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Showcasing the Variety of Biosocial and Evolutionary Approaches in Sociology: Introduction to the Special Issue

Sebastian Schnettler · Johannes Huinink

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Abstract This introduction to the special issue explores the increasing integration of biosocial and evolutionary approaches within sociology, highlighting the diverse ways in which these perspectives are incorporated into sociological research. In the past, sociology had reservations against or even rejected biological and evolutionary explanations of human behavior and often viewed them with skepticism. However, recent developments have seen a resurgence of interest in these approaches, leading to the emergence of interdisciplinary subfields such as biosociology, evolutionary sociology, neurosociology, and sociogenomics. This introduction provides a historical overview of biological and evolutionary thinking with regard to human behavior and sociality, tracing its roots from Darwinian theory to its contemporary applications within sociology. We discuss the conceptual and methodological differences between these approaches and offer an overview of key contributions that illustrate their relevance to core sociological topics. The articles in this special issue—which we summarize in this introduction—exemplify the variety of work being done at the intersection of sociology and the bio- and evolutionary sciences, from theoretical explorations to empirical studies. By presenting this range of interdisciplinary research, we aim to invite a broader sociological audience to engage with these perspectives, contributing to the development of a more comprehensive understanding of human behavior that sheds the dualism between nature and nurture—long over-

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come outside of sociology—for a consolidated effort to examine how nature and nurture are intertwined in multiple and complex ways.

Keywords Evolutionary sociology · Biosociology · Interdisciplinarity · Sociogenomics · Neurosociology

Darstellung der Vielfalt biosozialer und evolutionärer Ansätze in der Soziologie: Einleitung zum Sonderheft

Zusammenfassung Diese Einführung in das Sonderheft untersucht die zunehmende Integration biosozialer und evolutionärer Ansätze in der Soziologie und zeigt die verschiedenen Möglichkeiten auf, wie diese Perspektiven in die soziologische Forschung einbezogen werden. Die Soziologie war in der Vergangenheit biologischen und evolutionären Erklärungen menschlichen Verhaltens gegenüber zurückhaltend bis ablehnend eingestellt und hat diese oft mit Skepsis betrachtet. In jüngster Zeit ist das Interesse an diesen Ansätzen jedoch wieder erwacht und hat zur Entstehung interdisziplinärer Teilbereiche wie Biosoziologie, Evolutionssoziologie, Neurosoziologie und Soziogenomik geführt. Diese Einführung bietet einen historischen Überblick über biologisches und evolutionäres Denken in Bezug auf menschliches Verhalten und Sozialität, wobei die Wurzeln von der Darwinschen Theorie bis zu den heutigen Anwendungen in der Soziologie verfolgt werden. Wir erörtern die konzeptionellen und methodischen Unterschiede zwischen diesen Ansätzen und geben einen Überblick über die wichtigsten Beiträge, die ihre Relevanz für zentrale soziologische Themen verdeutlichen. Die Beiträge in diesem Sonderheft, die wir in dieser Einleitung zusammenfassen, veranschaulichen die Vielfalt der Arbeiten, die an der Schnittstelle von Soziologie und Bio- und Evolutionswissenschaften durchgeführt werden, von theoretischen Erkundungen bis hin zu empirischen Studien. Durch die Präsentation dieses Spektrums an interdisziplinärer Forschung möchten wir ein breiteres soziologisches Publikum dazu einladen, sich mit diesen Perspektiven auseinanderzusetzen und zur Entwicklung eines umfassenderen Verständnisses des menschlichen Verhaltens beizutragen, das den außerhalb der Soziologie lange Zeit überwundenen Dualismus zwischen „nature“ und „nurture“ zugunsten einer konsolidierten Untersuchung der vielfältigen und komplexen Verflechtung von „nature“ und „nurture“ aufgibt.

Schlüsselwörter Evolutionäre Soziologie · Biosoziologie · Interdisziplinarität · Soziogenomik · Neurosoziologie

1 Motivation

Sociology seeks to explain the changing structures of human societies and their institutions as the result of social action, which itself is conditioned by given social and nonsocial factors. This task requires a profound and precise knowledge of the factors determining individual behavior and decision-making and their impact

on structural and cultural features of social life. Therefore, it is not surprising that sociology has been facing competition to varying degree from other scientific disciplines investigating human behavior and its micro as well as macro consequences over time, for instance from economics and social physics.

