Part I

General Issues in Culture and Biology Interplay

1

Introduction to Culture and Biology Interplay

José M. Causadias, Eva H. Telzer, and Nancy A. Gonzales

The relationship between culture and biology, and the issues that arise with it, have been at the forefront of psychology since its origin. Pioneers in the field, with different degrees of success, sought to explain human behavior, cognition, and development using both biological and cultural arguments. For instance, while Darwin (1872) emphasized the evolutionary significance of emotions by connecting animal and human behavior, Freud (1930) examined the impact of culture in the etiology of neurosis, as well as the role of hard-wired drives in conditioning human behavior. But perhaps the strongest evidence of how this relationship has shaped the history of psychology lies in the emergence and persistence of the nature-versus-nurture debate, introduced by Galton (1869, 1874), which in a way exemplifies the tension between innate-biological influences and social-cultural processes (Rutter, 2006). Psychology has often oscillated between these two poles, emphasizing the role of biological influences in some periods and environmental and cultural forces in others (see Schwartz, Lilienfeld, Meca, & Sauvigné, 2016).

Several scholars have argued that we are witnessing a period in psychology of growing emphasis on the role of biological processes (see Eisenberg, 2014; Kitayama & Uskul, 2011). Technical and methodological innovations in biological research in the last decades, as well as the improved understanding of the brain and the genome they have afforded, have opened new opportunities to elucidate their role in shaping psychological processes (Miller, 2010). Importantly, these advances improve our ability not only to explain behavior, but also to predict it. For example, a recent study suggests that using a joint clinical and genomic risk assessment can substantively advance our ability to predict suicidality (Niculescu et al.,

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2015). Furthermore, a new generation of scientists have begun to integrate biologically informed methods into their psychological research on culture, offering new insights on how experiences of racial discrimination can affect diurnal cortisol rhythm among African Americans (Fuller-Rowell, Doan, & Eccles, 2012) and Mexican Americans (Zeiders, Doane, & Roosa, 2012) and examining how dopamine polymorphisms are related to cultural differences in independent versus interdependent social orientation (Kitayama et al., 2014) and how cultural processes are associated with distinct patterns of brain functioning (Chiao & Ambady, 2007; Telzer, Masten, Berkman, Lieberman, & Fuligni, 2010).

Obstacles to the Integration of Culture and Biology

Despite these recent advances, there are several obstacles to achieving a more meaningful integration of cultural and biological methods that can substantially improve our understanding of human nature (Causadias, Telzer, & Lee, 2017). First, scholars who conduct research on social and cultural processes are well aware of the challenges associated with conveying the complexity of subjective experiences, so they might be skeptical about simplistic approaches that can potentially limit rich behavioral and symbolic human expressions to an image reflecting brain activity (see Syed & Kathawalla, chapter 2 in this volume). There is a growing concern with the idea that brain- or gene-based processes will ultimately explain everything and eventually render psychology useless (Lilienfeld, 2007; Satel & Lilienfeld, 2013; Schwartz et al., 2016). These new arguments echo the pushback experienced by previous attempts to infuse biology into social sciences like sociobiology, that were condemned for the use of inappropriate reductionism (see Wilson, 2000).

Second, some scholars are predisposed against the use of these biological methods in cultural research, because biologically infused pseudoscience has in the past been employed to justify social and racial hierarchies (Hartigan, 2015), to rationalize group differences regarding intelligence (Sternberg, Grigorenko, & Kidd, 2005), and even to vindicate ethnic cleansing and genocide in the name of social Darwinism and the "survival of the fittest" (see Allen et al., 1975). Likewise, poorly designed and conducted studies of genes and culture that rely on incomplete data, deficient statistics, or logical fallacies are especially problematic and have been criticized from anthropological and biological perspectives (see Creanza & Feldman, 2016; Feldman, 2014; Guedes et al., 2013; Rosenberg & Kang, 2015).

Examples include studies that conclude that lower genetic diversity in the Americas and greater genetic diversity in Africa both lead to poverty, while the intermediate level of genetic diversity in Europe is favorable to economic prosperity (Ashraf & Galor, 2013), and studies that argue for a genetic basis to racial differences in wealth, intelligence, and social institutions (Wade, 2014). However, racial ideologies preceded scientific attempts to justify them, or, as Coates (2015) argued, “race is the child of racism, not the father. And the process of naming ‘the people’ has never been a matter of genealogy and physiognomy so much as one of hierarchy” (p. 7). Thus, severe scrutiny is necessary to avoid invalid conclusions that run the risk of providing pseudoscientific ammunition for those attempting to justify ethnic cleansing, the systematic mistreatment of immigrants and minorities, or the stopping of humanitarian aid (Creanza & Feldman, 2016).

