven, 2009; Ambridge & Pine, 2006). Thus, optional-infinitives and non-nominative subjects are a particularly interesting phenomenon, in that stored rote-learned strings lead not to well-formed utterances, but to errors.

**5. Basic Word Order**

***Analogy and adultlike abstract constructions***

In order to be able to produce and comprehend utterances that they have never heard before, children need to acquire abstract representations at the sentence level. Under the constructivist account, these representations are argument structure constructions:

[A] [B] Intransitive construction (e.g., *The ball rolled*)

[X] [Y] [Z] Transitive construction (e.g., *John rolled the ball*)

[P] [Q] [R] *to* [S] PO-dative construction (e.g., *John rolled the ball to Sue*); see Section 6.

An important characteristic of these constructions, which differentiates them from the determiner and morphological constructions discussed above, is that different instantiations of the same construction often share no lexical material. Thus to form these constructions, an additional step beyond the formation of slot-and-frame schemas is necessary (we are agnostic with regard to whether this final step occurs for constructions that always share some closed-class lexical material between instantiations – e.g.., the determiner and morphological constructions – given that an inventory of slot-and-frame schemas would, in principle, suffice).

 We would be the first to admit that the constructivist approach has offered only a rather vague and speculative account of what this process might be (though we hasten to add that rival approaches, such as those based on the notion of parameter-setting, fare no better in this regard; see Ambridge, Pine & Lieven, in press). This account, as outlined by Tomasello (2003) is as follows. Suppose that the child has schematized across the following stored utterances, and arrived at the following slot-and-frame schemas (which use meaningful slot labels, purely for convenience)

*I’m eating it Mummy kissed Daddy*

*I’m hitting it Daddy kissed Mummy*

*I’m kicking it Mummy kissed the baby*

I’m [ACTION]ing it [KISSER] kissed [KISSEE]

Although the schemas *I’m [ACTION]ing it* and *[KISSER] kissed [KISEE]* share no lexical material in common, what they do share is some kind of AGENT-ACTION relation (*I-[ACTION]* and *[KISSER]-kissed*) and ACTION-PATIENT relation (*[ACTION]it* and *kissed [KISSEE]*). The claim is that this type of relational overlap (between many such pairs of schemas) is sufficient for children to *analogize* across them via a process of *structural alignment*, and hence move towards an abstract [AGENT] [ACTION] [PATIENT] sentence-level argument-structure construction. Tomasello (2003) does not specifically address the issue of how these semantically-based constructions broaden into adultlike abstract constructions (e.g., *The situation justified the measures* does not conform to the [AGENT] [ACTION] [PATIENT] pattern), but elsewhere advocates a role for functionally-based distributional analysis. So presumably, the idea is that children expand - for example - the [ACTION] slot into a [VERB] slot on the basis of similarity between pairs of non-actional and actional verbs (e.g., *kiss, justify*) at both the distributional level (e.g., **He** kiss**ed**…; **He** justifi**ed**) and the functional level (both predicate something of “He”).

 There exists some empirical evidence for the claim that learners can analogize across different exemplars using structural alignment (e.g., Kotovsky & Gentner, 1996; Gentner & Medina, 1998), but only from non-linguistic domains, and only for older children (generally those 6-years and older) and adults. For example, in one study, Markman and Gentner (1993) showed adults a picture of a car towing a boat and another of a truck towing the same car. When asked to indicate the item in the second picture that was “the same” as the car in the first, participants ignored the literal match and chose the truck. That is, they aligned the TOWER-TOWEE structure of the two pictures and saw commonalties between the two TOWERs.

 The question of whether or not this account is correct must await empirical evidence. In the meantime, we suggest two small modifications that may somewhat reduce the burden on the learner. First – and this may be implicit in Tomasello’s (2003) account anyway - children do not have to analogize all the way from something like [AGENT] to something like [SUBJECT] in one leap. Rather, the process of analogy could proceed via a series of baby steps, which could have some overlapping lexical material in common (e.g., “GETTING it” is like “HOLDING it” is like “HAVING it”; “WATCHING Mummy” is like “LOOKING AT Mummy” is like “SEEING” Mummy is like “HEARING Mummy” is like “UNDERSTANDING Mummy”). Second, it may well be the case that, particularly for the transitive, that the endpoint is not a single construction (in this case, [SUBJECT] [VERB] [OBJECT]) at all. Perhaps adults have (at least) the following six different transitive constructions (again, meaningful slot labels are used for convenience only; each slot is a weighed average of the items that appeared in this position in the source utterances).

