Harmonic biases in child learners: In support of language universals

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ABSTRACT

A fundamental question for cognitive science concerns the ways in which languages are shaped by the biases of language learners. Recent research using laboratory language learning paradigms, primarily with adults, has shown that structures or rules that are common in the languages of the world are learned or processed more easily than patterns that are rare or unattested. Here we target *child learners*, investigating a set of biases for word order learning in the noun phrase studied by Culbertson, Smolensky, and Legendre (2012) in college-age adults. We provide the first evidence that child learners exhibit a preference for typologically common *harmonic* word order patterns—those which preserve the order of the head with respect to its complements—validating the psychological reality of a principle formalized in many different linguistic theories. We also discuss important differences between child and adult learners in terms of both the strength and content of the biases at play during language learning. In particular, the bias favoring harmonic patterns is markedly stronger in children than adults, and children (unlike adults) acquire adjective ordering more readily than numeral ordering. The results point to the importance of investigating learning biases across development in order to understand how these biases may shape the history and structure of natural languages.

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1. Introduction

1.1. Learning biases in language acquisition

A number of researchers have hypothesized that languages are constrained or shaped by tendencies, preferences, or biases that are part of the process of learning. While a number of distinct mechanisms have been proposed to link learning and language structure, the core of this hypothesis remains the same. First, certain linguistic patterns systematically recur across languages. Second, this systematicity is in part produced by processes active during language acquisition. A range of evidence from various

theoretical perspectives has supported this view (Berent, Lennertz, Jun, Moreno, & Smolensky, 2008; Bever, 1970; Culbertson, Smolensky, & Legendre, 2012; Fedzechkina, Jaeger, & Newport, 2012; Finley & Badecker, 2008; Hudson Kam & Newport, 2005, 2009; Morgan, Meier, & Newport, 1987, 1989; Morgan & Newport, 1981; Newport, 1981; Newport & Aslin, 2004; Slobin, 1973; Wilson, 2006; among others). For example, Morgan et al. (1987) found that learners are biased to rely on particular cues to phrase structure which tend to be found frequently across languages, and they do not successfully acquire languages that are missing those cues. In a different domain, Berent et al. (2008) showed that learning appears to be guided by a universal hierarchy of sounds organized by sonority. Following on natural language acquisition research by Singleton and Newport (2004), Hudson Kam and Newport (2005, 2009) showed that learners do not replicate patterns of

unpredictable variation, suggesting a bias against such variation in grammatical systems. Some of these investigators have suggested that the biases uncovered in learners reflect properties of the language faculty; some have invoked cognitive biases involved in pattern learning or other functional constraints. In any case, their effect is generally argued to promote those language structures which are more readily learnable and reduce or eliminate those which are more difficult to learn or more unlikely to be acquired successfully. Despite these convergent findings, however, the connection between language acquisition and language structure remains heavily debated.

This is in part due to the complexity involved in discerning the underlying cause of so-called typological universals or generalizations, used by some linguists to argue for a set of core universal principles of grammar (e.g., Baker, 2001; Chomsky, 1988; among others). Typological universals describe frequency differences among logically possible patterns across human languages. When a particular pattern (or set of related patterns) is very common compared to alternatives, this represents a potential typological universal. Nevertheless, not every such frequency difference, however intriguing, necessitates an explanation in terms of bias in the linguistic or cognitive systems of individuals. In fact it has been argued that few if *any* reveal meaningful biases (Dunn, Greenhill, Levinson, & Gray, 2011; Evans & Levinson, 2009), as the frequency of language types reflects the conflation of many non-cognitive factors, including genetic relationships among languages and geographic or socio-cultural influences (Atkinson, 2011; Bybee, 2009; de Lacy, 2006; Dunn et al., 2011). Advances in theories of learning mechanisms also suggest that language acquisition may succeed with a reduced set of language-specific constraints, or possibly with only domain-general learning biases (Chater & Manning, 2006; Pearl & Sprouse, 2013; Saffran, Aslin, & Newport, 1996; Perfors, Tenenbaum, & Regier, 2011). These issues, along with the fact that many so-called universals are statistical rather than absolute, call into question the classic view of language variation constrained by universal principles of the linguistic system.

