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Modal Action Patterns

▶ Fixed Action Patterns

Model Comparison

▶ Phylogenetic Analysis Within Comparative Psychology

Modeling

▶ Scaffolding in Learning

Modeling Language Transmission

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Definition

Languages adapt as they are transmitted from one generation to the next. Modeling language

transmission in computer simulations and laboratory experiments shows how this process gives rise to the structure found in language.

Introduction

Language is a defining characteristic of our species, so understanding its evolutionary origins is central to understanding human evolution. In their seminal paper, Pinker and Bloom (1990) argued that the evolution of language is best understood as the result of conventional Darwinian processes, just like other complex biological traits. However, languages themselves also adapt and evolve over repeated episodes of learning and use, providing two evolutionary mechanisms that shape language: the biological evolution of the human capacity for language *and* the cultural evolution of language itself. This entry outlines the consequences of cultural evolution for language and gives examples of how modeling language transmission can shed light on how language evolved.

Cultural Evolution and Language

Like many other human behaviors, language is socially learned and culturally transmitted: Humans learn the language of their speech community by observing the linguistic behaviors of other members of that community. More specifically, languages are transmitted via *iterated learning*: A language is learned by observing the linguistic behavior of another individual who learned their language in the same way. That humans are able to learn language presumably reflects some cognitive capacity or combination of capacities that is unique to humans (Hauser et al. 2002). However, repeated episodes of learning and use also allow for the cultural evolution of languages: Linguistic variants that are difficult to learn, impose substantial processing burdens, or do not meet the communicative needs of language users will tend to be replaced by those that are more learnable, easier to process, or more functional (Christiansen and Chater 2008). This is because the mistakes that language users make during learning, and the modifications they make while communicating, tend to be in favor of more learnable, more functional forms; poorly adapted variants will be replaced by superior ones. Cultural evolution thus gives rise to languages that are well adapted to being transmitted from one generation to the next.

Mathematical, computational, and experimental techniques developed over the past two decades have made it possible to systematically investigate how cultural processes shape language (see Kirby et al. 2014 for a review). This line of research has demonstrated that some of the fundamental properties of language can be explained as products of cultural evolution, thus highlighting the importance of understanding the role of culture in explaining language design and reframing the debate on the biological evolution of the language faculty (Thompson et al. 2016). This entry reviews some of this work here, focusing on experimental models of the emergence of compositional and categorical structure in language.

Cultural Transmission Gives Rise to Compositionality

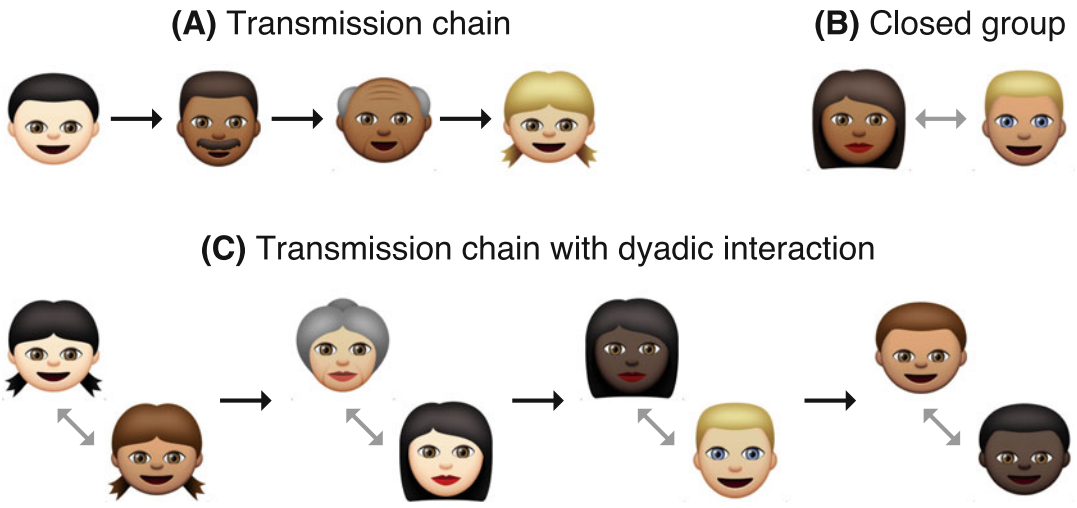
Language is compositional: The meaning of a complex utterance is a function of the meaning of its parts and the order in which those parts are combined. By combining a set of linguistic units in a particular order (e.g., *the dog bit the man*), a language user is able to form a complex meaning that is systematically related to an utterance that uses a different set of words (e.g., *the cat bit the man*) or that places the words in a different order (e.g., *the man bit the dog*). This compositional structure is central to the expressive power of language; with knowledge of the linguistic units and rules of combination, language users are able produce and understand any complex utterance—even those that have never been encountered before.