But in no other case has the reference to other scientific disciplines been viewed so critically as in the case of biological and evolutionary (bio/evo) approaches to human behavior and culture (cf. Ellis 1996; Hopcroft and Schnettler 2024). Among these bio/evo disciplines are behavioral ecology, evolutionary psychology, and cultural evolution approaches, as well as (behavioral) endocrinology, the neurosciences, and (epi)genetics. With few exceptions (e.g., Boorman and Levitt 1980; Esser 1993; Maryanski and Turner 1992; Van den Berghe 1979), sociology has neglected bio/evo research or even outright rejected it for much of the twentieth century (Degler 1991). More often, sociological references to bio/evo concepts were derisive, and often with reference to a simplified and, at times, somewhat distorted or outdated view of sociobiology, neglecting the full variety of existing bio/evo accounts (cf. Schnettler 2016).

Much has been written on sociology's neglect of bio/evo explanations relevant to core sociological topics. Our discipline has faced criticism for this from both fellow sociologists (e.g., Ellis 1996; Van den Berghe 1990) and scholars from other fields studying human behavior (e.g., Barkow 2006). Although we are not witnessing a decline of sociology as a discipline, as some internal critics have implied (Ellis 1996; Lopreato and Crippen 1999), we agree that sociology's reluctance to seriously engage with biological and evolutionary perspectives on human behavior and social organization remains a significant deficit. Maintaining this stance will substantially weaken sociology's explanatory power. In recent years, scholars outside of sociology who work from a bio/evo perspective have renewed calls for integrating different scientific perspectives. Such integration is necessary and could foster the overall goal of establishing an interdisciplinary science of human behavior (e.g., Brown et al. 2011; Plomin et al. 2013; Richerson and Boyd 2005).

Gladly, after two failed attempts of integrating bio/evo insights into the core of sociology, a new wave of engagement with bio/evo research in sociology is in the making (Hopcroft and Schnettler 2024). And this engagement is happening in surprisingly diverse ways. New (interdisciplinary) subfields such as neurosociology, sociogenomics, biosociology, and evolutionary sociology have emerged that are influenced by different traditions of bio/evo work outside of sociology and that are, as of today, to different degrees institutionalized (cf. Schnettler 2016). Programmatic and empirical entries in thematic handbooks and special issues as well as theoretical and empirical standalone papers in top sociology journals signify this new wave of engagement and show that it has reached the discipline's mainstream (Hopcroft and Schnettler 2024; Schnettler 2016). For German sociology, it might be indicative that, besides this special issue, at least three other books have been published recently that adopt or discuss (aspects of) bio/evo research in sociology or the social sciences more broadly (Hammerl et al. 2024; Pries 2021; Spörlein 2024). There are signs, however, that the acceptance of bio/evo accounts in the mainstream roughly follows existing fault lines in the discipline (cf. Voland and Meißelbach 2021). Fields like family sociology and stratification research are arguably the ones most strongly

influenced by bio/evo perspectives, yet in different ways. Whereas evolutionary family sociology draws heavily on evolutionary fields that emerged from sociobiology (Rotkirch 2018; Tanskanen and Danielsbacka 2018), stratification research is heavily influenced by recent advances in sociogenomics (Diewald et al. 2015).

The goals of this special issue are twofold. First, we aim to invite a broader sociological audience to engage with bio/evo research. To this end, the introduction includes a brief historical account of bio/evo thinking since Darwin and describes the emergence of various scientific fields outside of sociology that examine human behavior from a bio/evo perspective. This is followed by a description of the key conceptual and methodological differences of these approaches and an overview of scientific fields within sociology or at the intersection of sociology and other disciplines, that have developed in exchange with these external fields, such as biosociology, neurosociology, and sociogenomics. The second goal of this special issue is to illustrate the variety of relevant work already being done within sociology and neighboring fields to those interested in learning more about sociological work from a bio/evo perspective on human behavior. To this end, we have carefully curated contributions from different bio/evo fields in sociology, mixing theoretical and empirical contributions along with a few selected contributions from neighboring fields that are relevant to sociology. In the last part of this introduction, we provide a brief summary of these entries and discuss their significance in the overall framework presented here.

