Multiunit Sequences in First Language Acquisition

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Abstract

Theoretical and empirical reasons suggest that children build their language not only out of individual words but also out of multiunit strings. These are the basis for the development of schemas containing slots. The slots are putative categories which build in abstraction while the schemas eventually connect to other schemas in terms of both meaning and form. Evidence comes from the nature of the input, the ways in which children construct novel utterances, the systematic errors that children make, and the computational modelling of children’s grammars. However, much of this research is on English, which is unusual in its rigid word order and impoverished inflectional morphology. We summarise these results and explore their implications for languages with more flexible word order and/or much richer inflectional morphology.

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Multiunit Strings in First Language Acquisition

Introduction
The use of frequent multiunit strings in written and spoken language is well established and is associated with a range of processing advantages (Wray, 2012). These strings can be fully specified (e.g. *How are you? Don’t know*, Bybee & Scheibmann, 1999) or more flexible with slots of varying abstractness (*X found X’s way PP, X let alone Y*, Fillmore, Kay & O’Connor 1988). The question we address in this paper is the role that multiunit strings of differing degrees of abstraction might play in the learning of grammatical structure in first language acquisition. By ‘abstractness’ and ‘abstraction’, we mean any slot in a string that goes beyond a specific phonological form or word. So, for example, a child’s lexicon might initially contain a frozen phrase such as *Where’s Daddy?* before adding *Where’s PERSON?* and then *Where’s PERSON/OBJECT?*, ending up with *Where’s NP?*. During this process of developing slots of increasingly wider scope within schemas, the X slot in the *Where’s X?* schema has increased in abstractness.²

The role of multiunit strings in first language acquisition
From a usage-based theoretical perspective, our ability to understand and create novel utterances derives from the fact that they are like utterances we have heard and used before. Thus we can think of the task of language learning as learning to appropriately reuse the language that one hears. Researchers working within a usage-based perspective argue that multiunit strings form one important starting point in the language acquisition process. If multiunit strings occur frequently enough in the input, then it is possible for children to learn and use them. There are also good theoretical arguments for the idea that storing strings as well as words is computationally efficient provided there is enough redundancy in the system (Bannard & Lieven 2009). The process of abstraction is then thought to build on this early learning. Multiunit strings provide an opportunity for children to dissect and recombine linguistic elements, and to create more abstract frames by generalizing across lexical items; these strings in turn eventually link up to create an adult-like grammar (e.g. Lieven, Salomo & Tomasello 2009).

² We use CAPS for the content of a slot and *italics* to denote a schema or utterance
For the usage-based approach to work, three important criteria must be met. First, if children are to learn multiunit strings, these must exist in substantial numbers in the language that they hear. Second, we need evidence that at least some of children’s early language is based on these multiunit strings. Third, we need to demonstrate that multiunit strings facilitate the development of more abstract linguistic representations, which explains how, based on strings that they hear, children can produce novel utterances. Here, we take English as a test case for these processes, before considering their application cross-linguistically.

**Multiunit strings in English**

English, as a language which is governed by strict word order and does not allow argument ellipsis (except in certain pragmatically motivated contexts), lends itself to the acquisition of multiunit sequences. Previous studies show that the language English-speaking children are exposed to contains large numbers of multiunit collocations.

**Input**

Bannard and Matthews (2008) computed the frequency of 1-5 word strings in child-directed-speech (CDS) and found many strings that were at least as frequent as individual words in the core lexicon. This gives *prima facie* support to the suggestion that some multiunit strings are highly frequent and available for children to learn. In a more detailed analysis of the speech addressed to 12 English-learning children between the ages of 2-3 years, Cameron-Faulkner, Lieven, and Tomasello (2003) found that half of the utterances addressed to the children could be characterised by 52 item-based frames, with 45% beginning with one of just 17 different words. They argued that the distributional properties of the input were conducive to children’s acquisition of lexical frames, and that repeated exposure to these frames could provide a route into the more abstract linguistic system: “Whatever else it is, the acquisition of a language is the acquisition of a skill, and skills are crucially dependent on repetition and repetition with variation” (2003, p. 868).