Third, the scientific exploitation of disenfranchised groups by unscrupulous biomedical researchers also has negative repercussions for the field. Past examples include the experiments conducted with African-American men in Alabama and with prisoners in Guatemala in which individuals were purposely infected with syphilis, as well as the diabetes project with the Havasupai Tribe in which participants’ DNA was used for other studies without their consent. These cases have contributed to resistance among some communities to participating in biologically informed studies, and have diminished trust in scientists (see Freimuth et al., 2001).

Fourth, there are not many conceptual models available to researchers in psychology that can account for the multiple ways in which these two processes relate and shape normal and abnormal development, with some noteworthy exceptions (see Fischer & Boer, 2016; Li, 2003; Mesoudi, Whiten, & Laland, 2006). Arguably, there are several theories on culture and biology interplay formulated by evolutionary biologists and population geneticists, including sociobiology (Wilson, 1975), gene–culture coevolutionary theory (Cavalli-Sforza & Feldman, 1981) and dual-inheritance theory (Boyd & Richerson, 1985). However, these models have had limited impact on current research on culture and biology in psychology, partly because of interdisciplinary barriers. With some possible exceptions, like molecular anthropology (Goodman, Tashian, & Tashian, 1976), behavioral research in the fields of culture and biology has evolved into different traditions and veered towards hyper-specialization, resulting in separate conceptual and methodological niches that favor intellectual insularity. This is reflected in graduate and postgraduate training. Scientists are socialized through research training into very distinct subgroups, often concentrating on a limited set of assumptions, values, algorithms, and priorities that condition research decisions (Cicchetti & Richters, 1997). Thus, training programs that focus on culture frequently emphasize models and methods closer to the humanities and social sciences than to neurosciences, while psychological programs specialized in genetics traditionally gravitate more towards life and biological sciences, and less towards cultural issues (Causadias et al., 2016).

In sum, justified skepticism about reductionist approaches, predisposition against biological explanations of social issues, distrust among ethnic minority communities of biomedical research, the disconnection between research fields and diverging training traditions all contribute to a paucity of research that meaningfully integrates cultural and biological levels of analysis to help us advance our understanding of behavior, cognition, and development. The most detrimental consequence of the current lack of integration of culture and biology is a biased, incomplete, and, most importantly, bipolar perspective that overemphasizes either the biological or cultural dimensions, thus perpetuating the nature versus nurture dichotomy and severely limiting our understanding of human nature.

The Field of Culture and Biology Interplay

In order to overcome these obstacles and the resulting schism between these two dimensions, we introduce the field of culture and biology interplay. In this chapter, we define its basic principles, describe the importance of conducting research using this paradigm, provide an overview of its history, and examine different types, levels, and domains of research in culture and biology interplay. We close by presenting some conclusions and future directions.

Culture and biology interplay is the field of study that centers on how these two processes have evolved together, how culture, biology, and environment influence each other, and how they shape behavior, cognition, and development among humans and animals across multiple levels, types, timeframes, and domains of analysis (Causadias et al., 2016). The field of culture and biology interplay was introduced as a promising avenue to integrate culture into developmental psychopathology, another hybrid field that emphasizes complex and dynamic relationships among various areas of functioning (Causadias, 2013). Culture and biology interplay functions as a meta-paradigm, gathering under the same roof separate domains of research that have traditionally functioned separately (e.g., animal culture, cultural neuroscience), and bringing together other lines of research that have not been recognized as such (e.g., cultural genomics, cultural neurobiology). Rather than reducing cultural processes to biological indicators, research on culture and biology interplay can advance our understanding by illuminating how we have evolved to develop complex cultural systems, such as religions (see Northover & Cohen, chapter 3 in this volume).

We define culture as a shared system of behaviors (and cognitions) that are transmitted from one generation to the next. This system serves a function within a group that has a shared history (geographical, social), which informs traditions, beliefs, conduct, and institutions (Cohen, 2009). Culture has a wide-ranging impact in a myriad of domains of psychological functioning, and operates at an individual and social level (Kitayama & Uskul, 2011). Evidence suggests that humans and animals possess behavioral culture, while symbolic culture is believed to be exclusive to humans (Whiten, Hinde, Laland, and Stringer, 2011). We also approach biology from a systems perspective, as living creatures are themselves organized and composed of different structures, ranging from individual cells to superorganisms (Hölldobler & Wilson, 2009). In the case of humans and animals, we function as the result of an interconnected network of biological systems, such as the nervous, endocrine, and immune systems. Importantly, culture and biology are the two major systems of inheritance. While cultural inheritance is composed of the behavioral and symbolic systems, biological inheritance is constituted by the genetic and epigenetic systems (see Jablonka & Lamb, 2014). The term "interplay" is very suitable for conceptualizing the relationship between culture and biology for several reasons. According to the arguments formulated by Rutter (2006, 2007, 2013), "interplay" (or "interdependence") is less restrictive than terms like "interaction" because it conveys a variety of ways in which two processes affect each other, and is not limited to statistical relations.