By introducing new concepts of interdisciplinary theory, presenting examples of biological and evolutionary research in sociology, and including reflections by authors from neighboring disciplines on their link to sociology, we want to challenge scholars of our discipline to be more open to interdisciplinary research. This special issue is about nothing less than propagating research in the sense of a comprehensive “human science,” as Norbert Elias called it (Elias 1978). He emphasized the need for a multidisciplinary and holistic understanding of human behavior and social processes, one that requires insights from multiple disciplines and a focus on the interconnectedness and historical evolution of social phenomena. At the same time, Elias did not deny that sociology has a unique and important stance in such a human science. In fact, he saw “the dynamics and long-term transformations of human figurations as the proper object of sociological investigation” and “explicated a convincing rationale for the autonomy of sociology vis-à-vis neighboring disciplines, in the irreducible and ‘emergent’ character of such dynamics” (Quilley and Loyal 2005, p. 816). In specifying this general aim, we will further propose that not all parts of sociology will profit from a stronger engagement with a bio/evo perspective to the same degree. Therefore, in Sect. 5 we will also strive to briefly assess the conditions under which this type of interdisciplinary work is meaningful and for whom it is relevant. To this purpose, we suggest adding to Coleman’s famous “boat” or “bathtub” model an inner-individual process level besides the individual micro and supraindividual macro levels (cf. also Bernardi et al. 2019). The model helps to guide our assessment as to when it is sensible for sociologists to draw on inner-individual processes to provide rigorous explanations of collective phenomena, which is the main goal of sociological reasoning. It will be a collaborative task for the sociological community in the years ahead to develop guidance on which parts

of sociology can and need to be integrated with lower-level explanations and which cannot. To facilitate this integration, we need a stronger engagement with bio/evo perspectives in the first place.

2 A Brief History of Bio/Evo Thinking Since Darwin

The history of biological and evolutionary approaches is complicated and fraught with moral undertones, misunderstandings, and mutually perceived irrelevance. In this section, we will just briefly summarize the key developments in evolutionary theory since Darwin, outline sociology's stance toward evolutionary theory over time, and provide the key reasons for sociology's neglect of bio/evo thinking and how these have been addressed since. Much has been written on all of these aspects on a broad programmatic level; therefore, we will keep this part brief. For a more extensive treatment, we refer readers to other relevant works on the history of evolutionary thought and its application in sociology and the behavioral sciences (e.g., Degler 1991; Laland and Brown 2011; Lopreato and Crippen 1999; Mayr 1982; Segerstråle 2000).

2.1 The Darwinian Revolution(s)

Contemporary understandings of evolution are predominantly associated with Charles Darwin. However, it is important to recognize that evolutionary theories predated Darwin. In fact, evolutionary thinking had become more and more accepted during the eighteenth century and up to the middle of the nineteenth century, even though creationism—which credited God with the origin of life on earth and assumed a static world of short duration—remained the predominant worldview before Darwin's 1859 publication of "On the Origin of Species," both among laypeople and among scientists and philosophers (Mayr 2002).

Various combinations of different evolutionary theories were shared by other evolutionists, e.g., Jean-Baptiste Lamarck, Ernst Haeckel, Hugo de Vries, and Thomas Henry Huxley (Mayr 2002, p. 95), but the combination of these, as well as the impressive amount of evidence Darwin presented in "Origin of Species," left an impression on subsequent scientists. Although not all parts of his evolutionary theory were accepted at that time, following the publication of "Origin of Species," evolutionary theory quickly led to the first Darwinian revolution: a "secularization of science" indicated by the acceptance of evolutionary theory at the expense of creationist thinking (Mayr 2002):

"Even though some of Darwin's explanatory theories of evolution continued to encounter much resistance for another 80 years, his conclusion that the word had evolved was widely accepted within a few years after 1859. [... B]eginning with Darwin in 1859, more and more facts were discovered that were compatible only with the concept of evolution. Eventually it was widely appreciated that the occurrence of evolution was supported by such an overwhelming amount of

evidence that it could no longer be called a theory. Indeed, since it was as well supported by facts as was heliocentricity, evolution also had to be considered a fact, like heliocentricity” (Mayr 2002, p. 13).

Darwin’s work combines five major theories of evolution: First was the theory of evolution as such, with the description of a steadily changing world in which organisms were transformed over time, as opposed to a constant world of short duration. Second was the theory of common descent, the idea that all organisms descended from an ancestral species. Third was gradualism, which described evolution as a gradual process rather than one involving saltations, or discontinuities, in evolutionary change. Fourth was the theory of the multiplication of species, which was about explaining the enormous degree of diversity among plants and animals. Fifth was the theory of natural selection, which provided a natural mechanism driving (gradual) evolutionary change: Resource scarcity along with variation in traits that render individuals better or worse suited to their respective environmental niches leads to differential survival of members of a population, thus constituting the process of natural selection (Mayr 2002).

