

# Cognitive biases differ in improvisation and learning of noun phrase word order

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Previous research has shown that cognitive biases can influence linguistic behaviour both when language structure is *improvised* (Culbertson et al., 2020; Goldin-Meadow et al., 2008; Schouwstra & de Swart, 2014), and when it is *learned* (Culbertson et al., 2012; Fedzechkina et al., 2011; Hudson Kam & Newport, 2009). During improvisation, biases tend to target specific categories of items, for example, specific verb types (Schouwstra & de Swart, 2014) or dependents of a specific head (Culbertson et al., 2020). In learning, biases tend to target the wider language system, for example, harmony and regularity across different categories of items (Culbertson et al., 2012; Hudson Kam & Newport, 2009; Smith & Wonnacott, 2010). While improvisation and learning potentially represent two stages of language evolution—language creation, and subsequent transmission—the influence of category-specific biases can also persist from improvisation into learning (Motamedi et al., 2021). Here we explore a case in which competing category-specific and system-wide biases, active primarily during these different stages, lead to surprising typological patterns.

Languages tend to align heads and dependents within and across different phrases—this is called harmony (Greenberg, 1963; Hawkins, 1990). But there are surprising cases where harmony does not hold. For example, despite a harmonic tendency among multiple dependents within the noun phrase, adjectives (e.g. ‘*big house*’) show a typological tendency for postnominal order (N-Adj = 879 vs Adj-N = 373, Dryer, 2013a) whereas genitives (e.g. ‘*The child’s toy*’) tend to be prenominal (N-Gen = 468 vs Gen-N = 685, Dryer, 2013b). This leads to an unexpectedly high number of languages with a non-harmonic ordering of these elements. We report results from two experiments: a single trial forced-choice silent gesture task in which participants must choose an order to express a descriptive (adjective) or a possessive (genitive) meaning, and a silent gesture learning experiment in which participants are trained on a word order system including both types of modifiers. These experiments explore (i) whether category-specific preferences mirroring the typology are found in improvisation, and (ii) whether these continue to shape behaviour in a learning task, where a competing preference for harmony has been found (Culbertson et al., 2012).

Participants in experiment 1 showed a clear preference for gestures expressing the adjective meaning after the noun meaning, i.e., postnominal order ( $\beta = 0.51$ ,  $SE = 0.16$ ,  $z = 3.02$ ,  $p < 0.01$ ) and for gestures expressing the genitive meaning before the noun, i.e., prenominal order ( $\beta = 0.56$ ,  $SE = 0.16$ ,  $z = 3.43$ ,  $p < 0.001$ ). This aligns with the observed tendency in typology. Participants in experiment 2 learned the orders they were trained on ( $\beta = 1.34$ ,  $SE = 0.12$ ,  $z = 11.24$ ,  $p < 0.001$ ), but did not show the category-specific preferences found in experiment 1 ( $\beta = -0.14$ ,  $SE = 0.10$ ,  $z = -1.40$ ,  $p = 0.16$ ). Instead, participants tended to choose consistent gesture orders both within (measured as reduction in conditional entropy:  $\beta = -0.10$ ,  $SE = 0.02$ ,  $t = -8.74$ ,  $p < 0.001$ ), or across dependent types (measured as reduction in entropy:  $\beta = -0.22$ ,  $SE = 0.02$ ,  $t = -5.15$ ,  $p < 0.001$ ). These results suggest a complex picture of the combined contributions of category-specific biases—most active during improvisation, or where a linguistic system is not already in place—with system-wide biases—most active during learning and transmission. In the case of this exception to the cross-linguistic tendency for harmony, the typology may reflect both forces in competition, but the locus of this competition remains unclear.

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