**Evidence for frames in early English child language**

It is now well established, starting with the work of Braine (1976) and Peters (1983), that children’s early utterances are less complex and more lexically-specific than those of adult speakers. Our own work and that of our colleagues demonstrates that a large proportion of children’s early utterances can be accounted for by a small number of high frequency frames based around specific lexical items or multiunit chunks (e.g. *I'm V-ing it, It's a X, What can*...
Supporting evidence exists in a range of linguistic domains including children’s early use of auxiliary verbs (Theakston, Lieven, Pine, & Rowland, 2005), determiners (Pine, Freudenthal, Krajewski & Gobet, 2013), wh-questions (Rowland & Pine, 2000), and grammatical constructions such as the transitive (Theakston, Maslen, Lieven, & Tomasello, 2012). Many of the frames identified in early child speech occur with high frequency in the input addressed to children (Cameron-Faulkner et al., 2003).

Further studies have found that the schemas used in early child language appear to exist relatively independently of one another, at least in the earliest stages. They show relatively little overlap in their content, for example with respect to the main verbs produced with different auxiliaries (can’t X vs. don’t Y, Lieven, 2008) and the nouns used with particular determiners (a X vs. the Y, Pine et al., 2013). These schemas may be individually learned from the input and, initially at least, contain lexically and/or semantically restricted slots. Another, more direct, source of evidence for children’s learning and storage of multiunit sequences is the finding that children are better able to repeat four-word sequences found frequently in CDS than less frequent four-word sequences, even when the frequency of the individual items and bigrams is carefully controlled (e.g. compare a cup of tea with a cup of milk, Bannard & Matthews, 2008).

Finally, there is evidence that children (and sometimes adults) appear to rely on lexically-based frames in the production of complex utterances. Diessel and Tomasello (2001) reported that children’s earliest complement clauses are organised around only a small number of main verbs often occurring with specific subject arguments too, for example I think+COMPLEMENT. These kinds of schemas also extend into children’s and adults’ use of complex questions. Questions beginning with high frequency chunks such as What do you think...? were repeated more accurately than those with the same syntactic structure and vocabulary, but beginning with an infrequent sequence such as What does the old man think...? (Dąbrowska, Rowland & Theakston, 2009).

**Role of multiunit strings in abstraction, productivity and creativity**

We envisage children’s linguistic systems building up as a network of constructions which become increasingly interconnected along a range of dimensions: phonological, prosodic, semantic, pragmatic and structural. For example, from early on English-speaking children develop considerable flexibility with nouns such that they can use them across a number of
different schemas: I want a X, That’s a X. Initially this putative noun category may be quite low-scope e.g. of objects and/or people, and this may vary from child to child. But as children learn more and more constructions, the mapping of the semantics of ‘ENTITY’ to ‘noun phrase’ will become increasingly abstract, i.e. will lose much of its phonological and semantic specificity, ultimately allowing for the insertion of relative clauses, clefts etc.

One way to examine the process of abstraction is to look at how early-produced utterances are subsequently modified to produce longer, more complex sequences. If children are storing prefabricated chunks of language, then earlier learned words might be expected to appear in more complex utterances than later learned words, because the child has had the opportunity to gradually increase the length of the sequences learned from the input. Furthermore, if there is lexical overlap between earlier and later utterances, this might suggest that rather than constructing utterances from scratch by combining abstract semantic or grammatical categories, children are instead accessing prefabricated strings which they then combine with other words/strings to build complexity. These strings may function to free up the child’s processing resources as a result of automatization in memory or greater ease of retrieval (Logan, 1988), enabling them to extend their earlier productions.

In diary data from one child, Tomasello (1992) observed that there was added-value in her verb use over development as a function of her earlier uses of those same verbs. Verbs tended to be combined with the same kinds of arguments (e.g. actor, object) as they had been previously, with new arguments added over time. Complexity reflected their cumulative frequency of use but varied from one verb to the next, suggesting that their representations were not fully interconnected. Testing this claim more widely, McClure, Pine, and Lieven (2006) found that for 12 English-learning children between 2-3 years, verb utterances produced at MLU 2.0-2.49 were more complex for verbs that had been used previously and consequently had a higher cumulative frequency of use, than for newly acquired verbs, while Theakston et al., (2012), in a case study using densely sampled data, found that from age 2;0-2;6, 79% of the verbs the child used in a full subject-verb-object construction had previously been used in a simpler subject-verb or verb-object construction, many with the same subject and/or object arguments.