Principles for the Study of Culture and Biology

Culture and biology interplay is informed by an interdisciplinary, multiple-levels-of-analysis perspective (Cicchetti & Dawson, 2002) that incorporates theory and research from the fields of psychology, anthropology, evolutionary biology, population genetics, neuroscience, and neurobiology of stress. Ultimately, behavior and cognition are approached as the result of the interdependence, codetermination, and simultaneous influence of multiple processes (Sroufe, 2007). Moreover, cultural and biological processes are recognized as equally important and mutually influential. Thus, no component, subsystem, or level of analysis has causal privileges over the other (Cicchetti & Cannon, 1999).

One of the most detailed examinations of principles for the study of culture and biology was formulated by Overton (2007, 2010). One of the quintessential examples of fundamental split dichotomies, typical of Cartesian dualistic epistemologies and false dichotomies, is culture versus biology (Overton, 2010). However, from a relational epistemology this separation between culture and biology is only nominal, as both dimensions are in constant interpenetration, coaction, and reciprocal bidirectionality or multidirectionality (Overton, 2010). The relational epistemological perspective has taken hold of fields like physics (Smolin, 1997), anthropology (Ingold, 2000), and biology (Robert, 2004). Relationism is a metatheory that incorporates contextualism and organicism to approach scientific problems from four major principles (Overton, 2010).

First, the *holism* principle indicates that the meaning and significance of any given phenomenon depends on the relational context in which it is embedded (Overton, 2010). In the cases of culture and biology, holism invites us to acknowledge that even if we focus on just one component of each system – a single gene, a single cultural trait – we also need to recognize that these units must be contextualized because they operate as part of systems that function as wholes (e.g., genome, brain, cultural self, organism, community, population).

Second, the *identity of opposites* principle "establishes the *identity among parts* of a whole by casting them not as exclusive contradictions as in the split epistemology but as differentiated polarities (i.e., coequals) of a unified (i.e., indissociable), inclusive matrix – as a relation" (Overton, 2010, p. 14, emphasis in original). According to this principle, culture is biology and biology is culture: they are coequal and inseparable. Both are part of the matrix of evolution, adaptation, and transformation. Culture and biology are constantly engaged in a co-constructing feedback loop, in a reciprocal codetermination (Overton & Reese, 1973), that we are only beginning to understand. "[T]he fact that a behavior implicates activity of the biological system does not imply that it does not implicate activity of the cultural system, and the fact that the behavior implicates activity of the cultural system does not imply that it does not implicate activity of the biological system. In other words, the identity of opposites establishes the metatheoretical rationale for the theoretical position that biology and culture (like culture and person, biology and person, etc.) operate in a truly *interpenetrating* manner" (Overton, 2010, p. 15, emphasis in original).

Third, the *opposites of identity* principle aims at establishing a bedrock for inquiry by moving to a second moment of analysis – after the identity of opposites – in which the law of contradiction is restated and categories again exclude each other (Overton, 2010). Hence, next we should consider that culture is not biology, as each system is given a unique identity that differentiates it. This principle provides a platform in which these new opposites – culture and biology – become standpoints, points of view, lines of sight (Latour, 1993), or levels of analysis (Overton, 2010). "[A]lthough explicitly recognizing that any behavior is 100% biology and 100% culture, alternative points-of-view permit the scientist to analyze the behavior from a *biological* or from a *cultural standpoint.* Biology and culture no longer constitute competing alternative explanations; rather, they are two points-of-view on an object of inquiry that has been created by and will be fully understood only through multiple viewpoints" (Overton, 2010, pp. 15–16).

Finally, the *synthesis of wholes* principle functions as a third moment of analysis in the dialectical undertaking of relational epistemology, as it proposes a resolution to the bipolar tension of the opposites of identity by moving away from this conflict to formulate a new system that integrates the two poles (Overton, 2010). For instance, the person can function as a supra-ordinate system that coordinates, synthesizes, and resolves the tension between culture and biology by regulating and organizing them within the self (Magnusson & Stattin, 1998). In this synthesis, a standpoint provides a stable base for future research (Overton, 2010). From the person standpoint we can examine how the relation between culture and biology shapes individual differences in development. From the biology standpoint, we can investigate the relation between culture and the person by focusing on correlates of brain functioning. From the cultural standpoint, we can inquire into the relation between person and biology by centering on cultural variation in a given domain. In sum, Overton's (2010) relational epistemology provides a invaluable set of guiding principles for the study of culture and biology.