Contact (non-causative) [AGENT] [ACTION] [PATIENT] John hit Bill

Causative [CAUSER] [ACTION] [CHANGE] John broke the plate

Experiencer-Theme [EXPERIENCER] [EXPERIENCE] [THEME] John heard Bill

Theme-Experiencer [THEME] [EXPERIENCE] [EXPERIENCER] John scared Bill

“Weigh” Construction [THING] [MEASURE/COST/WEIGH] [AMOUNT] John weighed 100lbs

“Contain” Construction [CONTAINER] [CONTAIN] [CONTENTS] The tent sleeps four people

Given that the constructivist account posits rampant redundancy anyway (perhaps even storage of every utterance ever heard), there is certainly no *a priori* reason to posit a single transitive construction as opposed to six, or, indeed, sixty. Neither is there any reason to eschew multiple constructions with the same word order on the grounds of avoiding construction-level polysemy. Learners must deal with polysemy at the lexical level as well as – for many languages – the level of morphological schemas (e.g., German has two morphological *[X]t* schemas, for 3sg and 2pl present tense respectively).

Certainly the idea of several different transitive constructions, each made up of slots exhibiting their own constellation of semantic, pragmatic (etc.) properties seems more consistent with the approach we are developing here than the alternative: a single construction in which AGENTS, CAUSERS, EXPERIENCERS, CONTAINERS and so on are somehow seen as similar[[4]](#endnote-4). Indeed, the fact that transitive causative errors with more direct causers are rated as less unacceptable (e.g., *\*The comedian’s joke giggled Lisa > \*The comedian giggled Lisa*; Ambridge, Pine, Rowland, Jones & Clark, 2009) is evidence that the slots of the transitive causative construction have semantic properties that are presumably not shared by noncausative transitive constructions. Similarly, the fact that, in a recognition test, adults were lured into “recognizing” highly prototypical transitives that they had not in fact seen (e.g., *He sliced the bread*; Ibbotson, Theakston, Lieven & Tomasello, 2012) argues for a division between prototypical (contact/causative) transitives and others.

 But, to reiterate, this account of the formation of abstract sentence-level constructions from slot-and-frame schemas is essentially just speculation; we are aware of no studies that have tested this proposal directly.

***Early schemas***

 In contrast, the claim that children’s earliest sentence-level representations are lexically-specific slot-and-frame schemas (which derive ultimately from rote-learned utterance wholes[[5]](#endnote-5)) is extremely well-supported empirically. To stress a point that we have made several times already, the claim is not that children have no abstract sentence-level representations until (for example) age 3;0. Rather, the process of abstraction begins as soon as children have – in principle – two exemplars to abstract across. The claim relates not to age but to unevenness: Children will show excellent performance when they can make use of a well-learned sentence-level slot-and-frame schema, and worse performance when they cannot. Here is some evidence for this claim[[6]](#endnote-6):