On the other hand, recent work using artificial language learning paradigms has provided behavioral evidence of cognitive biases in line with universals hypothesized based on typology (Berent et al., 2008; Culbertson et al., 2012; Fedzechkina et al., 2012; Finley & Badecker, 2008; Hudson Kam & Newport, 2005, 2009; Newport & Aslin, 2004; Wilson, 2006; among others). Importantly, however, most of these studies have tested *adult* learners, who bring a range of knowledge (both linguistic and otherwise) to laboratory learning tasks. Thus any biases found in these studies potentially differ—either in content or strength—from those at play during first language acquisition.

In this paper, we report the results of an experiment with young children investigating the learning of word order patterns suggested by Greenberg (1963) as typological universals. We compare previous results from *adult* artificial language learning of word order (Culbertson et al., 2012) to *children's* behavior in a parallel task. We provide the first evidence that, like adults, children show a preference for harmonic or consistent word ordering patterns, in line with one of Greenberg's universals. Our results also reveal that adult and child learners differ in several ways—in particular, the *strength* of their biases, and the apparent role played by a particular lexical category, namely adjectives. These findings strengthen and extend the evidence connecting linguistic typology to learning biases and shed light on how these biases may change through development. While our main focus is on whether a particular set of syntactic language universals arises in a controlled study of language acquisition, we return in our discussion to a consideration of what types of mechanisms could account for our findings. In particular, we outline how the biases we find might be formalized in a more traditional view of linguistic universals and, alternatively, in a view which takes them to result from general cognitive principles.

1.2. Learning biases and word order universals

As mentioned above, a number of studies have found evidence of linguistic and cognitive biases at work during laboratory learning of artificial languages. In some cases, the biases revealed appear to parallel typological asymmetries. For example, a number of studies have found biases relevant to phonological patterns, including vowel and consonant harmony (Finley & Badecker, 2008; Pycha, Nowak, Shin, & Shosted, 2003; Wilson, 2003), velar palatalization (Wilson, 2006), and dependency length (Newport & Aslin, 2004; Pacton & Perruchet, 2008). In the domain of morphology, the suffixing preference (Greenberg, 1957) has been tied to cognitive or perceptual biases (e.g., Hupp, Sloutsky, & Culicover, 2009; Slobin, 1973; St. Clair, Monaghan, & Ramscar, 2009), and the general preference for efficient morphological marking (Comrie, 1989; Greenberg, 1963; Jäger, 2007) has recently been revealed in laboratory learning of case marking by Fedzechkina et al. (2012). Hudson Kam and Newport (2005, 2009), mentioned above, investigated children's acquisition of unpredictable variation (in particular, alternation between two determiner forms which varied inconsistently). Such variation is not common in the world's languages, and results showed that in fact child learners presented with such a system tend to regularize it. Adult learners also regularized under some conditions, but less readily than children. Here we investigate this regularization bias in combination with learning biases connected to typological asymmetries in *word order*—some of the best known of which were uncovered by Joseph Greenberg in his seminal (1963) work.

One such pattern is the well-studied typological preference for consistent or *harmonic* ordering patterns (Chomsky, 1988; Dryer, 1992; Greenberg, 1963; Hawkins, 1983). This has been formalized as the "head directionality" parameter in the Principles and Parameters framework (Baker, 2001). In the nominal domain, for example, a harmonic ordering preference can be seen quite clearly. Across languages, particular nominal modifiers (e.g., adjectives, number words, genitive phrases, relative clauses) may appear before or after the noun they modify. Notably, however, languages of the world tend to order these modifying phrases either all before or all after the noun. Table 1 shows the four logically possible