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Culture–gene coevolutionary psychology: cultural learning, language, and ethnic psychology

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While most psychologists recognize the importance of genes and culture in shaping human cognition, few theoretical perspectives in the field offer a framework for understanding their relationship and for deriving predictions about the structure of the variation we see across space and time. Here we argue that culture–gene coevolutionary (CGC) frameworks have such potential, and can unite disparate fields across the social sciences and sub-fields within psychology. We illustrate the power of this functionalist evolutionary approach by reviewing recent research on three interlinked topics; cultural learning rules, language cognition, and reasoning about ethnic social groups. We show how CGC approaches complement, and contrast with, traditional approaches in psychology on these topics. Furthermore, this theoretical framework has already been fruitful in drawing new predictions and pointing to new directions of inquiry.

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It is uncontroversial that both genes and culture shape human psychology. However, recent evolutionary approaches go one step further in formalizing the selection processes whereby BOTH genetic and cultural traits can change through time and produce functional psychological mechanisms for facing adaptive challenges. Moreover, these are not independent: Culture–gene coevolutionary (CGC) approaches explore the feedback between these two inheritance systems [1–3]. This approach allows researchers to formally develop theories about (1) the origins and functions of cognitive mechanisms that shape cultural learning and thus allow cultural evolution, and (2) the cultural evolutionary processes that generate cross-cultural patterns of psychological variation. This conceptualization clarifies that cultural capacities are integral components of human biology and that cultural psychological differences are not static monoliths, but rather the products of interacting individual minds that change across history and space.

Studies of the human genome show culture's ability to shape genetic evolution [4,5]. For example, in the last 10 millennia, cultural elements related to alcohol-making, herding, high-latitude farming have driven the spread of genes for alcohol tolerance, milk-drinking and pigmentation in particular populations [5]. Here, cultural evolution explains extant patterns of genetic variation and associated behaviors. Pushing deeper into our species' evolutionary history, there is increasing evidence that culture has been driving human evolution for at least hundreds of thousands of years [6]. Technologies such as cooking, food processing techniques, cutting tools, water containers, and projectile weapons, have shaped our stomachs, colons, teeth, sweat glands, and much more [6–8].

Effectively linking psychology to culture and institutions, this framework has spawned productive research programs on social norms [9,10,11•,12], cooperation [13,14,15•], religion [16–19], theory of mind [20•,21], teaching [22] and marriage [23]. Here, we focus on three areas of research that illustrate the full co-evolutionary process between genes and culture in domains that are likely to be of interest to psychologists: (1) cultural learning mechanisms [24–27], (2) language acquisition [28,29•], and (3) reasoning about ethnic groups [30•,31]. These three domains also reflect an evolutionary sequence of events; cultural learning mechanisms allow the evolution of complex and variable language structure, and language in turn co-evolves with cultural systems of social norms to become a pervasive and privileged marker of ethnic group membership. This pathway illustrates the potential of a CGC framework to unite disparate fields of social science and psychology.

Cultural learning mechanisms

Culture–gene coevolutionary approaches dissolve the false dichotomy between 'learning' and 'biological' accounts by turning the power of evolutionary theorizing on the question of how humans learn. Of course, psychologists have long studied these topics [32–34], but CGC theory provides (1) a rigorous way to build theories and generate predictions about the 'when, what and from whom' of adaptive learning [35–39], and (2) a cumulative framework seated within evolutionary theory that organizes insights from across the social sciences as well as subfields of social and developmental psychology [40,41].

To illustrate this, we review recent empirical work showing the extent to which people use some of the best theorized cultural learning rules: (1) skill, success and prestige biases and (2) conformist transmission [42].