* Pine and Lieven (1993; see also Lieven, Pine & Dresner-Barnes, 1992; Lieven, Pine & Baldwin, 1997) showed that 77% of children’s naturalistic utterances could have been generated by one of just 10 slot-and-frame patterns (e.g., *It’s a [X]*); two thirds of which had precedents in the form of recurrent (apparent) frozen phrases (e.g., *It’s a car*).
* Lieven, Salomo and Tomasello (2009) found that 58-78% of utterances in a small test corpus of child utterances were either verbatim repetitions of previous utterances (possibly rote-learned phrases) or could have been generated by a single operation, such as inserting a filler into a construction slot (see also Lieven, Behrens, Speares & Tomasello, 2003; Dąbrowska & Lieven, 2005).
* Bannard, Lieven and Tomasello (2009) used a mathematical model to generate slot-and-frame schemas automatically based on recurring strings in child corpora. Using these schemas, the model was able to generate 60-80% of children’s utterances at 2;0. Adding a NOUN category improved coverage at 2;0 and (to, a lesser extent, at 3;0) whilst adding a VERB category improved coverage at 3;0 only. This finding constitutes evidence of gradual generalization (i.e., formation of abstract construction slots).
* Ambridge & Lieven (2011:221) summarized 14 elicited-production studies in which a novel verb was trained in an intransitive, passive or no-argument construction (e.g., *This is called “tamming”*) and then elicited in a transitive construction (e.g., *Ernie is tamming the ball*). Unsurprisingly, the proportion of children able to produce a transitive with the novel verb rose steadily from around 20% at 2;6 to around 90% at 5;6. This finding alone constitutes little support for the constructivist approach, as it is consistent with various uninteresting explanations, such as decreasing performance limitations with age (Fisher, 2002). A much more compelling – but little remarked -finding is that, particularly for younger children, the vast majority of all arguments (e.g., 90% in Dodson & Tomasello, 1998) were pronouns (e.g., *He’s tamming it*), suggesting that children were relying heavily on the use of slot-and-frame schemas such as *He’s [X]ing it*. Investigating this issue more directly, Childers & Tomasello (2001) found that explicitly training children on these schemas using familiar verbs (e.g., *He’s pushing it*) increased the proportion of two-year-olds able to produce a transitive with a novel verb (e.g., *He’s tamming it*) from 9/20 to 17/20 (see also Abbot-Smith, Lieven & Tomasello, 2004).
* In a very similar vein, Akhtar’s (1999) finding that children’s ability to correct a “weird word order” (e.g., *Elmo the car gopping*) to SVO increases with age is well known. Less well-known, but potentially more important, is the finding that children used pronouns frequently (around 50% of all arguments) when correcting to SVO (e.g., *He’s gopping it*), but never when imitating SOV or VSO. This again suggests that, when producing novel SVO transitives, younger children rely heavily on slot-and-frame schemas such as *He’s [X]ing it* (see also Abbot-Smith, Lieven & Tomasello, 2001; Matthews, Lieven, Theakston & Tomasello, 2004; 2007).
* Again, in a similar vein, the syntactic priming study of Savage, Lieven, Theakston and Tomasello (2003; see also 2006) is best known for its conclusion that abstract priming does not occur until some time after age 4; a finding that is almost certainly incorrect (Huttenlocher, Vasilyeva & Shimpi, 2004; Shimpi, Gamez, Huttenlocher & Vasilyeva, 2007; Bencini & Valian, 2008; Rowland, Chang, Ambridge, Pine & Lieven, 2012). But more important is the often-ignored fact that Savage et al’s 3-4 year olds *did* show both active🡪active and passive🡪passive priming when the prime sentences used lexically-specific slot-and-frame schemas that children could re-use in their own productions (*It is [X]ing it* or *It got [X]ed by it*).
* Younger children’s reliance on slot-and-frame schemas is also evidenced in comprehension studies. Childers and Tomasello (2001, Study 2) found that two-year olds showed significantly better performance when asked to enact novel transitive sentences with pronouns (e.g., *He’s meeking it*) than full NPs (e.g., *The dog’s meeking the car*), even though the entitites to be manipulated were never named in the pronoun condition.

The findings of preferential-looking and pointing studies are often argued to constitute evidence against the constructivist account. In fact, they constitute evidence only against an extreme version of the account that posits virtually no generalization until (say) age 3;0, and positive evidence *for* an account based around a protracted period of generalization that begins as soon as children have – in principle – two exemplars across which to generalize. The headline finding is that, if presented with an audio sentence such as *The duck is glorping the bunny*, children – in some cases as young as 1;9 - look longer at, or point to, a video screen where a duck is performing a novel action on a bunny, rather than vice versa (Gernter, Fisher & Eisengart, 2006; Noble, Rowland & Pine, 2011; Fernandes, Marcus, Di Nubila & Vouloumanos, 2006).

But this effect is fragile. Children fail if the actions on the two screens are identical (with the roles reversed), or if they are not given a training session in which the same characters subsequently used at test enact sentences with familiar verbs (Chan, Meints, Lieven & Tomasello, 2010; Dittmar, Abbot-Smith, Lieven & Tomasello, 2008). They struggle on intransitives with conjoined subjects (e.g., *The duck and the bunny are glorping*), seemingly interpreting them as if they were simple transitives (e.g., *The duck is glorping the bunny*) (Hirsh-Pasek, Golinkoff & Naigles, 1996; Kidd, Bavin & Rhodes, 2001; Bavin & Growcott, 2000; Noble, Rowland & Pine, 2011). They struggle on transitives with non-canonical mappings, interpreting – for example – “the one who’s blicking the balloon from the other one” as if it were “the one who’s blicking the balloon *to* the other one” (Fisher, 1996).

 Taken as a whole, this pattern of findings is exactly what one would expect if young children have only the very first tentative outline of an abstract [X] [Y] [Z] transitive construction, where the [X] slot is probabilistically associated with properties such as moving first, moving towards the other character, instigating contact with this character, and so on (Abbot-Smith & Tomasello, 2006). This schema gives the wrong interpretation for sentences with conjoined-subjects or non-canonical mappings and cannot be accessed at all unless it is “primed” in a training session with familiar verbs.