Despite the sudden acceptance of evolution as such, as described in the quote above, it took several decades for other parts of Darwinian evolution to be accepted, even within the field of biology—most importantly, the theory of evolution by means of natural selection (Mayr 1982). Even after 1859, non-Darwinian evolutionary theories remained popular, e.g., the idea of soft inheritance as propagated by Lamarck and evolution as a saltational process (Mayr 1982). It was not until many decades later that the combination of Mendelian genetics with Darwinian evolutionary theory in the modern synthesis, or second Darwinian revolution, in the middle of the twentieth century “led to a gradual dismissal of alternative versions of evolutionary theory and an acceptance of Darwinian theory” (Schnettler 2010, p. 17). The insights from the modern synthesis quickly spread through the field of evolutionary biology. Since then, further progress happened rather quickly, with the discovery of DNA, the sequencing of the genome, and the differentiation of evolutionary research into several biological subfields and their spread into neighboring disciplines (Mayr 2002).

Although, as Mayr’s quote above suggests, evolution is now so well supported by evidence that it can be viewed as one of the major scientific facts, some specifics about the evolutionary process remain under development today. A promising and relatively new development is niche construction theory, which emphasizes that organisms, rather than being completely passively placed into a fixed environmental niche, can modify—that is, construct—their own niches and the niches of others, thereby affecting the very process of natural selection (Laland et al. 2016). Although some “intellectual pioneers” had discussed the idea of niche construction much earlier, a consensus as to the importance of niche construction began to emerge in biology only around 1990 (Laland et al. 2019). If organisms affect their own and others’ niches, this can explain variation in the strength of natural selection (Clark et al. 2020). What may sound revolutionary to sociologists who have long viewed evolutionary accounts as overly deterministic is that the concept of organismic agency has thus entered evolutionary biology. Agency so far has had no place

in the modern synthesis (Laland et al. 2019). Yet it has had an important place in sociology since the foundation of the discipline. A version of evolutionary theory that includes a concept of agency could help reduce the perceived gap between the social and evolutionary sciences.

Currently there is an ongoing debate in biology about updating the modern synthesis to a version of an “extended,” “integrated,” “postmodern,” or “inclusive” modern synthesis. This updated version of the modern synthesis is thought to cover, besides the concept of niche construction, other important evolutionary concepts that have been discussed and increasingly bolstered by evidence in the decades since the modern synthesis, such as multilevel selection, bidirectional causality between cultural and biological evolution, self-organization, etc. (e.g., Pigliucci and Müller 2010; Corning 2020; Laland et al. 2015). These developments are interesting from a sociological and potentially integrative perspective, as they might decrease the perceived incommensurability between social and evolutionary sciences as viewed by some of the fiercest critics within sociology. It is argued that the updated synthesis should also aim at integrating new subdisciplines of biology and subdisciplines from other fields (e.g., evolutionary demography) that have emerged in the last decades and that deal with aspects of physiology and behavior within an evolutionary framework (Laland et al. 2015; Pigliucci and Müller 2010). Just regarding human behavior, this would cover a range of disciplines besides evolutionary biology: evolutionary psychology, behavioral ecology, cultural evolution approaches, behavioral endocrinology, neurophysiology, genetics, and epigenetics. There is much in these disciplines that is very relevant for sociology, especially given the many examples of interactions between social and biological processes. After a brief detour into the history of sociobiology as a precursor to some of these fields, we will explore these disciplines in greater detail in the subsequent section.

2.2 The Evolution of Behavior and the Short Life of Sociobiology

Much of the early work on evolution was on physiological traits and instincts, with the exception, for instance, of Darwin’s own “Descent of Man” in 1871, which included first ideas on how human sociality and morality might have evolved. But around Darwin’s time, the study of behavior did not exist as a distinct scientific field (Burkhardt 1985, p. 329). This changed with the emergence of sociobiology, starting gradually in the United Kingdom in the 1960s, and included work by evolutionary biologists including Richard Dawkins, Richard Hamilton, and John Maynard Smith, and came to the stage more suddenly in the United States with Edward O. Wilson’s 1975 publication of “Sociobiology: The New Synthesis.” What started as an attempt among early sociobiologists to explain seemingly altruistic behavior in the animal kingdom culminated in the attempt to establish a new subfield of evolutionary biology that focused on the “systematic study of the biological basis of all social behavior.” Although Wilson had formulated the idea of a unified sociobiology earlier (Wilson 1971), it was in “Sociobiology” that he extensively presented his attempt at such a unification and synthesized existing theory and empirical evidence on animal behavior from various biological subfields, including ethology, population biology, and zoology. Unlike ethology, which focuses on animal behavior, sociobi-

ology explicitly integrated the study of animal behavior within the framework of evolutionary theory and functionalist reasoning. Methodologically quite similar to rational choice theory in the social sciences, formal modeling and evolutionary game theory played an important role in sociobiology from its start (e.g., Maynard Smith and Price 1973; Binmore 2007).