In the first work of its kind, Kirby et al. (2008) ran an experiment showing that the property of

compositionality can emerge as a result of language transmission, replicating the results of earlier computer models (e.g., Kirby 2002). Participants had to learn an "alien" language which consisted of words for colored moving shapes. After a training phase in which participants observed the objects together with their labels, participants were prompted to recall the labels for those objects. The responses of a given participant were then taught to a new participant, whose responses were in turn taught to another new participant, thus modeling what happens when languages are transmitted between individuals (Fig. 1a). Each transmission chain was initialized with an unstructured, non-compositional language in which every object was associated with a randomly generated label. After around ten generations of the iterated learning process, linguistic systems emerged that exhibited compositional structure. An example of this result is shown in Fig. 2a. The initial input language taught to the first participant in a chain contains no system-wide structure, but by the ninth generation, the language had evolved a compositional system in which the first syllable encodes color, the second syllable encodes shape, and the final syllable encodes movement.

Compositionality Depends on Transmission *and* Communication

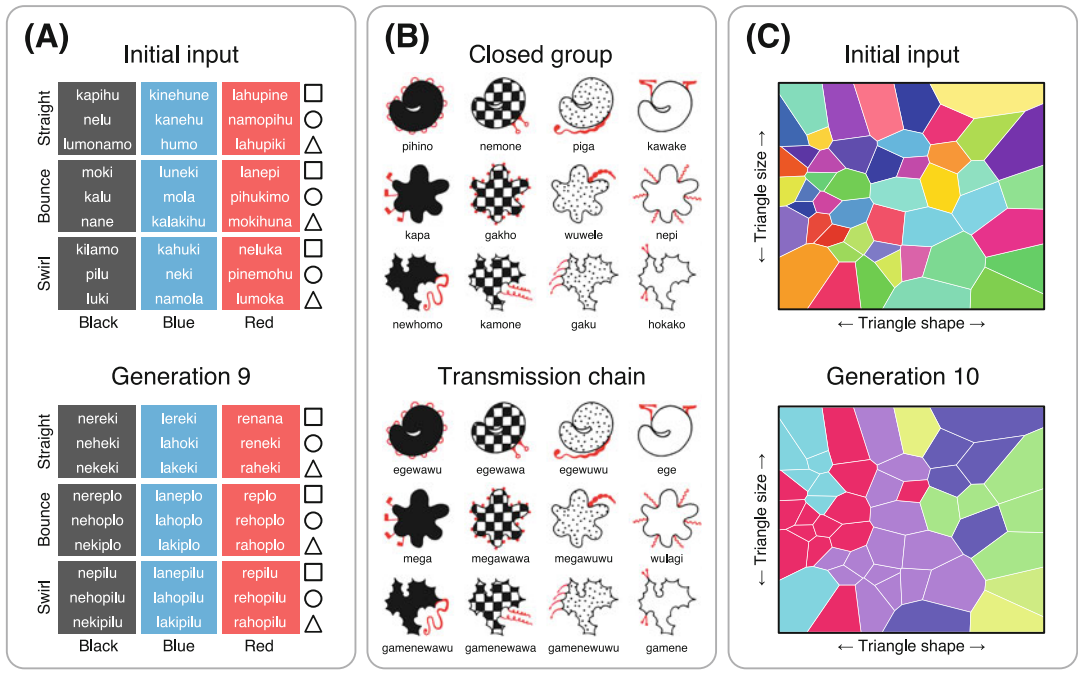
Languages are not merely transmitted from person to person via learning and recall; they are used for communication, and the communicative use of language provides the input to language learning. This means that language is shaped by two pressures. On the one hand, a language needs to be expressive—it should allow its users to convey important distinctions when communicating. On the other hand, it also needs to be learnable. These pressures for expressivity and learnability are not necessarily aligned: Languages that convey many distinctions are likely to be harder to learn than languages that encode few distinctions. Indeed, the easiest language to learn would be one in which every concept was conveyed by a single, maximally ambiguous utterance, but such a language would be inexpressive. Kirby et al. (2008), described above, used an artificial proxy for expressivity: If a participant provided the same label for two objects, only one of those labels was passed on to the next learner, thus concealing evidence that languages could be inexpressive. In another experiment in the same paper, Kirby et al. (2008) found that removing this artificial



Modeling Language Transmission, Fig. 1 Three models of cultural transmission. (**a**) shows a simple transmission chain in which a language is passed from one individual to another. (**b**) shows a pair of language users who interact back and forth using a language. (**c**) shows a transmission chain with dyadic interaction at each generation

pressure for expressive languages produced a radically different outcome: Rather than becoming compositional, the languages are rapidly simplified, losing words and distinctions at every episode of transmission.

In a follow-up series of computer models and experiments, Kirby et al. (2015) explored the trade-off between these competing pressures, modeling the expressivity pressure in a more naturalistic way by having participants use the language they had learned in a communication game. In one condition, two speakers had to communicate back and forth about a small set of objects (Fig. 1b). After interacting for some time, the pair of language users developed a system in which each object was described by a unique, idiosyncratic word—communicatively functional but lacking compositional structure (as shown in Fig. 2b). This condition was referred to as a *closed group*, since unlike Kirby et al. (2008) no new, naïve participants were introduced. In comparison, in the *transmission chain* condition, two participants had to communicate about the same objects, but the language was then passed on from one pair of participants to another: The language produced during communication by one pair became the input to learning for the next pair (Fig. 1c). This combination of cultural transmission to naïve learners (imposing a pressure for learnability) plus communication (favoring expressivity) led to languages with compositional structure (as shown in Fig. 2b). Communication alone, or learning alone, is not sufficient to drive the evolution of compositional structure; instead, compositionality is language's solution to pressures requiring it to be as simple and as learnable as possible without sacrificing expressive power.