 We conclude this section by discussing a common objection to this account: Isn’t it all far too Anglo-centric? Postionally-based schemas and constructions might work well enough for languages that follow relatively strict word order, but what about languages that do not (though see Stoll, Abbot-Smith & Lieven, 2009)? Whether or not the constructivist account can accommodate findings from any particular language is, of course, an empirical question. However, we see no reason why the account outlined in this chapter could not be applied directly to very different languages. Suppose, for the sake of argument, that there exists a language that uses entirely free word order, with all roles indicated using case-marking. Although the positional patterns outlined in the present section would be quite useless, this simply shifts the burden onto the morphological schemas discussed in the previous section. Indeed, this previous section summarizes evidence from a relatively free word-order language (Polish) that schemas built around noun case-marking morphemes are learned in the same way as those built around verbal tense/agreement markers (e.g., the English past-tense *[X]ed* schema). In reality, most “free” word order languages are probably better described as displaying pragmatic word order. This too is handled comfortably by the present account, on the assumption that the slots that make up sentence-level constructions (e.g., the [X] [Y] [Z] transitive construction[s]) probabilistically exhibit not only semantic properties, but also pragmatic properties (e.g., being discourse-old).

 What *is* Anglo-centric is the alternative: taking categories, rules and analyses developed largely on the basis of English, and trying to cram all languages into this template. Indeed, evidence from typology suggests that even such apparently fundamental lexical categories as VERB and ADJECTIVE do not seem to be universal (Evans & Levinson, 2009; McCawley, 1992; Dixon, 2004; Haspelmath, 2007). Given this considerable cross-linguistic diversity, the only viable solution is to posit that abstract representations are built from the input, on an entirely language-specific basis; i.e., exactly the approach taken by constructivist accounts.

***The retreat from error***

Before moving on to consider more advanced constructions, we owe the reader an account of why children make errors, and how they come to stop making them. Essentially errors have two sources. The first is the use of a rote-learned string in an inappropriate context. We have already met several errors of this type including the use of (a) a 3sg verb form in a 3pl context (e.g., in Spanish, Brazilian Portuguese and Finnish), (b) a truncated non-finite string in a finite context (e.g., ~~does~~ he eat cake) and (c) a truncated non-nominative string in a nominative context (e.g., *~~let~~ me do it*). The second source of error is the use of an item in a schema or construction slot with which it is less than optimally compatible. Examples include the use of an irregular verb in the English past-tense [X]*-ed* schema (e.g., *\*[sleep]ed; \*[sing]ed*) and the use of an intransitive-only verb in the [X] [Y] [Z] transitive-causative construction (e.g., \*[*The funny joke*][*giggled*][*Lisa*])[[7]](#endnote-7).

Under the present account, the mechanism that causes children to make these errors is the same mechanism that causes children to stop making these errors: competition (e.g., MacWhinney, 2004). A speaker has a given message that she wishes to express. All stored forms – from single words, through slot-and-frame schemas, to abstract constructions compete for the right to express this message. Early in development, the wrong form may win out, because it is more frequent and hence more strongly represented (e.g., 3pl *juega* over 3sg *juegan*), or because children have not yet learned an alternative schema/construction with a more appropriate slot (“appropriate” in this context means exhibiting phonological/semantic etc. overlap between the slot and its filler). This is the case when, for example, the child uses *sleep* in the regular *[X]-ed* schema instead of the more appropriate irregular *[Y+vowel shortening]-t* schema, or uses *giggle* in the transitive causative construction (e.g., \**The funny joke giggled Lisa*) instead of the periphrastic causative (*The funny joke made Lisa giggle*).

Children retreat from error as they learn schemas/constructions who slots have better fits for the items in the message. Two factors are important here: statistics and semantics. With regard to statistics, children learn probabilistic links between particular items (e.g., *giggle*) and particular constructions (e.g., periphrastic causative, intransitive), which cause these constructions to be activated at the expense of competitors (e.g., transitive causative) when the relevant item (e.g., *giggle*) is part of the speaker’s intended message. Consequently, the likelihood of children’s using (e.g., Brooks, Tomasello, Dodson & Lewis), accepting (Ambridge et al, 2008; 2009; 2009) and comprehending (Dittmar, Abbot-Smith, Lieven & Tomasello, 2013) verbs in non-attested constructions decreases with increasing verb-frequency[[8]](#endnote-8). With regard to semantics, children learn the fine-grained semantic properties of particular construction slots (e.g., that the [Z] slot in the [X][Y][Z] construction denotes direct causation), meaning that verbs that are not compatible with this meaning (e.g., *giggle*) are a better fit for slots in other, competing constructions such as the intransitive and periphrastic causative (Ambridge et al, 2009; 2012; in press).