A key concept of sociobiology is the explication of the gene as the unit of evolution rather than the individual organism and, related to that, the concept of kin selection (Dawkins 2006; Hamilton 1963). According to kin selection or inclusive fitness theory, reproductive success can be increased either by reproduction of the carrying organism of a gene or by reproduction of another organism carrying the same gene. Taking into account the benefits and costs of reproduction, Hamilton provided a mathematical framework for predicting that in some constellations, supporting reproduction of close relatives can aid the spread of an individual's genes to the same degree as, or even more than, having offspring oneself (Hamilton 1964a, b). The concept of kin selection helped explain certain forms of apparently kin-altruistic behavior and cooperation. It was also important in solving the puzzle of cooperation. From an evolutionary standpoint, it was long unclear how seemingly altruistic acts, which carry higher costs than benefits in terms of reproductive fitness, could be explained. An example of such an altruistic act is the attempted rescue of another person (e.g., from drowning) that carries a risk for the rescuer. The concept of kin selection theory basically took the "altruism" out of a certain subclass of seemingly altruistic acts by explaining that these acts, under certain circumstances, actually benefit the reproductive success of the "altruist" (Trivers 1971, p. 35).

However, the concept of kin selection did not solve the puzzle of cooperation with regard to altruistic acts among nonrelatives. With reciprocal altruism, Trivers (1971) introduced another important concept in sociobiology that helped explain this class of behavior under certain circumstances. He specified that under conditions that ensure many opportunities for reciprocity among known individuals, a behavioral tendency for reciprocal altruism could evolve. Among these conditions were long lives, low dispersal rates, and stable social groups (Trivers 1971). This is similar to predictions made by game theoretical models of repeated cooperation games (cf. Fehr and Gintis 2007; Trivers 2006), with the difference being that sociobiology does not necessarily assume a conscious strategy. Rather, it posits that if these preconditions held long enough in human history, relevant mechanisms likely evolved for humans to behave altruistically.

Group selection is another concept used to explain certain forms of cooperative behavior among nonrelatives. Here, the idea is that selection can also act at the level of groups rather than just genes or individuals. How selection operates at multiple levels was formally described by Price (1970). With regard to cooperation, the idea was that a behavioral tendency for altruistic acts, even though they come at a reproductive cost for the altruist, could evolve if such acts benefit the group. Group selection had gone out of favor after the gene-centered view of evolution had started to dominate in the 1960s (Dawkins 2006 [1976]), but it regained some appeal in the form of multilevel selection. This concept assumes that selection processes can operate on different levels of aggregation (Bowles and Gintis 2013; Kramer

and Meunier 2016; Richerson et al. 2016; see also Wilson 2012; Wilson and Sober 1994).

The publication of “Sociobiology” sparked significant controversy. In the 27th and final chapter of his opus magnum, Wilson proposed that his evolutionary framework for social behavior could also apply to humans. This suggestion was highly controversial and triggered the “sociobiology debate” or “wars” of the 1970s and 1980s (Schnettler 2020). The controversy spanned two fronts: between sociobiology and the social sciences, and between Wilson and his colleagues in evolutionary biology, notably Stephen J. Gould and Richard Lewontin (Segerstråle 2000, 2001). Both Gould and Lewontin criticized Wilson for what they saw as naïve adaptationism, genetic determinism, and a new incarnation of Spencer’s social Darwinism. They were part of a sociobiology study group that was critical of sociobiology and even published a critical letter in the *New York Review of Books* (Bogdany 1980; Schnettler 2020; Segerstråle 2001). Segerstråle’s (2000) detailed analysis of the sociobiology controversy reveals that moral and scientific arguments were often conflated, and Wilson’s critics largely misrepresented his scientific work (Bogdany 1980; see also Eckland 1976). In a reappraisal of Wilson’s text for *Science*, Wade (1976) also came to the conclusion that neither the alleged social Darwinism nor the genetic determinism were present in Wilson’s work. In fact, quite to the contrary, Wilson estimated that genes had given away most of their sovereignty and that only about 10% of social behavior had a genetic basis (Wade 1976, p. 1152). Nevertheless, at that time, the controversy was so intense that conducting research under the term “sociobiology” became untenable for years (Schnettler 2010, p. 19).

