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Iterated Learning

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Iterated learning describes a process in which individuals acquire a system of knowledge or behavior by observing other individuals who acquired it in the same way. Many systems of human knowledge and behavior are transmitted via iterated learning, including language, music, and social stereotypes. Iterated learning has been studied using computational and mathematical models and in experiments with humans and other animals. This work shows that the iterated learning process converges to systems that reflect the biases of learners, such that systems that are easy to learn tend to proliferate. This pressure for learnability also interacts with other pressures during transmission (e.g., ease of reproduction or communicative utility).

History

While the definition of iterated learning is very broad (learning from someone who learned in the same way), iterated learning is often characterized by a focus on *transmission chains*, in which one individual learns from behavior produced by a single preceding participant (see Figure 1). This experimental method has a long history, dating back at least to Frederic C. Bartlett (1932), who used chains of transmission to investigate memory. Bartlett asked participants to study a stimulus (e.g., an image or a story) and attempt to reproduce it from memory, with the reproduction being presented to the next participant in a chain of transmission. Bartlett's interest was in how materials transmitted in this way changed as a consequence of errors (omissions and intrusions) in the process of memorization and recall.

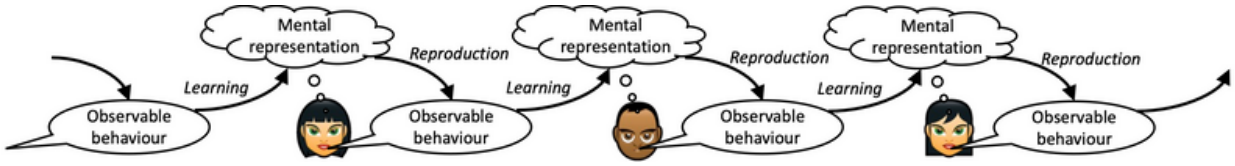


Figure 1

Iterated learning in a transmission chain. An individual encounters observable behavior (e.g., in the case of language, linguistic data) and forms a mental representation through a process of memorization or learning (e.g., for language, they form a grammar). Through a process of reproduction, they then generate further observable behavior that forms the input to the next individual in the transmission chain.

The same transmission chain methods were rediscovered in evolutionary linguistics in the late 1990s and early 2000s, most notably in the work of Simon Kirby (e.g., Kirby, 2002). Kirby was interested in how linguistic systems evolved as a result of their repeated learning and reproduction, and he used computational models to study this process. Subsequent modeling work by Thomas L. Griffiths and colleagues (e.g., Griffiths & Kalish, 2007; Kirby et al., 2007) recast iterated learning as a process of iterated Bayesian inference, in which learners at one generation apply Bayesian inference to infer an underlying grammar from data generated by the individual in the preceding generation.

Iterated learning has also been investigated experimentally. A strand of modern work looking at the transformative effects of memory and recall on transmitted stories (Mesoudi et al., 2006) traces its intellectual

lineage back to Bartlett's original work on memory; experiments using iterated learning to explore the evolution of miniature languages in humans (Kirby et al., 2008) and the evolution of song in songbirds (Fehér et al., 2009) have also proved influential, providing paradigms to test hypotheses about the role of transmission in shaping evolving communication systems.

Core concepts

Biases in learning and reproduction shape the outcomes of iterated learning

Behaviors that are transmitted through iterated learning persist through a cycle of learning and reproduction and therefore evolve in response to biases in those processes. Modeling work framing iterated learning in Bayesian terms (e.g., Griffiths & Kalish, 2007) shows that the prior biases of learners are crucial in understanding the outcomes of iterated learning: iterated learning converges to systems that reflect those priors, and in some restricted cases, the outcomes of iterated learning will exactly mirror the priors of learners [see Bayesianism and Bayesian Models of Cognition]. Although biases in reproduction have been less extensively studied, the interplay between biases in learning and reproduction are particularly important in some domains. For example, natural languages seem to reflect not just biases in learning but also communicative constraints operating during their reproduction, which exert a pressure to produce expressive signals, with natural languages adopting structures that are learnable but also communicatively useful (Kirby et al., 2015).

Experimental iterated learning across domains

Iterated learning has been combined with artificial language learning (in which participants learn and reproduce miniature linguistic systems) to study processes of linguistic evolution previously studied in simulation but in human learners rather than artificial agents (Kirby et al., 2008). These experimental methods have been extended to study the emergence of structure in gestural communication (Motamedi et al., 2019) and in the transmission chains of children (Raviv & Arnon, 2018) as well as the evolution of arbitrary symbols (Caldwell & Smith, 2012) and iconic forms (Vinson et al., 2021), combinatorial phonology (Verhoef et al., 2014), functional language (Fay et al., 2018), and even orthographic transparency in spelling (Carr & Rastle, 2024) [see Gesture]. Beyond language, the same methods have been applied to the evolution of music (Anglada-Tort et al., 2023) and social stereotypes (Martin et al., 2014). A small number of studies have also looked at the effects of iterated learning in nonhuman animals, for instance as a tool to show how song learning biases shape the evolution of song cultures in birds (Fehér et al., 2009).

Questions, controversies, and new developments

Most iterated learning models and experiments assume that learners are homogeneous and bring the same biases and preferences to the processes of learning and reproduction. The consequences of iterated learning in communities where individuals have heterogeneous biases, as is plausibly the case in the real world, is an open question (see, e.g., Johnson et al., 2020; Navarro et al., 2018).

Iterated learning has also been studied in machines as a method for optimizing model-internal structures (Vani et al., 2021) but also to answer the pressing question of the likely consequences of training the next generation of language models on data generated by current language models (Shumailov et al., 2024) [see Large Language Models].

Broader connections

Iterated learning is a method for studying, and provides a particular perspective on, social learning, culture, and cultural evolution [see Cultural Evolution; Cultural Attractors; Social Learning; Animal Culture]. Since iterated learning is concerned with the cumulative consequences of biases of learning and reproduction and because social learning is involved in so many domains of human knowledge, it has numerous connections with other cognitive science disciplines that study learning and processing, most obviously in language but also in the acquisition of concepts and categories and in social cognition [see Language Acquisition; Psycholinguistics; Statistical Learning; Concepts; Social Epistemology]. Foundational work modeled iterated learning using Bayesian models of learning and communication, connecting iterated learning to rational models of cognition more generally.

Further reading

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