History of Culture and Biology Interplay

The interplay of culture and biology is rooted in evolution, as natural selection has favored the transmission of a predisposition to cooperate and participate in cultural communities (Tomasello, 1999). There is a long tradition of applying evolutionary mechanisms to understand the nature and function of cultural change (see Whiten, Hinde, Stringer, & Laland, 2012), beginning with Darwin's (1859, 1871) observation of the similarities between language and biological evolution. According to Darwin (1871), "[w]e find in distinct languages striking homologies due to community of descent, and analogies due to a similar process of formation. The manner in which certain letters or sounds change when others change is very like correlated growth. We have in both cases the reduplication of parts, the effects of long-continued use, and so forth. The frequent presence of rudiments, both in languages and in species, is still more remarkable" (pp. 59–60). These notions were further elaborated in the work of Pitt-Rivers (1906), Steward (1955), White (1959), Huxley (1955), Sahlins and Service (1960), and Campbell (1965). But research on the interplay of culture and biology has truly gained momentum in the last decades with the irruption of three landmark conceptual models: Wilson's (1975) sociobiology, Cavalli-Sforza and Feldman's (1981) gene–culture coevolutionary theory, and Boyd and Richerson's (1985) dual-inheritance theory.

E. O. Wilson (1975) formulated sociobiology in an attempt to explain the role of evolution in the emergence of complex social behaviors in animals and humans, such as culture, altruism, eusociality, violence, and caregiving. For instance, using his work with social insects, Wilson (1975, 2000) discussed the evolutionary implications of slavery in ants (i.e., dulosis), arguing that it benefits ant colonies, thus maximizing natural selection. Sociobiology was widely criticized (Wilson, 2000), but the most scathing diatribe came from those who argued that it justified the oppression of disadvantaged groups throughout history by explaining social processes purely on the basis of evolutionary mechanisms (see Allen et al., 1975).

Another important antecedent of research in culture and biology interplay is gene–culture coevolutionary theory. Cavalli-Sforza and Feldman (1981) examined how evolutionary mechanisms (e.g., natural selection, mutation, migration, and genetic drift) can also explain the process of cultural transmission and evolution. Two of the most compelling innovations of this model are the delineation of the role of social learning as the main process of cultural transmission, and the introduction of highly detailed mathematical models of vertical (e.g., parent–child, teacher–student) and horizontal (e.g., peer–peer) cultural transmission. Cultural traits play a crucial role in evolution by increasing adaptive fitness in the population, and a parallel role to genetic inheritance (for further discussion, see O'Brien & Bentley, chapter 8 in this volume).

The third major theoretical antecedent of culture and biology interplay is dual-inheritance theory. Boyd and Richerson (1985) proposed that the evolution of genes and culture as inheritance systems is shaped by natural selection and that these two systems are engaged in a dynamic competition to influence the phenotype of individuals. However, these two systems differ in the way they are transmitted. While culture is continuously transmitted by either genetically related or unrelated individuals, genes are passed only once by parents. Furthermore, while parents might not contribute equally in the transmission of culture to their offspring, their genetic contribution is equal (Richerson & Boyd, 1978). One of the most noteworthy features of this model is the consideration of cultural processes as a second inheritance system that operates in dynamic interplay with genes, the first inheritance system. More recently, Mesoudi and colleagues (2006) proposed a unified theory of evolution that attempted to synthesize biological, social, and behavioral sciences, but this formulation was met with fierce criticism (see Ingold, 2007), and was followed by further disagreements (see Acerbi & Mesoudi, 2015; Morin, 2016).

In psychology, there is also a tradition of research in this field, as scholars have employed biological metaphors to account for the role of culture in child development (e.g., developmental niche, Super & Harkness, 1986). In addition, Li (2003) formulated a biocultural model to approach cognitive and behavioral development across the lifespan. Li (2003) proposed a triarchic perspective that approached culture as ongoing social processes (e.g., interpersonal interactions, social situations) that operate in the present time, as relevant for the development (e.g., cognitive) of individuals throughout their lives, and as socially inherited resources (e.g., tools, knowledge, values) that have accumulated throughout human evolution. We delineate different levels of culture and biology interplay by employing these three perspectives of biocultural analysis formulated by Li (2003).

Levels of Culture and Biology Interplay

The interplay of cultural and biological processes takes place at the social, developmental, and evolutionary levels (for other discussions of levels of analysis in culture and biology, see Causadias & Korous, and Doane, Sladek, & Adam, chapters 7 and 10 in this volume). First, the social level of interplay encompasses scenarios in which cultural and biological processes are influencing each other in social situations in the present time. For instance, enculturation into individualistic social orientations is associated with differential activation of the prefrontal cortex, in contrast to individuals exposed to collectivistic cultural values (Chiao et al., 2009). In contrast, some cultural practices can have distinctly positive biological effects, as research suggests that prenatal behaviors among first-generation Mexican-American mothers are the healthiest in comparison to other ethnic groups (Fuller & García Coll, 2010).