2.3 After Sociobiology: The Emergence of an Evolutionary Behavioral Science?

Whereas many sociologists seem to have had a one-dimensional and almost stereotypical view of biological treatments of human behavior in the form of a simplified and outdated version of sociobiology (cf. Machalek and Martin 2004), in fact a variety of modern biological and anthropological subfields deal with human behavior and cognition and are thus, in various ways, potentially relevant to the social sciences. To sort these subdisciplines, it is useful to follow a distinction between ultimate and proximate causation common in biology. Whereas “ultimate” or “evolutionary” causation focuses on the big questions as to why a certain trait evolved or what adaptive functionality a trait might have, “proximate” causation deals with the mechanisms modulating a behavior, that is, the hormonal, neural, (epi)genetic, or otherwise physiological pathways involved in producing a behavior or cognition (Laland and Brown 2011; Mayr 1961).

Within the realm of fields focused on “ultimate” causation, we can distinguish at least three disciplines that can be seen as descendants of sociobiology: evolutionary psychology, behavioral ecology, and cultural evolution approaches. These newer approaches differ in their focus on various aspects of human behavior and employ different methodologies to study them. However, their shared conceptual roots offer significant potential for integration under the new label “evolutionary behavioral science” (Brown et al. 2011). As these fields are grounded in the same evolutionary principles developed in sociobiology but differ in their premises, details, thematic

focus, and methods, they are consequently not mutually exclusive but are seen as complementary to each other (Micheletti et al. 2022, p. 669).

Behavioral ecology emerged within anthropology in the late 1970s, in the midst of the sociobiology controversy, with a focus that had shifted toward putting ideas from sociobiology to an empirical test in different niches (Brown et al. 2011; Winterhalder and Smith 2000). A central premise of behavioral ecology is the extreme flexibility of behavior that allows individuals to adjust to very different social and physical environments. Thus, differently from sociobiology, the focus here is much more on variance of behavior in different environments rather than behavioral universals. Assuming that behavior goes along with varying cost–benefit ratios in different environments, the task was to empirically examine the optimality of behavior with regard to evolutionary fitness. A common approach is to match empirical observations of behavior from different populations with ideal-typical behavior derived on the basis of evolutionary assumptions and by means of mathematical models, and to evaluate the extent to which the behavior is fitness-maximizing in the respective context (Laland and Brown 2011; Winterhalder and Smith 2000). As in sociobiology, there is no explicit focus on the mechanisms that drive people to act in fitness-maximizing ways under certain circumstances or even on whether individuals make conscious choices or not (Brown et al. 2011). Whether (adaptive) behavior in different ecological niches is culturally learned or genetically inherited is secondary in behavioral ecology (Laland and Brown 2011). In fact, culture, as seen by behavioral ecology, is a highly flexible system to create an adaptive behavioral system in different ecological niches. That does not mean, however, that cultural variation always contributes to the adaptation of behavioral patterns (cf. Micheletti et al. 2023). What is adaptive may change depending on early life circumstances. Thus, behavioral ecologists often draw on life history theory, which states that individuals may follow different life history strategies depending on early life conditions.

Whereas earlier studies in behavioral ecology focused on foraging strategies in the context of less developed and economically deprived societies, later studies expanded the focus to include a larger variety of both behavioral domains and populations in contemporary developed societies (Winterhalder and Smith 2000). But the scientific payoff has been larger with regard to traditional as compared to modern societies, as in the latter the speed of sociocultural evolution by far exceeds the speed of genetic evolution. Current living conditions are very different from conditions in the ancestral past when behavioral programs emerged, leaving room for maladaptation of behavior, a point made more explicit in evolutionary psychology with its concept of the “environment of evolutionary adaptation” (EEA; see below; see also Micheletti et al. 2023).