 We should end this section by acknowledging that we have presented only a brief sketch of the retreat from overgeneralization here; at least in part because this is a topic that we have covered particularly extensively elsewhere; Ambridge & Lieven, 2011: 242-265; Ambridge, Pine, Rowland, Chang & Bidgood, 2013).

**6. More Advanced Constructions**

The previous sections have outlined a constructivist account of language acquisition, focusing on the basic morphological and syntactic schemas and constructions that constitute the “bread and butter” of everyday language use. A charge that is sometimes leveled at constructivist accounts, however, is that it struggles in the face of more complex utterances; that it cannot account for the acquisition of three-argument constructions (e.g., datives, locatives), movement-constructions (e.g., passives, questions) and multiple-clause constructions (e.g., relative- and complement-clause constructions). Our goal in this section is to argue that, on the contrary, all of these phenomena can be explained using the basic assumptions that we have outlined above, without the need for any additional theoretical machinery. That said, it is certainly the case that these areas have attracted considerably less attention from constructivist researchers, which is one of two reasons for the relative brevity of this section (the other, of course, being the ubiquitous “space limitations”).

***Three-argument constructions***

Many languages have some kind of dedicated transfer construction. English has two: the double-object (DO) and prepositional-object (PO) dative

[P] [Q] [R] *to/for* [S] DO-dative construction (e.g., *John sent the letter to Sue*)

[A] [B] [C] [D] PO-dative construction (e.g., *John sent Sue the letter*)

Exactly as for other constructions, children begin by storing a number of rote-learned utterance wholes (*Gimme it;I’ll tell you a story*), across which they then abstract to acquire slot-and-frame schemas (*Gimme [X]; I’ll [Y] you a story*). We are aware of no studies that have directly attempted to find evidence of these holophrases or schemas in children’s speech. However, suggestive evidence comes from the naturalistic data study of Campbell & Tomasello (2001) who showed that just nine verbs were used by at least six of the seven children studied (*give, read, bring, take, show, tell, get, buy,* and *make*), with the single verb *give* accounting for around 50% of all dative tokens. This study also found that children’s dative uses were highly similar to their parents’. For example, DO-dative uses of *give* outnumbered PO-dative uses of *give* by around 3:1, in both parental and child speech. Other verbs, such as *make*, showed a PO-bias in some parents and a DO-bias in others, with children generally replicating this pattern in their own speech.

 Later, children abstract across these schemas to acquire more abstract constructions. Exactly as for the simpler constructions discussed above, priming, comprehension and novel-verb production studies demonstrate that children have at least some abstract knowledge of these two constructions by a relatively young age (though, in this case 3-4, rather than 1-2; Shimpi et al, 2007; Thothathiri & Snedeker, 2008; Conwell & Demuth, 2007; Rowland, Chang, Ambridge, Pine & Lieven, 2012). Again, though, a closer look at the data suggests that these finding reflect only the first tentative outlines of an abstract construction. For example, Conwell and Demuth (2007; Experiment 2) found that novel verbs taught in the PO-dative were extended to the DO-dative only 8% of time the time. Exactly as for the transitive construction, Rowland and Noble (2010) found that children showed significantly better (comprehension) performance for prototypical datives that were consistent with possible slot-and-frame patterns (e.g., *I’m [X]ing the [Y] to [NAME]*)[[9]](#endnote-9).

Finally, via this process of gradual abstraction, children arrive at abstract PO- and DO-dative constructions whose slots exhibit probabilistic semantic and – in some cases – phonological properties. For example, the third slot in the DO-dative prototypically denotes a human recipient or potential possessor, which is why it is odd to say *\*I sent Chicago the package* (c.f., *I sent the package to Chicago*), whilst the second (“VERB”) slot has the probabilistic phonological property of monosyllabicity/first-syllable stress, which is why it is odd to say *\*I suggested him the idea* (c.f., *I suggested the idea to him*) (Pinker, 1989). Ambridge, Pine, Rowland, Freudenthal and Chang (in press) and Ambridge, Pine, Rowland and Chang (2012) showed that independently-obtained ratings of verbs’ semantic and phonological properties were able to predict their relative acceptability in PO- and DO-dative constructions.

 English also has a second pair of three-argument constructions, the figure- and ground-locatives (e.g., *Lisa sprayed water onto the flowers; Lisa sprayed the flowers with water*). This construction has received considerably less attention than the dative, but, again, the evidence suggests that children’s earliest uses are closely tied to the language that they hear (Twomey, Chang, Ambridge, Rowland & Pine, submitted), and that learners eventually acquire a construction whose slots place probabilistic semantic restrictions on the verbs that can appear felicitously therein (Ambridge, Pine & Rowland, 2012).