Second, the developmental level includes scenarios in which early experiences can set up probabilistic trajectories that shape future outcomes in the lifespan of an organism (i.e., ontogenetic history). For instance, repeated negative social experiences can have important biological effects: research conducted by Chae and colleagues (2014, 2016) has shown that African Americans subjected to chronic discrimination internalize bias, and are more likely to later experience telomere erosion, mental illness, and shortened lifespans. Also, cultural experiences can account for differences in developmental trajectories of autonomic nervous system functioning between European Americans and African Americans (Fuller-Rowell et al., 2013).

Third, the evolutionary level exemplifies scenarios in which culture and biology have influenced each other over centuries and shaped the adaptation of populations of organisms (i.e., phylogenetic history). The role of agriculture in evolution leads to one of the prototypical examples of how cultural changes increase our evolutionary fitness and shape the genome, because it led the development of adult lactose tolerance. In most mammals, the activity of the enzyme lactase, responsible for the digestion of lactose in milk, is dramatically reduced after weaning. However, among human populations with traditions of dairy farming there is a high percentage of individuals who continue to produce lactase (they are lactose-tolerant), in contrast with populations without this cultural practice (see Aoki, 1986; Feldman & Cavalli-Sforza, 1989). The evolutionary level illustrates one of the unique features of culture–biology interplay, in that human beings are capable of using their own cultural capital (e.g., science, technology, medicine) to offset selective environmental pressures (e.g., disease survival, life expectancy), thereby shaping their own biological evolution (Li, 2003). This idea is so revolutionary that it generated a debate between evolutionary scientists that place natural selection as the preeminent mechanism of population change, and those who argue in favor of reciprocal causation and the role of alternative mechanisms, such as niche construction (see Laland et al., 2014). Niche construction is the process by which some species modify their own environment and act as co-directors of their own evolution (Laland, Odling-Smee, & Myles, 2010), as is the case with human agriculture (O'Brien & Laland, 2012). Importantly, niche construction builds upon and enhances our traditional views of inheritance, incorporating a third component in addition to genes and culture: the constructed niche or ecosystem (for a more detailed discussion of niche construction, see O'Brien & Bentley, chapter 8 in this volume).

Types of Culture and Biology Interplay

In addition to the social, developmental, and evolutionary levels, there are different types of culture and biology interplay. Using Rutter's (2006, 2007, 2013) distinction, we can examine different ways in which these two processes relate. First, culture can affect biological processes (*C*→*B*) at the developmental level, through the effects of sociocultural experiences like racial discrimination on neurobiological functioning (Zeiders et al., 2012), and at the evolutionary level, as in the case of the emergence of the lactose-tolerance genotype among some populations as a result of the invention of dairy farming (Aoki, 1986; Feldman & Cavalli-Sforza, 1989). Second, biological processes can shape culture (*B*→*C*), as evidence suggests that individuals with certain dopamine genotypes may be more likely to engage in reward-seeking behavior and migrate (Chen, Burton, Greenberger, & Dmitrieva, 1999). Third, there are culture and biology interactions (*CxB*) at the developmental level: some studies have found that certain genetic variations moderate the link between racial discrimination and the development of conduct problems (Brody et al., 2011) and criminal arrests (Schwartz & Beaver, 2011). Fourth, culture and biology correlations (*rCB*) are similar to *B*→*C*, and refer to biological influences on variations of exposure to particular cultural environments (Richerson, Boyd, & Henrich, 2010). *rCB* can be approached at the evolutionary level to represent gene–culture covariation. For instance, recent research on the association between phonemes (i.e., the smallest units of speech capable of being perceived), genes, and geography has shown that both genetic distance and phonemic distance between populations were significantly correlated with geographic distance, suggesting historical migration and recent population contact (Creanza et al., 2015). In contrast, at the social and developmental level, research on *rCB*s has shown how genetic and neighborhood influences contribute to youth aggressive or non-aggressive antisocial behavior (Burt, Klump, Gorman-Smith, & Neiderhiser, 2016). Fifth, in culture–biology–environment interactions (*CxBxE*) genetic, cultural, and ecological inheritance work together to produce certain outcomes: studies have shown how genetics, ethnic heterogeneity, and neighborhoods shape aggression among adolescents (Hart & Marmorstein, 2009), and how neighborhood disadvantage and genetics shape antisocial behavior (Burt et al., 2016). For an examination of gene–culture–niche interplay research (*GxCxN*), see Causadias and Korous, chapter 7 in this volume. Finally, there are developmental approaches to culture and biology interplay, including research on developmental cultural neuroscience (see Qu & Telzer, chapter 19 in this volume) and on the developmental effects of gene–environment on culture (*dcGE*; see Causadias & Korous, chapter 17 in this volume).