Further evidence for the process of using multiunit strings comes from a series of studies that attempted to derive later utterances from those heard or produced earlier in development. In a
study of two children’s early utterances, Lieven et al. (2009) found that at 2;0 many of the children’s apparently novel utterances could be formed by making only minor changes to their previous utterances. In a more robust test of this process, frequency-driven grammars derived from child speech using a Bayesian computational model (Bannard, Lieven, & Tomasello, 2009) were demonstrated to provide a better fit to children’s early utterances than a more abstract grammar incorporating broad categories like Noun and Verb. However, by 3;0, introducing these categories made a significant difference to the goodness of fit.

A further source of evidence for the role of low-scope, multiunit strings in the development of abstraction is the gradual convergence between child and adult language, as children acquire greater flexibility in language use. In a recent study, Theakston, Ibbotson, Freudenthal, Lieven & Tomasello (2015) examined the degree of overlap in the nouns used as Subject and Object between children’s and their caregivers’ Subject-Verb-Object combinations at 2 and 3 years of age, with the application of controls for vocabulary and sample size. Over development, both the degree of lexical overlap between mother and child in the nouns used with a given verb, and the degree of items uniquely attested in the children’s speech increased, demonstrating both abstraction in the slots, and convergence on the adult grammar. In summary, for English at least, children’s acquisition of lexical collocations and low-scope variable frames appears to provide one plausible route into more abstract and general grammatical representations.

The role of pronouns in abstraction

Multiunit strings can be sequential but there is also ample evidence that they can be created around variable slots, for example in the frame Where’s X gone?. We know that infants are better able to detect non-adjacent patterns in strings of syllables if there is sufficient variation in an intervening element between two relatively stable anchors (Gomez, 2002), and in older children there is some evidence that constructions modelled with a number of different verbs facilitate generalisation to new verbs (Savage, Lieven, Theakston & Tomasello, 2006). In the creation of these slot-and-frame patterns, pronouns have been observed to play a privileged role as anchors around a variable verb slot. For example, pronouns account for over 80% of transitive subjects in the input to young English-speaking children (Cameron-Faulkner et al., 2003) and thus may support the acquisition of schemas such as He’s V-ing it, into which new verbs can be inserted. Evidence for this suggestion comes from multiple sources:
• when children corrected sentences with novel verbs presented in non-English word orders (SOV - *The fox the bear tammed*), roughly half of the time they did so using pronoun subjects and objects (Akhtar, 1999)
• children show sensitivity to the form and placing of pronouns in their interpretation of transitive sentences (Ibbotson, Theakston, Lieven & Tomasello, 2011)
• in our dense data analysis of one child’s early transitive SVO use between age 2;4-2;6, over 75% of objects were represented by the pronoun *it* (Theakston et al., 2012)
• although children can generalise the SVO construction to a novel verb when exposed to hundreds of examples with known verbs, generalisation improves if these models include pronominal as well as lexical subjects and objects (Childers & Tomasello, 2001)
• a computational model of early language exposed to child-directed-speech spontaneously generated pronoun islands of organisation based on frequency of exposure (Jones, Gobet, & Pine, 2000)

Thus, because pronouns are both frequent and systematically ordered in strings, they afford not only the earlier learning of these strings but also the creation of increasingly abstract slots preceding or following them. Because they are a closed set with extensive interconnections across the child’s developing system, they allow for earlier, more sophisticated production and comprehension than is shown with lexical nouns.

**The role of multiunit strings in children’s errors**

Children’s errors are an important test for the role of multiunit strings in acquisition, since adults will not produce these errors. High frequency strings can both protect from error (and conversely explain why children make more errors with strings of lower frequency), and lead to error when children utilise them in the wrong contexts (Ambridge, Kidd, Rowland & Theakston, 2015).

Evidence that high frequency strings can protect from errors comes from a number of studies. For inflectional morphology, Arnon & Clark (2011) found that children produced irregular plurals (e.g. *mice*) more accurately, avoiding overregularisation errors (e.g. *mouses*), when they were part of strings such as ‘*Three blind …*’ than after unrelated high frequency strings (*So many …*). In unpublished work, we found similar results for irregular past tense forms. In
corpus data from 19 children between 2;0-3;6, overregularisation errors (e.g. run-ed) occurred significantly less often as part of high frequency three-word strings (defined from collocations with the target verbs in CDS) than did correct utterances with those same verbs. In wh- and yes-no-questions, where the required wh+auxiliary or auxiliary+pronoun combination is frequent in the input, children produce fewer uninversion (e.g. *What he can do?) and double marking errors (e.g. *Can he can’t go to the park?), than for questions without a high frequency frame (Ambridge & Rowland, 2009; Rowland & Pine, 2000, see Dąbrowska et al., 2009 on complex questions).

