



Original Articles

Social biases modulate the loss of redundant forms in the cultural evolution of language

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ABSTRACT

According to the competitive exclusion principle (Gause, 1934), competition for the same niche must eventually lead one competitor to extinction or the occupation of a new niche. This principle applies in both biology and the cultural evolution of language, where different words and structures compete for the same function or meaning (Aronoff, 2016). Across languages, for example, word order trades off with case marking as a means of indicating who did what to whom in a sentence. Previous experimental work has shed light on how such trade-offs come about as languages adapt to human biases through learning and production, with biases becoming amplified through iterated learning over generations. At the same time, a large body of work has documented the impact of social biases on language change. However, little work has investigated how social biases interact with learning and production biases. In particular, the social dimension of language may provide alternative niches for otherwise redundant forms, preventing or slowing their extinction. We tested this hypothesis in an iterated-learning experiment in which participants were exposed to a language with two dialects, both of which had fixed word order, but differed in whether they employed case markers. In one condition, we biased participants socially towards speakers of the dialect that employed case; in other conditions we provided no bias, or biased participants for or against the dialect without case. As expected under our hypothesis, the use of case markers declined over time in all conditions, but the social bias in favor of case-dialect speakers slowed the decline.

1. Introduction

In language there is often more than one way to say the same thing (Labov, 1972). Indeed, the arbitrariness of linguistic form-meaning mappings means that words can vary infinitely in form: The words *dinner*, *vecheria*, *swper*, *Abendessen*, *cena*, *wanfan*, for instance, represent a tiny subset of the many words that exist for the evening meal. But this variation is constrained. In the case of individual words, it is vanishingly rare to find perfect synonyms. For example, *dinner* and *supper* might refer to the same meal in different dialects, but almost never carry exactly the same meaning for the same speaker – suggesting that it is very hard for two different words to occupy the same semantic niche (Taylor, 2002, p. 471). This phenomenon can be understood in evolutionary terms with reference to the competitive exclusion principle, according to which two competing entities cannot coexist indefinitely in the same niche (Gause, 1934; Hardin, 1960). The result of competition is either that one of the forms drives the other to extinction

(as with English *yes* and *no* versus *yea* and *nay*) or that they come to occupy different niches, as with *regal*, *royal* and *kingly* (see Aronoff, 2016, for a discussion of the competitive exclusion principle in language).

As with the lexicon, the grammars of natural languages exhibit both variation between languages and competition between different structures within the same language. For example, languages differ in their preferred order of the subject and object in simple transitive sentences and in the amount of flexibility they allow in ordering these constituents (Dryer & Haspelmath, 2013). Latin and Russian are examples of languages with relatively flexible word order, while English and French are examples of languages with relatively fixed word order. Within a language, word order competes with other cues to grammatical role assignment (i.e., who is doing what to whom in a sentence). The most obvious competitor is morphological case marking (i.e., changes to the form of certain categories of words to indicate their grammatical role), though the same information can also be conveyed

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by such means as agreement, prosody, or pragmatics (van Everbroeck, 2003). Importantly, no language uses all of these means at the same time. In fact, cues to grammatical role assignment have long been observed to trade off across languages, with case marking and word order providing a good example (Blake, 2001, p. 15; Sapir, 1921, p. 66). In the Modern English sentence *Brutus killed Caesar*, word order unambiguously conveys who did the killing. In Latin, however, *Brutus Caesarem interfecit* and *Caesarem Brutus interfecit* both mean “Brutus killed Caesar”, and it is the case markers on *Caesar* and *Brutus* that indicate their grammatical roles. Further support for the existence of this trade-off comes from language change. In later Latin, for instance, case marking became less consistent and word order became more fixed, so that the modern Romance languages typically exhibit relatively fixed SVO word order and little case (Kabatek & Pusch, 2011). A similar process occurred in the history of English (Marchand, 1951).

The trade-off between cues to grammatical role assignment has been argued to stem from a trade-off between robust message transmission – the speaker’s goal to be understood – and production effort (Fedzechkina, Jaeger, & Newport, 2012, 2016; Kurumada & Jaeger, 2015). In languages with relatively fixed word order, grammatical role assignment can usually be inferred based on word order alone, rendering case marking redundant. In flexible-word-order languages, however, case provides important information about sentence meaning, as word order is less informative of grammatical role assignment. As case marking requires effort to produce, the implication is that languages evolve culturally such that case marking is maintained predominantly in those languages when its utility is high (i.e., those with flexible word order). Experimental support for this claim comes from work using the miniature artificial language learning paradigm. For example, Fedzechkina et al. (2016) showed that participants introduced cross-linguistic patterns of case and word order trade-offs into novel miniature languages if the input grammars were not consistent with such trade-offs. In particular, learners of a miniature language with flexible word order were more likely to maintain case marking in their own productions, while learners of a language with fixed word order tended to drop it.