***“Movement”-constructions***

Movement constructions are so called because, under traditional approaches, they are generated from phrases that have canonical word order, via syntactic movement. For example, a passive such as *The ball was kicked* is generated from the VP *kicked the ball* by (amongst other processes) the movement of the Determiner Phrase *the ball* from “OBJECT” to “SUBJECT” position (SPEC IP). Similarly, a question such as *What can he eat?* is generated by movement of both the *wh*-word (*what*) and the auxiliary (*can*) from *He can eat what?*

 The constructivist account does not posit movement. Rather, these constructions are abstracted from input utterances using the same processes outlined above. With regard to passives, although there are few studies of the early stages, the available data (e.g., Israel, Johnson & Brooks, 2000) again suggest that children start out with rote-learned holophrases (e.g., *It’s broken*), across which they abstract to form, first, lexically specific schemas (e.g., *[X] is broken*) and, ultimately, abstract constructions (e.g., *[X] BE/GET [Y] by [Z]*). Again, although children show some early successes with the construction (e.g., Bencini & Valian, 2008; Messenger, Branigan & McLean, 2011; Messenger, Branigan, McLean & Sorace, 2012), they perform best when they can use a well-learned slot-and-frame schema (e.g., *It got [X]ed by it*; Savage et al, 2003[[10]](#endnote-10)), particularly if they receive direct training on this schema (Brooks & Tomasello, 1999). Conversely, when faced with non-canonical passives that are a poor fit to their emerging *[X] BE/GET [Y] by [Z]* construction, children struggle, even at age 6. For example, the [Y] (“VERB”) slot has the probabilistic semantic property of “action that affects the patient”. Children show excellent performance when this slot is filled by a verb with compatible semantics (e.g., *Bob was* ***hit*** *by Wendy*) and poor performance when the verb has less-compatible semantics (e.g., *Bob was* ***seen*** *by Wendy*) (Horgan, 1978; Fox & Grodzinksky, 1998; Gordon & Chafetz, 1990; Hirsch & Wexler, 2006; Maratsos, Fox, Becker & Chalkley, 1985; Sudhalter & Braine, 1985; Gordon & Chafetz, 1990; Pinker et al, 1987; Meints, 1999; Messenger, Branigan & McLean, 2012; Ambridge, Bidgood, Pine, Rowland, Chang & Freudenthal, submitted)[[11]](#endnote-11).

 With regard to questions, constructivist studies have tended to focus not on children’s abstract question constructions, but on the earlier stages. There exists a considerable body of evidence that children’s earliest questions are rote-learned holophrases or formed using lexical slot-and-frame schemas. With regard to holophrases, Labov and Labov (1978) reported an error rate of 80% for *what* questions with a full auxiliary, dropping to 23% with a contracted auxiliary; a difference likely due to the frequent use of the single question *What’s that?* With regard to slot-and-frame schemas, both naturalistic (e.g. Rowland & Pine, 2000; Rowland, 2007; Dąbrowska & Lieven, 2005) and experimental studies (e.g., Ambridge, Rowland, Theakston & Tomasello, 2006; Ambridge & Rowland 2009) provide evidence that children seem to be using slot-and-frame schemas such as *What are [X][Y]ing?* (e.g., *What are you doing?*): Exactly as for all of the other constructions discussed in this review, utterances that could have been produced using such a schema (identified on the basis of children’s previous utterances and/or their input) displayed significantly lower error rates than those that could not.

***Relative- and complement-clause constructions***

Relative clause sentences – or, at least the standard “textbook” examples – contain a clause that provides additional information about either the subject or the object of the main clause (e.g., *The dog [that the pig jumped over] bumped into the lion*). Again, the empirical data suggest that children (a) start out with holophrases and slot-and-frame schemas, moving only gradually towards abstract constructions, and (b) show significantly better performance on relative clause sentences that are highly consistent with these schemas and constructions. In an analysis of naturalistic data, Diessel and Tomasello (2000) found that the majority of children’s relative clause sentences were presentational relatives (e.g., *Here’s a tiger that’s gonna scare him*), consistent with simple slot-and-frame schemas (e.g., *Here’s a [X] that [Y]*), rather than full abstract constructions. Similarly, Kidd, Brandt, Lieven and Tomasello (2007) found that 75% of children’s object relatives had inanimate main-clause objects, whilst 87% of relative-clause subjects were one of three pronouns: *I, we* and *you*. This means that a very large proportion of children’s relative clause utterances could have been generated using schemas such as (*There’s the [X] that I [Y]ed*). Even later in development, when children’s knowledge becomes more abstract, they still show better performance for relative clause sentences that are consistent with these construction prototypes, even when these are object as opposed to subject relatives and hence – from a formal linguistic perspective – more complex (e.g., Kidd et al, 2007; Diessel & Tomasello, 2005). Similar findings were also observed for German (Diessel & Tomasllo, 2005; Brandt, Kidd, Lieven & Tomasello, 2009) and Hebrew (Arnon, 2010).