Sometimes, children appear to learn multiple strings from the input which then compete for activation, leading to errors when they are used in inappropriate contexts. The likelihood of any given string being produced depends on a number of factors including the relative frequency of the competing strings in the input, and which string has most recently been primed for retrieval. For example, in both typical and atypical language development (Theakston & Lieven, 2008; Leonard & Deevy, 2011), apparently optional use of tense and agreement markers is influenced by the input. Children who hear subject-verb strings with no intervening auxiliary as part of a more complex utterance (e.g. Are you keefing?) produce lower levels of auxiliary verb provision in their subsequent declaratives (You keefing).

Children’s erroneous use of me instead of I as the subject of sentences (e.g. *Me do it) can be explained in a similar way as competition between a me-verb and I-verb frame. Kirjavainen, Theakston, and Lieven (2009) showed that 2-3-year-old children’s production of me-for-I errors was related to the relative rate at which their caregivers produced complex sentences in which the accusative pronoun me appeared pre-verbally (e.g. Let me do it). Furthermore, the verbs that children used erroneously with me were significantly more likely to occur in their caregivers’ speech with pre-verbal me than those used correctly (see Kirjavainen, Lieven & Theakston, in press for a similar account of infinitival-to omissions). In all of these examples, the assumption is that errors are gradually eradicated as children build up representations of the appropriate complex sentence structures, thus reducing the activation of erroneous competing forms for simple sentences.

However, children also produce many utterances which cannot be a direct ‘reading off’ from the input (e.g. *Me can’t do it, *Why can it can’t fit?), suggesting that children move beyond simple repetition of strings to create more abstract slot-and-frame patterns from a legitimate
use in the input which they then use productively, resulting in error. Accounting for the productivity which leads to errors is critical, and although high frequency strings can get us so far in explaining children’s correct uses and errors, there is a clear need for multifaceted models of acquisition to move us beyond a simple reliance on early learned schemas based directly on the input children hear (Ambridge, et al. 2015).

In some areas of acquisition, initial attempts have been made to consider how frames might be derived from the input in a less direct manner and then underpin children’s early linguistic representations and their development towards the adult end-state. Here, instances of children’s linguistic creativity require a focus on the interaction between the distributional properties of the input and communicative function. One example is the development of linguistic structures to express the negation of activities or events denoted by verbs. An analysis of dense data for one 2-3-year-old child revealed his early use of a largely ungrammatical no-Verb construction, before shifting to a not-Verb construction, then finally settling on the more typical adult use of negated auxiliaries (can’t, don’t-Verb) to express different functions (Cameron-Faulkner, Lieven, & Theakston, 2007). Although his early uses were certainly not typical of patterns in the input, their origins were apparent: no was the most frequent single word negator in the input whereas not was the most frequent form used in multiword utterances. The late-acquired negated auxiliaries showed a function-specific pattern of emergence (see also Drozd 1995) which related to the frequency and specificity of the mapping between auxiliaries and functions in the input. Similar arguments have been put forward to explain children’s use of double marked questions (e.g. Why do you don’t like cake?), such that, in the absence of a suitable negative question frame (Don’t you…?) children may resort to combining a well-known question frame (Do you…?) with an already learned declarative form (You don’t like X) (Ambridge & Rowland, 2009). Thus, children appear to make productive use of the resources that are available to them at any particular point in development, reflecting a creative process by the child to discover and/or create regularity in form and function.

**Interim summary**

English-learning children hear highly frequent multiunit strings in their input. Many of their early utterances are based on these strings and this has been shown to have important effects on the order and nature of developmental change in their linguistic systems. These strings can explain why there are differences for structures that, despite having the same formal
description, differ in whether children can produce them with or without error. They can also explain the ways in which abstraction and schematicity build up and, in turn, account for some instances of linguistic creativity. However, as children’s linguistic systems develop, these strings will become interconnected in an increasing variety of ways, allowing children to use them more or less appropriately or creatively in different situations. Developing precise predictions for the relative balance of factors in the production and comprehension of particular types of utterances over time will require the use of converging methods involving corpus analysis, experiments and modelling.

