When and how do children develop knowledge of verb argument structure? Evidence from verb bias effects in a structural priming task

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ABSTRACT

In this study, we investigated when children develop adult-like verb–structure links, and examined two mechanisms, associative and error-based learning, that might explain how these verb–structure links are learned. Using structural priming, we tested children's and adults' ability to use verb–structure links in production in three ways; by manipulating: (1) verb overlap between prime and target, (2) target verb bias, and (3) prime verb bias. Children (aged 3–4 and 5–6 years old) and adults heard and produced double object dative (DOD) and prepositional object dative (PD) primes with DOD- and PD-biased verbs. Although all age groups showed significant evidence of structural priming, only adults showed increased priming when there was verb overlap between prime and target sentences (the lexical boost). The effect of target verb bias also grew with development. Critically, however, the effect of prime verb bias on the size of the priming effect (prime surprisal) was larger in children than in adults, suggesting that verb–structure links are present at the earliest age tested. Taken as a whole, the results suggest that children begin to acquire knowledge about verb-argument structure preferences early in acquisition, but that the ability to use adult-like verb bias in production gradually improves over development. We also argue that this pattern of results is best explained by a learning model that uses an error-based learning mechanism.

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Introduction

A critical part of language acquisition is learning verb argument structure. Verb argument structure refers to the fact that in language, verbs can only occur in, or prefer to occur in, particular syntactic structures; and these verb–structure links need to be learnt if children are to produce well-formed sentences (for example, verbs like "sold" can occur in dative structures (*the rock star sold the undercover agent some cocaine*), but not in intransitive structures (**the rock star sold*)). Although argument structure is one of the most important components of syntactic development, we know very little about when and how children learn to link verbs to particular syntactic structures. In this work, we investigated the effect of verb bias on structural priming to determine when children learn verb–structure links, and to examine the nature of the learning mechanism behind the development of these links.

Structural priming has traditionally been used as a way to investigate the nature of adult syntactic representations, but it can also be used to investigate the way in which these representations interact with the verb lexicon. A number of priming studies have shown that adult speakers

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tend to repeat the syntactic structure of the sentences that they have recently encountered. For example, in a well-known study by Bock (1986), adults were more likely to describe a target picture using a prepositional object dative (e.g., *The man is reading a story to the boy*) if they had just produced a prime sentence that was also a prepositional object dative (e.g., *The rock star sold some cocaine to an undercover agent*). This structural priming effect is not contingent on non-syntactic factors (such as the prosody of sentences or the thematic roles played by arguments), nor does it rely on the repetition of words across sentences. Thus, the phenomenon of structural priming is widely interpreted as evidence that adults have abstract representations of syntax that are stored independently of lexical items (e.g., Bock, 1989; Cleland & Pickering, 2006; Noppeney & Price, 2004).

The fact that structural priming does not rely on superficial comparisons between lexical items is now well-established. Nevertheless, it has been found that adults' knowledge of a verb's preferred argument structure (verb bias) influences their structure choice during priming tasks. Priming effects tend to be larger when prime and target sentences share a verb (the *lexical boost*; Pickering & Branigan, 1998), and the syntactic preference of both the target verb (target verb bias; Gries, 2005) and the prime verb (Bernolet & Hartsuiker, 2010; Jaeger & Snider, 2013) affect the size of the structural priming effect. For example, both Bernolet and Hartsuiker, and Jaeger and Snider have shown that priming is stronger when the prime verb's bias does not match the prime structure in which it is presented – a phenomenon called *prime surprisal*. Taken together, these findings demonstrate that, although adults have abstract representations of syntactic structure, they also store links between verbs and the structures in which these verbs occur, and that these links can influence structural priming.

Structural priming has also been used in the language acquisition literature to investigate the nature of children's early syntactic representations (e.g., Bencini & Valian, 2008; Messenger, Branigan, & McLean, 2011; Shimpi, Gámez, Huttenlocher, & Vasilyeva, 2007; Thothathiri & Snedeker, 2008a). Developmental studies have established that children have acquired at least some abstract representations that enable them to generalise across similarly-structured sentences by around the age of three years (though see Savage, Lieven, Theakston, & Tomasello, 2003, for contradictory evidence). However, an important question not addressed by these studies is how children's knowledge of syntactic structure interacts with their knowledge about the behaviour of particular verbs (verb argument structure). Thus, unlike the adult priming literature, the child priming literature has little to say about when children develop links between abstract syntactic representations and their developing verb lexicon, and even less about the mechanisms that might mediate this relationship.

One exception to this pattern is a recent study by Rowland, Chang, Ambridge, Pine, and Lieven (2012). Using a structural priming task, Rowland et al. found evidence of abstract priming in both children (aged 3–4 years and 5–6 years) and adults. However, they reported that, unlike

adults, the children were not influenced by overlap in the identity of the prime and target verb: Only the adults showed a substantially larger priming effect when there was verb overlap. So, although abstract priming effects were evident from early in development, the lexical boost did not emerge until relatively late. These results suggest that it may be possible to use structural priming to look at the way in which the relationship between syntactic representations and the verb lexicon develops.

In adult studies, the relationship between syntactic structure and the verb lexicon has been examined by looking at the effect of verb bias on structural priming. Although many dative verbs can occur in both double object (DOD) and prepositional object datives (PD) (e.g., *I gave him a cake/I gave a cake to him*), they tend to occur more often in one structure than another (e.g., *give* tends to occur more often in double object than prepositional object dative structures; see Campbell & Tomasello, 2001; Gries & Stefanowitsch, 2004). These preferred argument structure constraints (or verb biases) have a significant effect on adults' choice of syntactic structure in priming studies. For example, in a corpus analysis of English dative verbs, Gries (2005) found that target verbs that were strongly biased towards one structure resisted being primed into another structure. In another study by Coyle and Kaschak (2008), priming effects were found to be larger when the target verb was not strongly associated with one structure (i.e., when it was equi-biased). In other words, an adult's knowledge of a verb's preferred argument structure (e.g., whether this verb occurs more often in a DOD or a PD structure) influences how easy it is to prime that adult to produce that verb in that structure. These verb bias effects provide us with a way of tapping into a participant's knowledge of the links between verbs in the lexicon and syntactic structure.

Another source of verb bias effects is the influence of the prime verb's bias on priming. The identity of the prime verb plays an important role in the size of the priming effect, such that priming is stronger when the verb occurs in a prime structure that is unexpected. For example, Jaeger and Snider (2013) found stronger priming when DOD-biased prime verbs were presented in PD prime structures, and Bernolet and Hartsuiker (2010) reported stronger priming when primes with PD-biased verbs were presented in DOD-structures in Dutch. Fine and Jaeger (2013) reanalysed Thothathiri and Snedeker's (2008b) comprehension study and found that prime structures that were more surprising led to stronger expectations that that same structure would also be used in the target sentence. Jaeger and Snider referred to this as prime surprisal since participants were more likely to be primed when the co-occurrence of the prime verb and prime structure was unexpected. Not only do these results show that adult speakers store information about verbs' syntactic preferences, they also suggest that adults make predictions about prime sentences based on their knowledge of these preferences: When these predictions are not met (i.e., when a verb is presented in an unexpected structure), prime surprisal works to boost the priming effect (Chang, Dell, & Bock, 2006).

The first aim of the present study then, was to use a structural priming task to determine when children first