 Complement clause sentences contain a sentence-like clause that serves as the subject or (more commonly) object of the verb in the main clause (e.g., *John wondered* ***[whether the boy had eaten the cake]***). Again, the linguistic complexity of these textbook examples hides the fact that children’s earliest utterances are highly stereotypical, and could have been generated using slot-and-frame schemas. For example, Diessel and Tomasello (2001) found that 98% and 100% of children’s complement-clause sentences with *bet* and *guess* respectively had *I* as subject, suggesting that children start out with *I bet [X]* and *I guess [Y]* schemas that function simply as hedges or attention-getters (see Limber, 1973 and Bloom, Rispoli, Gartner & Hafitz, 1989, for similar findings). Again, when children’s ability to repeat or produce these structures is examined naturalistically (Brandt, Lieven & Tomasello, 2010) or probed experimentally (Kidd, Lieven & Tomasello, 2006; 2008; ), they show better performance when they are potentially able to use a well-learned high-frequency slot and frame schema (e.g., *I think [she is riding the horse]*) than when they are not (e.g,. *I pretend [she is riding the horse]*).

**7. Conclusion**

Whatever the domain of acquisition, the constructivist account holds that children start out with rote-learned holophrases (e.g., *I’m eating it; I’m hitting it; I’m kicking it*) across which they abstract to acquire lexically-specific slot-and-frame schemas/patterns (e.g., *I’m [X]ing it*). In at least some domains, children then analogize across these schemas to arrive at fully-abstract constructions (e.g., the transitive *[X] [Y] [Z]* construction[s]). Although long and protracted, the processes of schematization and analogy *begin* as soon as children have stored – in principle - two relevant utterances across which to abstract. Importantly, each slot in the resulting schema or construction probabilistically exhibits the semantic, pragmatic, phonological (etc.) properties of the items that appeared in this position in the relevant source utterances. The greater degree of overlap between a slot and its potential filler, the more easily the resulting utterance is produced and comprehended, and the greater the extent to which is rated as acceptable by adults.

 As we have stressed throughout this chapter, the prediction that follows from this account relates not to age (“children do not have abstract knowledge until age X”) but to unevenness: Children will display significantly better performance when they can use a stored holophrase or slot-and-frame schema, and/or when the target utterance is a highly prototypical instance of the relevant abstract construction (i.e., exhibits high slot-filler overlap). On our reading of the literature, this prediction is well supported in every domain in which it has been tested, including all of those included in this review: determiners, morphological constructions, basic syntax and more complex constructions.

 Although the present chapter has not touched upon rival approaches (c.f., Ambridge & Lieven, 2011; Ambridge, Pine & Lieven, in press), it is difficult to imagine how any account that did not posit the gradual abstraction of constructions from the input could account for any one of many the lexical and prototype effects summarized here. Thus although the constructivist approach faces many challenges, not least providing an account of precisely how children move from slot-and-frame patterns to abstract constructions, on our view, the findings summarized above are sufficient to conclude that some form of constructivist, input-based account is the only realistic candidate for a viable theory of language acquisition.