However, it is critical to acknowledge that these types of culture–biology interplay illustrate associations in a simplistic way in order to convey their variety and isolate mechanisms. In reality, many of these interrelations occur simultaneously. It is also important to approach these types under Overton's (2010) relational epistemology principles. Furthermore, cause-and-effect relationships in biology are not easy to determine for multiple reasons, including the extreme complexity of highly integrated systems, the randomness of some events, the uniqueness of biological entities, and the emergence of new qualities (Mayr, 1961). Therefore, these types of interplay are suggestive of the influence of one system on another at a given moment, rather than strict models of cause and effect.

Domains of Culture and Biology Interplay Research

The study of culture and biology interplay can be organized into different domains that focus on the relationship between cultural processes and one particular biological level of analysis, including animal culture, cultural genomics, cultural neurobiology and cultural neuroscience (see Figure 1.1). These domains provide the structure for this handbook.

Animal Culture

Research on animal culture has grown exponentially in the last decades, advancing our understanding of variation in social learning and traditions, as well as the crucial role culture plays in animal communities (Whiten et al., 2011). Evidence of animal culture can be seen in the documented ability of different populations of chimpanzees (*Pan troglodytes*) in Africa to use small stones as hammers and large stones as anvils to extract nuts from their shells, as well as in the training involved in teaching their offspring how to use these tools so the skill can be passed on to the next generation (for an introduction, see Snowdon, chapter 4 in this volume). Comparative

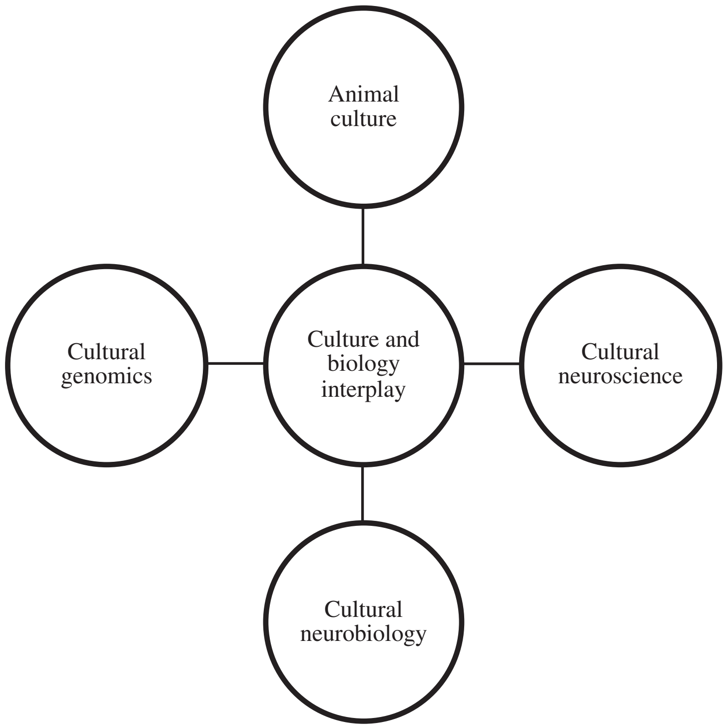

Figure 1.1 Domains of research in culture and biology interplay

research on animal culture can also improve our understanding of evolution and adaptation, for instance by comparing and contrasting primate and cetacean culture (see Botting, van de Waal, & Rendell, chapter 5 in this volume). Primate communication and the biological basis of caregiving constitute another key line of animal culture research, which explores the multiple ways in which cultural processes and natural selection influence each other (see Snowdon, chapter 6 in this volume).

The notion that animals create and re-create culture is truly revolutionary in two ways. First, it dignifies the animal kingdom because it allows us to further appreciate the enormous complexity, sophistication, and meaning of non-human behavior and social systems. Second, it keeps us from claiming that culture is exclusively human, while at the same time it allows us to see connections with other social creatures. New research has shown that animals also have culture, although debate exists over its precise nature. Whereas there is wide consensus that animals are incapable of creating rich symbolic systems similar to human innovations (Laland & Janik, 2006), of radically shaping their environment to the degree humans have (Laland, Atton, & Webster, 2011), or of transmitting and accumulating cultural capital (see O'Brien & Bentley, chapter 8 in this volume), recent evidence calls into question the notion that animals are incapable of symbolic culture. A recent study, for example, documented that in chimpanzee behavior there may be evidence of primitive rituals unconnected to food or status (Kühl et al., 2016).

Nevertheless, we recognize the existence of culture in animals when it is approached not with a rigid anthropocentric bias but as the transmission of skills and knowledge from one generation to the next (Laland, 2008), and when we recognize that these behaviors are learned and not merely explained by genetic inheritance, that they are restricted to specific communities, and that there are important variations between animal communities of the same species. Perhaps one way of settling the animal culture debate is by reframing the question. Instead of forcing the debate to be about whether culture is or is not exclusively human, which is possibly a false dichotomy, we can approach it as a non-hierarchical, horizontal continuum that ranges from behavioral to symbolic culture. We could place fish and insects at one end of the spectrum, great apes and cetaceans further down the line, and humans at the other end.