Modeling Language Transmission, Fig. 2 Results from three iterated learning experiments. (**a**) shows results from experiment 2 from Kirby et al. (2008). The initial input language lacks systematic structure, but after nine generations of cultural transmission, the language evolves a compositional system. (**b**) shows results from Kirby et al. (2015). Under the closed-group method, a holistic language emerges; under the chain method, a compositional language emerges. (**c**) shows results from Carr et al. (2016). The initial input language contains no categories (each color is a different word), but after ten generations of cultural transmission, the continuous meaning space is carved up into semantic categories

Cultural Transmission Gives Rise to Semantic Categories

As described above, languages combine linguistic units, such as words, according to a compositional system. These units pick out *categories* rather than individual items or actions. For example, in English, the space of possible drinking vessels is carved up by a small number of words (e.g., *bottle*, *cup*, *flask*, *glass*, and *mug*). This categorical structure allows language users to refer to an infinite range of possible meanings using a manageable, finite number of labeled categories; this, in combination with compositional structure, is fundamental to the communicative power of human languages.

Carr et al. (2016) show how this categorical structure develops through iterated learning. Previous experiments (including Kirby et al. 2008, 2015) had participants learn and communicate about meanings drawn from a small, finite set. Carr et al. (2016) instead introduced a continuous and open-ended meaning space. Participants had to learn words for, and subsequently label, triangles that were randomly generated by selecting three vertices on a plane, such that there were effectively infinitely many objects participants could be faced with. In addition, participants were always tested on their ability to label entirely novel triangles, none of which they had seen during training. After ten generations of iterated learning using the transmission chain paradigm (Fig. 1a), category systems emerged in which this continuous space of possible triangles was carved up into around four or five categories that related primarily to their shape and size (as shown in Fig. 2c). When this experiment was adapted to include a communication game at each generation (Fig. 1c), as in Kirby et al. (2015), this combination of pressures for expressivity and learnability resulted in emergent languages that exhibited both categorical and compositional structure, thus demonstrating that both semantic categories and compositional structure can arise simultaneously out of cultural evolutionary processes.

Conclusion

Humans are the only known species with a communication system as complex as language, which must reflect unique features of our biological endowment (and thus our unique evolutionary history). Biology can provide an explanation for the basic building blocks required for language, such as the capacity for vocal learning found in other animals or the capacity and motivation to reason about the mental states and communicative intentions of others (Fitch 2010). Nevertheless, it is clear that cultural processes play a potentially important role in explaining the structure of human language. These processes can be studied in the lab, and a growing number of experiments that model what happens to languages when they are transmitted across generations have shown that at least some of the universal properties of language can be explained as a product of cultural evolution. This suggests that biological evolution should be seen as providing the basis on which cultural evolution can operate, with the detailed structural properties of language being a product of cultural evolution. Modeling language transmission therefore has an important role to play in helping us understand how language evolved.

Cross-References

- ▶ Communication and Social Cognition
- ▶ Darwin on the Origin of Language
- ▶ Evolution of Culture
- ▶ Language
- ▶ Language Acquisition
- ▶ Language Development
- ▶ Language Instinct, The
- ▶ Language Modularity
- ▶ Learning
- ▶ Laryngeal Descent
- ▶ Linguistic Evolution
- ▶ Meaning (Philosophy)
- ▶ Mother Tongue Hypothesis
- ▶ Musical Protolanguage
- ▶ Pinker's (1994) the Language Instinct
- ▶ Social Learning and Social Cognition

- ▶ Symbolic Culture
- ▶ Vocal Communication
- ▶ Universal Grammar

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Modern Human Origins

- ▶ Symbolic Culture

Modern Moral Relativism

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Synonyms

Moral constructivism; Moral conventionalism; Moral subjectivism

Definition

According to the main version of moral relativism, there are no objective moral facts or properties, and instead moral facts and properties depend for their existence on certain attitudes held by individuals or groups forming moral judgments.

Introduction

This entry first provides some background about how to define moral relativism. It then reviews two different strands of the contemporary discussion of moral relativism. The first concerns the question of whether most people endorse, either implicitly or explicitly, some form of moral relativism. The second concerns the question of whether moral relativism is actually true. Here the focus will be on the influential work of Shaun Nichols, who has proposed an account of the psychology of moral judgments which he takes to provide support for moral relativism. Some problems will briefly be raised with Nichols's main argument (The material which follows is reprinted with permission from Miller 2011).

Defining Moral Relativism

Following the custom in the philosophical literature, it is common to distinguish between three