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1. Of course this account begs a whole host of questions regarding exactly how this “weighted average” is calculated; for example, is it calculated over types or tokens, or some function of the two? And what counts as a “type” or, for that matter, a “token”, given that no two instantiations of the same word will be phonologically identical? Probably the only way in which we will ever be able to begin to answer these questions is with the aid of computational models that take approximations of child-directed speech as input and produce output that can be directly compared to that of real children (e.g., Chang, Dell & Bock, 2006; Freudenthal et al, 2007; Solan et al, 2003; Daelemans et al, 2010). [↑](#endnote-ref-1)
2. Yet another possibility is that there are several different routes - (a) use of a stored form, (b) use of an independently-represented slot-and-frame schema, (c) phonological analogy to stored forms (e.g., Abbot Smith & Tomasello, 2006) – and that which route is used on any given occasion depends on factors such as how recently this form, or phonologically similar forms, occurred in prior discourse. [↑](#endnote-ref-2)
3. (p.276) “A major point of contention within the categorization literature in general is whether learners develop abstractions that supersede (and essentially efface) the experienced exemplars, as in a ‘pure’ version of prototype theory or, alternatively, whether generalization occurs solely through online analogical comparison to a set of previously learned exemplars. We opt in the end for a kind of hybrid model comprising both abstractions and the retention of the exemplars of which those abstractions are composed”. [↑](#endnote-ref-3)
4. It is for this reason that we diverge from Tomasello’s (2003) account in not positing a separate role for distributional analysis in this construction-formation process. If children have (at least) six different transitive constructions, there is no need to assimilate (for example) *kiss* and *justify* into a single unitary transitive construction on the basis of distributional similarity between the two. This is not to dispute the claim that children perform distributional learning. Our claim, rather, is that the gradual probabilistic construction-abstraction process outlined here *is* the particular form of distributional learning that children use. [↑](#endnote-ref-4)
5. Until recently, the empirical data demonstrated only that many of children’s utterances were *potentially* *consistent* with the use of rote-learned multi-word holophrases. However, four recent studies (Bannard & Matthews, 2008; Matthews & Bannard, 2010; Arnon & Snider, 2010; Arnon & Clark, 2011) have provided fairly direct evidence for the claim that these holophrases are indeed stored. Young children’s utterances are more fluent and/or accurate when they are able to make use of a multi-word string that is of high frequency in the input (even when controlling for of individual word and bigram frequency). [↑](#endnote-ref-5)
6. Incidentally, although Tomsello’s (1992) *Verb-Island Hypothesis* is perhaps the single best-known constructivist study and theoretical claim, note that most of the “islands” that children appear to be using in the studies summarized here are organized not around verbs (e.g., *[X] kick [Y]*), but around pronouns, auxiliaries, inflectional morphemes and other closed-class items (e.g., *He’s [X]ing it*). Thus, as Tomasello concedes (e.g., Childers & Tomasello, 2001: 746), this particular hypothesis, or at least the privileged status that it accords to verbs, seems to be incorrect (see also McClure, Pine & Lieven, 2006). [↑](#endnote-ref-6)
7. To the extent that a particular construction has particular “contextual” (i.e., semantic, functional, pragmatic etc properties), errors of the first type (use of an item in an inappropriate context) can be seen as special cases of errors of the second type (use of an item in an inappropriate construction). For example, the *reason* it is wrong to say \**He eat cake* is that the [Z] slot in the [X] [Y] [Z] transitive construction exhibits the semantic/functional properties of denoting an event that is bounded in time. [↑](#endnote-ref-7)
8. Thus under this account, effects such as *entrenchment* (Braine & Brooks, 1995) and *pre-emption* (Goldberg, 1995) are seen not as separate mechanisms, but as mnemonics for frequency effects arising from the same construction-competition process. [↑](#endnote-ref-8)
9. The findings of Rowland et al’s (2012) priming study suggest that, by 3;8, children’s knowledge of the PO- and DO-dative constructions is as abstract as adults’, and that young children do not show a lexical boost when the same verb is used in the prime and target sentence. However, this study (unlike Rowland & Noble, 2011) does not address the issue of whether children or adults show better performance when they are potentially able to use a lexical frame such *I’m [X]ing the [Y] to [NAME]*; indeed, participants hardly ever used pronouns in this study. [↑](#endnote-ref-9)
10. This study reported a “lexical-boost” effect whereby the youngest children showed priming only when the prime sentence used a slot-and-frame schema - *It got [X]ed by it* – that could also be used to produce the target sentence. A more recent study of the dative constructions (Rowland et al, 2012) found no lexical-boost effect for young children, and indeed suggested that such effects may be a red herring, reflecting not the priming of slot-and-frame schemas but explicit memory of the prime sentence. But setting aside controversy over the lexical-boost, a separate finding from the Savage et al (2003) study provides evidence for the use of slot-and-frame schemas: In the condition in which they frequently produced passives (around 1.5 passives per child), 3- and 4-year olds used pronouns twice as often as nouns. In the condition in which they rarely produced passives (under 0.5 passives per child) 3- and 4-year olds used pronouns half as often as nouns. In other words, children are much better at producing passives when they use schemas such as *It got ACTIONed by it*. [↑](#endnote-ref-10)
11. Indeed, there is evidence to suggest that some adult speakers may never acquire a fully-abstract passive construction. Dabrowska and Street (2006) found that, amongst a group of adults who read only rarely, and hence had little experience with this construction, which is rare in spoken discourse, around 1/3 showed at-chance performance on a comprehension task. Thus although we have presented a one-size-fits-all account here, individual differences in level of abstraction as a function of literacy and educational level constitute a phenomenon that requires further empirical investigation, and incorporation into theoretical accounts of acquisition. [↑](#endnote-ref-11)