Cultural Genomics

Cultural genomics studies the interplay of genes, cultures, and environments, or the multiple ways in which cultural experiences affect, are influenced by and covary with the genome and the environment to shape behavior and cognition at the social, developmental, and evolutionary levels (see Causadias & Korous, chapter 7 in this volume). Cultural genomics also approaches the interplay of genes, culture and environment at three levels: the social, developmental, and evolutionary levels (for a more detailed discussion of the evolutionary level of gene–culture interplay, see O'Brien & Bentley, chapter 8 in this volume). The social level of gene–culture interplay represents day-to-day scenarios in which these processes affect each other. For example, some individuals with certain genetic variants might be more susceptible to particular cultural experiences, such as racial discrimination and prejudice (Brody et al., 2011; Sales et al., 2015). At the developmental level of analysis, the study of gene–culture interplay examines how genes, or culture, or both, trigger probabilistic trajectories that lead to adaptive or maladaptive outcomes. For instance, evidence suggests that continuity in cultural development is related to decreases in depressive symptoms in individuals who carry specific genetic variants

(Dressler, Balieiro, Ribeiro, & Santos, 2009). At the evolutionary level, cultural genomics examines the cumulative effect of gene–culture interplay in natural selection and adaptation of humans over centuries. Agriculture, for instance, epitomizes how we not only adapt to our environment, but build new niches to fit our needs. In turn, cultural innovations in agriculture have eventually led to changes in the human genome (see O'Brien & Laland, 2012).

Researchers in cultural genomics can inform our comprehension of the importance of studying the joint influence of nature and nurture, for instance by investigating religion, culture, and genetics (see Lo & Sasaki, chapter 9 in this volume). Cultural genomics is one of the least studied domains of culture and biology interplay in psychology, and most of the studies employ a *CxB* approach by examining gene-by-culture interactions. Also, while most research on this domain of culture and biology interplay focuses on single genetic variants, such as 5-HTTLPR, there is an increased awareness of the importance of using alternative approaches that can provide a more compelling picture, including polygenic models, genome-wide association analyses, and twin, family and adoption studies (see Causadias & Korous, chapter 7 in this volume).

Cultural Neurobiology

Cultural neurobiology, or the neurobiology of cultural experiences (Causadias et al., 2016), encompasses moment-to-moment, day-to-day, year-to-year or ontological transactions among cultural processes and central and peripheral stress-sensitive neurobiological systems, including the autonomic nervous system (ANS), the hypothalamic-pituitary adrenal (HPA) axis, and immune mechanisms (for an introduction, see Doane, Sladek, & Adam, chapter 10 in this volume). For instance, stereotype threat has been associated with increases in blood pressure and cardiovascular reactivity, sympathetic activation, and cortisol levels (John-Henderson, Rheinschmidt, Mendoza-Denton, & Francis, 2014), while lifelong subjection to racial discrimination, as well as discrimination in the form of threats or actual aggression, has been found to inversely predict heart rate variability (Hill et al., 2017).

Cultural neurobiology is one of the domains of culture and biology interplay that have received most recent attention: a growing number of lines of study have examined the relationship between poverty, stress, and allostatic load (see Doan & Evans, chapter 11 in this volume), the biological consequences of unfair treatment (see Ong, Deshpande, & Williams, chapter 12 in this volume), the effects of cultural experiences, social ties and stress on the HPA axis (see Wang & Campos, chapter 13 in this volume), cultural influences on parasympathetic activity (see Hill & Hoggard, chapter 14 in this volume), and stress reactivity and drug use vulnerability in culturally diverse communities (see Obasi, Wilborn, Cavanagh, Yan, & Ewane, chapter 15 in this volume). Importantly, most of the literature in cultural neurobiology focuses on $C \rightarrow B$ effects. Similarly to cultural genomics, research on this domain of culture and biology interplay often employs a single marker of the neurobiological effects of stress, such as measures of cortisol. There is an increasing awareness of the need to utilize comprehensive indexes that provide a most comprehensive picture of the affected systems, such as allostatic load (for a discussion, see Doan & Evans, chapter 11 in this volume).