Evolutionary psychology, like sociobiology, focuses on adaptation and posits that our psychological architecture, like our physiological mechanisms (e.g. bipedalism, object recognition; see Vollmer 1998), evolved in response to recurrent physical and social selection pressures. Distinct from the agnosticism about the evolved mechanisms driving behavior in sociobiology and behavioral ecology, evolutionary psychology provides an explicit theory of how our minds work. It posits that humans lived in hunter-gatherer bands for most of their evolutionary history, facing constant and changing selection pressures. They dubbed the constant or repetitive

part of environments in humans' evolutionary past the "environment of evolutionary adaptedness" (EEA). A central argument is that, although living conditions changed significantly with the transition to agricultural societies roughly 10,000 years ago, this period might have been too short for major changes to our evolved psychological apparatus, which developed over millions of years (Barkow et al. 1992; Buss 1995). This is because complex traits evolve over a very long period of time. Although this argument is contested, the fact that many of our psychological mechanisms (or their roots) have a shared history along our phylogenetic tree means that they evolved over millions of years, implying some stability in the genetic hardwiring underlying these mechanisms (cf. Eastwick 2009; Lloyd 1999). Many phenotypic traits are encoded by a multitude of genes (polygenicity), and the same genes are involved in various unrelated phenotypic traits (pleiotropy).

If, based on this logic, environments since the Neolithic revolution have changed faster than the underlying psychological architecture, humans in modern societies possess a psychological architecture adapted to a vastly different environment than today's. Behaviors that once were adaptive may be maladaptive today. One example that illustrates this idea is our preference for sweet and fatty foods, which once signified high caloric, life-saving sustenance, but have become a health burden in modern societies with the constant availability of highly condensed industrial foods. Much of the empirical research in evolutionary psychology focuses on detecting and mapping evolved psychological mechanisms like these, which had previously been treated as black boxes. The assumption is that a number of domain-specific psychological modules evolved in response to specific adaptive problems in the EEA. The assumed number of those mechanisms ranges from hundreds or even thousands of specialized psychological modules, among proponents of an extreme version of modularity (Barkow et al. 1992; Buss 1995), to, among other psychologists, just a few that go along with a domain-general architecture (cf. Baumeister 2005).

Evolutionary psychology, like sociobiology, was criticized for its occasionally naïve adaptationism and tendency toward "predictive promiscuity" (Freese 2007). This term refers to the ease with which superficially plausible ad hoc hypotheses about the evolutionary functions of behaviors can be generated, despite a lack of robust historical evidence due to our limited knowledge of conditions in the EEA. However, the pursuit of functional explanations can be highly valuable heuristically. It aids in the discovery of previously unknown psychological mechanisms and offers pathways for empirical testing of their operations. John Maynard Smith (1995) encapsulates the usefulness of adaptive thinking despite its limitations with the following quote:

"There are plenty of bad adaptive stories: we can all laugh at the suggestion that flamingos are pink because it camouflages them against the sunset. Their critique forced us to clean up our act and to provide evidence for our stories. But adaptationism remains the core of biological thinking. Confronted with feathers, or eyes, or ribosomes, we cannot not ask what they are for. It would be no more plausible to suppose that they are accidental and non-selected byproducts

of something else than it would be to suppose that the gyroscope in the V2 rocket was connected as it was because some German fitter made a mistake” (Maynard Smith 1995).

Cultural evolution research can be characterized as a type of multilevel approach, with variants focusing on different levels of explanation (Richerson et al. 2016). On one level, it focuses on the diversity and change of culture itself (Micheletti et al. 2022, p. 20). This macro perspective on culture is particularly relevant to human societies, as humans uniquely exhibit cumulative culture. Although aspects such as symbolic communication, the production and transmission of material artifacts, and social learning are observed in other species as well (Konner 2010; McGrew 1998; Pollick and de Waal 2007; van Schaik et al. 2003; Whiten et al. 1999), the passing on of cultural achievements through generations, leading to increasing complexity, is unique to humans (Dean et al. 2014; Laland and Hoppitt 2003; for recent contributions, see, e.g., Henrich 2020; Turchin 2018). On another level, cultural evolution approaches treat culture as a set of mechanisms that, together with genetically evolved mechanisms, solve adaptive problems and thus help to explain human behavioral diversity across populations (Laland and Brown 2011, pp. 139 ff.).

Cultural evolution research, especially in its macro variant, bears some resemblance to the sociology of social change, dealing with the same phenomena to be explained (e.g., institutions and social structures). What distinguishes cultural evolution approaches from cultural sociology is their explicit evolutionary and adaptationist framing, marking an important step in applying evolutionary theory to cultural development (Richerson and Boyd 2005; Richerson et al. 2016). In this tradition, the concept of multilevel or group selection was given a new relevance, meaning that “competition” between cultural units (e.g., statelike collectives) plays a major role in cultural change (Richerson et al. 2016). Richerson and Boyd (2005) define culture as “information capable of affecting individuals’ behavior that they acquire from other members of their species through teaching, imitation and other forms of social transmission.” Thus, informational units serve as analogues to genes in genetic evolution: “Much like genes, many elements of culture (for example, technology, language and religion) appear to change through descent with modification, and in many cases, genetic and cultural evolution interact in both developmental and evolutionary time” (Brewer et al. 2017, p. 1).