Other languages
There are (at least) two important differences between English and many other languages which could affect whether children can extract and learn from multiunit strings in the same ways that English children can. First, English word order is much more syntactically constrained than in many other languages. Although some languages are described as having ‘free word order’, it is almost certainly the case that this is pragmatically constrained, but this will still give more flexibility than in English. Thus, the word order regularities that allow children to learn multi-word strings may be less available in other languages. The second major difference is that, relative to many languages, English has very little morphology. Case-marking is almost totally absent except on pronouns, and person, tense and aspectual marking on verbs is also very limited. Other languages have extensive case systems (e.g. Estonian and Polish are usually credited with seven singular and seven plural cases) and verbal inflections (e.g. in addition to person, number and tense, Turkish marks evidentiality and Russian marks perfective/imperfective aspect). Thus, rich inflectional morphology may pose different challenges for children learning these types of languages.

Word order
Looking first at the input, Stoll, Abbot-Smith, and Lieven (2009) used a method similar to that of Cameron-Faulkner et al. (2003) to determine the evidence for low-scope frames in the CDS of German, English, and Russian. Despite differences due to the typology of the languages, they found a very high degree of repetition in the first 1-3 words of the mothers’ utterances, which could facilitate the early acquisition of low-scope frames (see also Arnon 2016 for Hebrew). In computational modelling work, researchers have demonstrated that words from a variety of languages can be classified into grammatical categories (e.g. Croatian, English, Estonian, Dutch, French, Hebrew, Hungarian, Japanese, Sesotho) using a
combination of distributional and phonological information (Monaghan, Christiansen, & Chater, 2007), or localised slot-and-frame patterns (Mintz, 2003, but see Stumper et al., 2011). McCauley and Christiansen (2014) developed a chunk-based learning model and applied it to corpora of children’s language and their input in 29 languages that differ widely in their degree of morphological complexity. The model learns from CDS using backward transitional probabilities and then is set the task of generating the children’s utterances by correctly sequencing words presented in random order (see Chang, Lieven & Tomasello, 2008). The model achieves a mean accuracy rate of 78% for English child corpora. When tested with 29 languages, the model was less accurate with morphologically complex languages than for those with simpler morphology. However, since the model is trained on words rather than morphemes, this suggests that there is considerable information in the transitional probabilities between words, even in highly inflected languages.

One study that suggests that children learning languages other than English extract strings from the input is a cross-linguistic comparison of tense omission errors (Freudenthal, Pine & Gobet, 2010). Using a computational model which builds up chunks from the ends of utterances in CDS, they showed that differences in the rates of tense omission in children learning different languages could be explained by typological differences in the organisation of finiteness marking, with some languages (English, German and Dutch) having a larger proportion of non-finite verb forms at the ends of utterances than others (French & Spanish). Further evidence comes from children’s use of complement-taking verbs in German. Brandt, Lieven and Tomasello (2010) demonstrated that children start out with separate schemas for verb-final and verb-second complements, each appearing with different groups of verbs and different types of main clauses. Only gradually, over the third year, are these separate constructions used more flexibly and in overlapping ways, providing evidence for children creating structural links between them.

We have suggested that for English, pronouns act as an anchor for the learning of lexical frames and as a basis for generalisation into more abstract constructions. The extent to which pronouns might play a similar role in other languages will depend on whether their relative frequency and distributional properties lend themselves to early acquisition. To illustrate, consider a ‘weird word order’ study with French-speaking children (Matthews, Lieven, Theakston, & Tomasello, 2007). Although English-speaking children frequently corrected weird word orders by producing pronominal objects, in contrast, French-speaking children...
rarely did so. The likely explanation is that French word order is more variable than in English and differs according to whether lexical or pronominal objects are produced. Object clitic pronouns appear pre-verbally (SoV - *Il la pousse*), whereas lexical noun objects occur after the verb (SVO - *Il pousse Marie*). Consequently, it may be more difficult for French-speaking children to derive the form-function mappings for the transitive and, initially at least, they may learn two more fragmented constructions, and learn these more slowly due to the lower individual frequency of the two word orders.

**Morphological patterns in other languages**

Thus far, we have mainly focussed on multi-word strings as the potential building blocks for the acquisition of more abstract syntactic constructions. For English, this works reasonably well, and we have also demonstrated the potential utility of such an approach in other languages. However, in many languages it is necessary to consider the initial building blocks at an even lower level of granularity – that of morphological marking.