Cultural Neuroscience

Cultural neuroscience is an emerging interdisciplinary field that integrates theories and methods from cultural and social psychology, anthropology, and social and cognitive neuroscience to investigate the interactions between culture and the brain at different timescales (for an introduction, see Lin & Telzer, chapter 16 in this volume). Cultural neuroscience studies sociocultural variations in cognitive and social processes and how they are represented in the brain. It aims to uncover how repeated engagement in different sociocultural environments might have influences on the brain (Kitayama & Uskul, 2011). Cultural neuroscience does not necessarily look at neural similarities and differences between races and nationalities but rather between and within cultures (Chiao & Ambady, 2007; Chiao et al., 2010). Studies in this field have shown that Latino adolescents who reported greater family obligation values showed decreased activation in reward regions during risk taking and increased activation in cognitive control regions during behavioral inhibition (Telzer, Fuligni, Lieberman, & Gálvan, 2013), underscoring how cultural values can shape the brain. Importantly, these neural systems predict long-term adjustment (Telzer, Fuligni, Lieberman, & Gálvan, 2014), further highlighting that culture shapes neural processing, which impacts behaviors over time.

Cultural neuroscience is perhaps the most established domain of research in culture and biology interplay, with an emerging literature on the causes and consequences of cultural differences in social cognition (see Meyer, chapter 17 in this volume), culture and self–other overlap (see

Varnum & Hampton, chapter 18 in this volume), and culture, brain, and development (see Qu & Telzer, chapter 19 in this volume). As a testament to this growth, the last decade has seen special issues and handbooks devoted to cultural neuroscience, and even a new journal (*Culture and Brain*). Notably, most of the literature in cultural neuroscience focuses on $C \rightarrow B$ effects.

Conclusions and Future Directions

There are possible aids to overcoming obstacles in future culture and biology research (see Table 1.1). First, we should avoid reductionism and determinism in the employment of increasingly sophisticated biological methods in behavioral science in order to overcome well-founded skepticism (Schwartz et al., 2016). To do so, we should aspire to develop models and methods that reflect the complexity of human and animal culture, as well as conducting research on the intersection of multiple types, levels, and domains of culture and biology. Following Overton's (2010) principles will be key in this endeavor. They provide a stable base for inquiry – not an absolute fixity or absolute relativity, but a relative relativity (Latour, 1993). Admittedly, creating a grand theory of the field might not be attainable in the short term, so in the meanwhile we can focus on "patchy reductions" in which sections of a causal network are elucidated, progressively leading to a better understanding of the whole system (see Kendler, 2005; Schaffner, 1994).

Second, instead of using biomedical and genetic methods to justify social and racial hierarchies, we should employ these methods to document the effects of social injustice and inequality. For instance, we can use novel

Table 1.1 Obstacles and solutions in culture and biology interplay research

Obstacles	**Solutions**
Reductionism and determinism	Complexity and "patchy reductions"
Justification of social hierarchies	Documenting the effects of injustice and inequality
Unethical biomedical research	Community participatory research
Disconnection between fields	Interdisciplinary research approaches

biologically informed methods to provide further evidence of the deleterious effects of racial discrimination and unfair treatment on the nervous system (see Hill & Hoggard, and Ong, Deshpande, & Williams, chapter 12 in this volume) and on genes (Chae et al., 2014, 2016). Similarly, by appreciating the complexity of animal culture we might be persuaded to promote conservation efforts for endangered species of apes and other mammals, which are rapidly losing their cultural heritage through poaching and habitat loss (see Yong, 2015).

Third, to overcome the legacy of unethical biomedical research with underprivileged communities, and the mistrust that it has engendered, we should develop community participatory research approaches that make individuals and groups active partners in research designs, and incorporate their needs and legitimate demands into the proposed outcomes (see Minkler & Wallerstein, 2008). This would not only help advance science, but hopefully generate interventions and applied solutions to community challenges that arise from the intersection of culture and biology.

Fourth, in order to address the disconnection between scientific fields and avoid intellectual insularity, it is necessary to promote new hybrid training programs, interdisciplinary research groups, grant opportunities, and peer-reviewed journals that can truly carve a new niche for this emerging discipline. Along these lines, we have created the Culture and Biology Initiative, an effort aimed at generating innovative models, studies, and questions. This initiative includes this handbook, which showcases some of the most ground-breaking thinking and research in this field, a special section on culture and biology in the journal *Cultural Diversity and Ethnic Minority Psychology* (see Causadias et al., 2016), symposiums in research conferences, new courses and teaching seminars, and the formulation of novel collaborative research projects.

In this chapter, we began by examining some obstacles preventing the integration of culture and biology in behavioral sciences. To overcome these obstacles and their consequences, we introduced the field of culture and biology interplay, defining its basic principles and providing an overview of its history. We examined different types, levels, and domains of research in culture and biology interplay. The chapters that follow offer varied examples that illustrate the breadth of the disciplines and methods that are giving shape to this emerging field. We hope this collection will illustrate how insights that cut across disciplines, across biological systems and conceptualizations of culture, and even across species, may facilitate a better understanding of what it means to have culture, and the evolutionary significance of culture and biology as integrated systems of adaptation.

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