Adaptive learners can improve the quality of the information they acquire from others by being selective about whom they learn from. Everyone from infants to adults uses such model-based biases, for example, attending to cues of greater skill and success in directing their cultural learning. Recent work in developmental psychology shows how children, as young as 12 months, use cues of competence and reliability in learning tool-use, word-meaning and novel practices [6,41,43–45]. Learners can also use prestige cues—such as the visual attention of others — to zoom in on whom to learn from [46,47]. In a recent laboratory study [48], for example, researchers show that 3–4 year old children use the visual attention of others to guide their imitation in selecting a novel food, drink and means of using an artifact. Similarly, Atkisson *et al.* [49] find that adults use prestige cues as much as biases for copying successful individuals, despite the latter's higher payoffs in the task.

Adaptive learners can also take advantage of the wisdom of crowds to extract information from groups. Frequency-dependent biases are social learning rules that exploit the relative proportion of traits in the population, when considering whether to adopt a belief, motivation or behavior. Models of conformist transmission lead to specific predictions about when individuals should disproportionately weigh the majority trait rather than rely on other learning heuristics. Lab experiments confirm many theoretical nuanced predictions [50,51], including most recently that a conformist strategy is more common with larger model sets [52] and larger numbers of possible traits to copy [53•]. See Ref. [54] for a review of recent developmental research showing other mechanisms that make humans cultural learners.

Languages

The cultural learning machinery described above allowed the unique human capacity for complex language — perhaps the best-studied cognitive adaptation arising from culture–gene co-evolution. Recent evidence from developmental psychology shows that children use many of the cultural learning biases described above for learning word meanings [55]. These cultural transmission events in interaction with human-specific psychological mechanisms facilitated the development of complex communication systems, and their cross-cultural diversification into languages [28].

The long running debate over the nature of cognitive mechanisms for acquiring syntactical structures continues [56–58]. There is increasing evidence that cultural evolutionary processes can produce complex linguistic structures that facilitate coordination and make languages more learnable [28,59,125] even in the absence of genetic evolution. So languages can evolve culturally to fit brains. However, the resulting language structures plausibly selected for better cognitive capacities, for example for recursive computation [60–62]. Alternatively cognitive capacities for linguistic recursion may have co-evolved with, or been exapted from, cultural and genetic capacities for complex tool-making [6,63,64].

Perhaps less appreciated is the fact that both phoneme and morpheme repertoires can be analyzed as culturally-evolved tools for communication with consequences for natural selection. Human laryngeal morphology, neural circuits for motor control and greater memory capacities likely reflect natural selection acting on human bodies and brains in response to the need to produce more distinct sounds and words [65]. There is also evidence that cultural evolution has patterned the current variation in languages' sound and word repertoires [6,66,67]. For example, larger populations where phonemic distinctions facilitate intelligibility, and those with less history of population bottlenecks that cull variation, have larger phonemic repertoires [68–70], although this is still debated [71–73]. Similarly, lexicon size — for example, number of color words — is associated with cultural complexity [74]. At the individual-level color lexicon is correlated with gray matter in the visual cortex [75] and has cognitive effects on color discrimination tasks [76]. Similar findings in the domain of numerical and spatial cognition suggest the importance of culturally-evolved language structures as aids to human thought [77,78]. A cultural evolutionary approach provides a mechanism whereby lexically and phonemically rich languages co-evolve with institutions in large-scale societies, thus patterning several aspects of plastic psychological variation. Correlations between particular genetic variants and the use of tonality in languages suggest that even some language-driven genetic evolution may be underway in response to culturally-evolved variation [79]. However, we should stress that the extant linguistic variation is unlikely to have fedback much on natural selection at the population-level, as evidenced by the fact that adopted children will easily learn any language they are raised with.

Thinking about ethnic groups

Humans universally mark their membership in culturally-structured groups, often using the linguistic variation described above to do so. We refer to symbolically marked boundaries associated with cultural traits as ethnic. Ethnic boundaries then is the product of individuals' social interactions given their suite of cognitive mechanisms — for example, for cultural learning, intergroup behavior, categorization, among others. However, cognitive heuristics likely evolved in response to these culturally-constructed social boundaries. For example, if individuals from different groups have dissimilar cultural expectations and