Languages vary greatly not only in the extent of inflectional morphology present but also in its complexity. For instance, languages like English, Chinese and Japanese have relatively little inflectional morphology and what there is, is relatively transparent (they are more ‘analytic’ or ‘isolating’). At the other end of the scale are ‘polysynthetic’ languages like Chintang (a Tibet-Burman language spoken in Eastern Nepal) in which a transitive verb has more than 1849 synthetic forms per verb (Stoll & Bickel 2013). Between these two extremes lie ‘synthetic’ languages but these can vary greatly in their degree of transparency in morpheme-to-function mapping. Some languages are agglutinative with a fixed sequence of morphemes which map on a one-to-one basis with a function (e.g. Turkish). Others are fusional (e.g. Polish in which gender, person and number are all combined in one morpheme). Finally, some languages show a lot of homophony (e.g. German, where one form of the determiner, *die*, can be feminine, singular, nominative or accusative, as well as masculine, feminine or neuter, nominative or accusative, plural). These different types of morphological systems will set different challenges to learning.

In determining the nature of the challenge facing the learner, it is essential to look at the morphological complexity of the language that children hear: as Xanthos et al (2011) point out, this could differ considerably from the full array of forms and combinations possible in the grammar. Xanthos et al. developed a measure of the morphological richness of nouns and
verbs in CDS and child corpora for a variety of languages (Mean Size of Paradigm, MSP), and demonstrated that this can be relatively low even for languages with complex morphology (e.g. although Croatian has complex morphology, for instance 18 different verb forms (Stephany et al. 2007), the MSP in Croatian CDS was a relatively low 1.4, compared to Turkish CDS of 1.91). Their MSP measure of CDS across 9 languages was strongly positively related to the speed with which the children developed the noun and verb paradigms of the language that each was learning.

It is clear that children learning highly inflected languages do not start out with a fully-fledged system. Studies on Spanish and Polish show that when a comparison is made between the degree of flexibility in the use of morphemes in CDS and the child’s speech, with careful controls applied for vocabulary, available inflections, and sample size, children are significantly less productive than their caregivers until around age 3;0 (Aguado-Orea & Pine 2015, Krajewski, Lieven & Theakston, 2012). Furthermore, entropy measures suggest that initially morphemes are closely tied to particular constructions and that they become less closely associated as the child’s system develops (Krajewski, et al., 2012; Stoll & Bickel 2013), raising the possibility that children learning complex morphological systems may rely on strings or low-scope frames. Moreover, although overall error rates in the use of inflected forms might be low, this typically hides pockets of pronounced error in (lower frequency) parts of the system. Aguado-Orea & Pine (2015) showed that for Spanish present tense inflections, very high rates of error are found in some parts of the person-number paradigm. Frequency was very strongly associated with correct use, suggesting that inflected forms may initially be learned as ‘chunks’ from the input, (only two verbs, I want=qüiero and I can=puedo, accounted for nearly 50% of correct, 1st person usage, see also Rojas Nieto 2011).

Morphological richness is demonstrated not only through the number of distinct noun/verb forms possible in a language, but also by the number of affixes that can be present in a word. Here, however, it is important to consider the degree of systematicity in the ways in which these forms are combined. Kelly, Wigglesworth, Nordlinger and Blythe suggest that “Polysynthetic languages contain words with many morphemes and expressing complex grammatical concepts, but may be relatively regular in the templatic sequence in which they are used.” (2014: 61). Although they express doubt about the usefulness of chunk learning in these types of languages, if children are learning these templates as partially productive strings, with some slots becoming schematic before others, this could provide a way into the
structure. In a study of Turkish newspaper articles (presumably with more complex language that that addressed to children), Durrant (2013) identified ‘morpheme bundles’, sometimes fully specified, other times containing partially productive slots; combinations that appeared frequently, and which speakers could represent as highly accessible strings, suggesting that a language like Turkish might lend itself to templatic slot-and-frame-based learning. Indeed, Aksu-Koç and Slobin (1985: 206) suggested that Turkish children sometimes use schwas as placeholders i.e. having learned the kind of templatic sequence that it seems Kelly et al. are referring to, they were aware that a morpheme was required but did not know what it was.