Work on cumulative cultural evolution has linked the cognitive biases influencing individual learners to long-term patterns of language change. This work suggests that even small learning and production biases that are too weak to be detected in one generation of learners can have sizeable effects on the linguistic system over multiple generations (Kirby, Griffiths, & Smith, 2014). Supporting evidence for this claim comes in particular from studies using the iterated-learning paradigm, in which the linguistic output of one learner is used as the input for another learner, who is either a simulated agent (e.g., Kirby, 1999; Reali & Griffiths, 2009) or a human participant (e.g., Kirby, Tamariz, Cornish, & Smith, 2015; Smith & Wonnacott, 2010).

The linguistic system is also subject to a range of social biases alongside the learning and production biases discussed above (Labov, 2001). One’s choice of name for the evening meal, for example, may communicate more than which meal is being referred to: In certain parts of Great Britain and Ireland, the use of “tea” in this sense is associated with working-class speakers and thus implies different things about the speaker’s origins and social identity than the more middle-class option, “dinner”. Over the last century a large body of work has documented the important role of social factors in language change (Bailey, Cameron, & Lucas, 2013; Labov, 2001), including the role of local identity (e.g., Pope, Meyerhoff, & Ladd, 2007), ethnicity (Lanehart, 2015), gender (Holmes & Meyerhoff, 2003), and class (Rampton, 2010).

While the impact of social factors on language change has also been acknowledged by researchers taking an explicitly cultural-evolutionary approach (e.g., Croft, 2000), experimental work on the cultural evolution of language has primarily focused on the role of learning and production biases in language change (e.g., Fedzechkina et al., 2016; Kirby et al., 2015) and has paid relatively little attention to the role of

social biases. This is unfortunate, as social and non-social biases are likely to interact, jointly shaping the process of language change. For example, we know from previous experimental work (Fedzechkina et al., 2016) that, as a result of biases for efficient communication, learners of miniature languages are more likely to drop redundant case markers if word order is fixed than if it is flexible. However, such change tends to lead to variation between speakers (because some adopt the change sooner than others), and this variation provides raw material for social meaning. That is, if there is more than one way of saying the same thing, one of those ways may acquire social significance. This, in turn, might influence the trajectory of language change so that it differs from what we would predict based on learning and production biases alone. A natural-language example of this seems to be provided by English *whom*, the object form of *who*. In modern English, *whom* has become redundant and competes with *who* in the object position. In evolutionary terms, its niche has been invaded by a clearly fitter competitor: Outside some narrow contexts in formal written English, *who* is acceptable everywhere that *whom* is, and a speaker who does not acquire *whom* is at no serious disadvantage. The reverse is not true. So why has *whom* not disappeared yet? One possibility suggested by the competitive exclusion principle (Aronoff, 2016; Gause, 1934) is that it has found a new niche. A word like *whom* tends to be associated with more educated speakers (cf. Milroy & Milroy, 2012), and may thus serve as a means of signaling group identity, which may slow its disappearance from the linguistic system.

The purpose of this paper is to experimentally test the hypothesis that social biases can interact with learning and production biases during the cultural evolution of language, modulating the loss of a redundant form (such as case marking in a language with fixed word order) that would otherwise be expected to disappear. In evolutionary terms, the question is whether a form under threat from a fitter competitor for the same communicative niche (such as word order in later Latin, which – by becoming more fixed – had become a more informative cue) will survive longer if it has a new social niche – e.g., a desirable social meaning – to take refuge in. We tested this hypothesis using a miniature artificial language learning paradigm, which has been shown to be well-suited to studying both the influences of individual-level biases on language structure (Culbertson, Smolensky, & Legendre, 2012; Fedzechkina et al., 2012; Hupp, Sloutsky, & Culicover, 2009; see Fedzechkina, Newport, & Jaeger, 2016, for a review) and the role of social biases in language change (Samara, Smith, Brown, & Wonnacott, 2017; Sneller & Roberts, 2018; see Roberts, 2017, for a review).

In our study, participants learned a miniature “alien language” with fixed word order. The language had two dialects (indexed by the color of the alien speakers), one of which consistently employed redundant case marking, while the other had no case marking at all. We manipulated social biases acting on participants by varying the information provided about the different alien groups, encouraging participants to feel positively or negatively oriented towards one color of alien compared with the other (cf. Labov, 1963). This yielded four conditions in total: first, a condition biasing participants towards the aliens who used case markers; second, a condition biasing participants *against* the aliens who used case markers; third, a condition biasing participants towards the aliens who did *not* use case markers; and, fourth, a control condition with no bias towards either alien group. We simulated the generational transmission of language by using iterated learning, in which the output of learners is used to generate the input to other learners, creating “chains” of participants (Kirby et al., 2014). Given that case marking was in constant competition with word order, and taking into account evidence from previous work for a bias against maintaining excessive redundancy (Fedzechkina et al., 2016), we expected that the case markers would disappear from the language over time. We predicted, however, that this process would be modulated by social biases, and that the redundant case marking would persist over more generations when there was a social bias to feel positively oriented towards the group of aliens who used case in their dialect.

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