We have conceptualised morphological slot-and-frame patterns as developing out of fixed elements such as particular stems or morphemes which combine with a variety of items (e.g. words denoting actions, morphemes denoting different person/number combinations or tenses). If one thinks of inflectional morphology as showing regularities both ‘vertically’ (declensions, conjugations) and ‘horizontally’ (cases, person marking), there is evidence that children can show partial productivity on both fronts. Thus, Dąbrowska and Tomasello (2008) documented Polish children’s ability to abstract a particular case and generalise it to other novel nouns (‘horizontal’ generalisation), while Krajewski, Theakston, Lieven and Tomasello (2011) showed that children’s ability to provide the correct inflection for a particular noun varies as a function of the previous case in which they heard it (‘vertical’ generalisation). However, this process may be complex in languages in which inflections encode more than one function (e.g. a combination of both case and person as in Polish). Furthermore, in many languages, there is no base form or stem, and thus the challenge facing the child is not simply one of removing and replacing morphemes, but of learning relations between distinct inflected forms.

All this suggests that the learning of phonologically-specific, inflected words, followed by the development of low-scope, slot-and-frame patterns might be important processes in the early learning of inflectional morphology. But the truth is that research from this perspective is only just getting off the ground, and there are many challenges to be addressed in understanding the extent to which these processes operate as we consider languages with a wide range of typological characteristics and complexities.

Remaining issues
Although there has been considerable work on the role of multiunit strings in children’s acquisition of English and to a lesser extent in other languages, in terms of forming the basis for longer utterances, and underpinning grammatical errors and correct use, the question of how these strings facilitate the process of abstraction has been less closely explored. And yet understanding the process of abstraction is critical to developing a full theory of language acquisition. In constructivist or usage-based approaches to adult language, it is widely acknowledged that linguistic representations exist at multiple levels, from the fully phonologically specified through to partially productive and fully abstract forms (Goldberg 2006, Verhagen 2005). Thus, in acquisition, children starting out with less abstract forms will simultaneously begin to develop more abstract representations while retaining at least some of the earlier learned forms.

As this process gets underway, we might expect to find some interesting patterns of results, depending on whether children are utilising more abstract or more specific representations. Indeed, some work with adults suggests that multiunit strings may differentially influence speakers’ production and comprehension of high vs. low frequency exemplars, with low frequency items more influenced by the global statistics of the input, whereas higher frequency items retain item-specific patterns of use (Wonnacott, Newport, & Tanenhaus, 2008, see Dittmar, Abbot-Smith, Lieven, & Tomasello, 2013 for similar work on children’s interpretation of passive sentences with familiar and novel verbs). Thus, learners apparently keep track of specific linguistic information whilst simultaneously deriving the broad statistics of the language. The extent to which either the broad or local statistics influence subsequent behaviour is dependent on the strength of association between specific items and the material with which they co-occur, and this will change over the course of development.

Another influence on the process of abstraction is construction meaning, and its interaction with the meanings of particular lexical items. For example, Ambridge and colleagues (Ambridge, Pine & Rowland, 2012) have demonstrated that the likelihood of adults and children judging argument structure errors as grammatical (e.g. *He disappeared the rabbit) depends on the extent to which the verb meaning is deemed compatible with the meaning of the construction. This means that to understand how multiunit strings are broken down and recombined in the language learner, we will need models of acquisition that are sensitive to the meanings of the strings, and the semantic scope of the resulting slots. There is already an assumption that the slots in constructions are semantically restricted, as reflected in the
choice of terminology (e.g. I PROCESS THING; Lieven et al., 2009), and there is some
evidence that slot-and-frame patterns in CDS may have particular functions (Cameron-
Faulkner & Hickey, 2011). However, to date there is relatively little work which explores this
issue directly (although see Matthews & Bannard, 2010).

Conclusions
In summary, multiunit strings provide one useful basis from which to learn language, but
while we have begun to understand their utility in the earliest stages of acquisition, there is a
long way to go before we can hope to fully understand how these mechanisms change over
time, how both multiunit strings and grammatical abstractions can co-exist into adult
language, and how these processes differ across languages as a function of their typological
make up. Critically, though, different cues are going to be used to a greater or lesser extent in
different languages, and with variable success depending on the kind of distributional
information that is available. Thus, only a learning mechanism that can pick up a variety of
cues and weigh them appropriately as a function of the language being learned will be
successful in explaining how and when multiunit strings will be learned from the input, what
the units consist of and how they might develop in terms of abstraction across different
languages.
References


Brandt, S., Lieven, E. & Tomasello, M. (2010). Development of word order in German


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