The gene analogy in cultural evolution is most explicitly developed in the field of memetics, which was popularized by Richard Dawkins (2006). Here, the “meme” is brought into play as the smallest unit of information, a unit that is subject to processes similar to genetic evolution—variation and selection—that drive cultural change (Dawkins 2006). For a variety of reasons, memetics has not yet evolved into a rigorous research program (Laland and Brown 2011, p. 141). One crucial reason may be the difficulty in empirically delimiting the concept of meme with sufficient precision (Aunger 2007). However, the broader idea of cultural evolution underlying memetics, that cultural change follows Darwinian laws, has been successful to date and has been pursued within the framework of a quantitatively oriented theory of cultural evolution inspired by population genetics (Laland and Brown 2011, pp. 139 ff.).

Dual-inheritance theory, also known as “gene–culture coevolution,” is a variant of cultural evolution approaches and focuses on how genes and the cultural environment co-influence each other over time. That is, variation in human traits is conceptualized as the result of social and genetic inheritance mechanisms with an assumed bidirectional relationship between the two types of inheritance. In the course of their codetermination, both gene frequencies in a population and the distribution of certain cultural variants change. In contrast to other evolutionary fields that deal with human behavior, dual-inheritance theory is unique in that it neither looks solely at an autonomous cultural system that is examined without reference to biological evolution nor does it focus on biological evolution without taking socio-cultural context into account. An example of application of dual-inheritance theory is the relationship between the historical emergence of dairy farming and the spread of genes for lactose tolerance (Brown et al. 2011, p. 317).

While cultural evolution approaches focus on culture, they are not exclusive in this among the disciplines that emerged from sociobiology. In behavioral ecology, culture is viewed as a flexible system for creating adaptive behaviors in various ecological niches (Laland and Brown 2011). However, behavioral ecologists often treat the mechanisms of local adaptations as black boxes (cf. Schnettler 2016), whereas cultural evolution scholars aim to explicate these links. Evolutionary psychologists distinguish between “universal,” “evoked,” and “epidemiological” culture. Here, “universal” culture includes traits shared by all human populations. “Evoked” culture arises from local environmental conditions, producing adaptive fits. This is a key area of empirical work in evolutionary psychology, focusing on how different environmental cues lead to various behavioral outcomes. “Epidemiological” culture, resulting from social or cultural transmission, falls beyond the scope of evolutionary psychology (Brown et al. 2011). This distinction illustrates that although the three distinct fields have somewhat different foci in their research on culture, they are not at odds with each other.

With regard to other explananda, the situation is similar. Therefore, scholars have recently emphasized the potential of integration of these different fields—evolutionary psychology, behavioral ecology, and cultural evolution approaches—into one *unified evolutionary behavioral science*. After all, the differences in these approaches are mostly in focus and methodology rather than in their core premises. Methodologically, behavioral ecology derives hypotheses about behavior from formal models based on fundamental evolutionary principles and tests empirically whether behavior can be considered fitness-maximizing in the respective context. In evolutionary psychology, hypotheses about the structure of psychological mechanisms are derived from assumptions about the EEA, which are then tested in laboratory experiments and with survey data. In cultural evolution research, models of evolutionary game theory are used and applied in complex simulation studies (agent-based modeling). Empirical research is conducted in still existing indigenous groups and social formations who live in conditions somewhat similar to those in the late Paleolithic and Neolithic periods (Huinink and Schnettler

2024). Thus, overall, the different approaches may be seen not only as compatible but even as complementary.¹

2.4 Hormones, Neurons, Genes, and Other Proximate Factors

Independent of the developments surrounding the sociobiology debate and the potential emergence of a unified evolutionary behavioral science, various scientific fields have emerged to study the proximate mechanisms of human behavioral variation. These include behavioral (epi)genetics, behavioral endocrinology, and various branches of neuroscience. These fields are relevant to sociology not merely because they also address behavior. If they only provided the physiological backbone of sociological phenomena, sociologists could largely ignore this research. However, as we will explore later, nature and nurture intricately interact through hormones, neurons, genes, and epigenetic regulation, making these fields potentially significant for sociology. Moreover, as we will see in the next section, sociology has already drawn on these areas, leading to the emergence of new sociological subfields.

Behavioral genetics, which emerged in the 1960s, focuses on the genetic basis of behavior and originates from two research traditions: quantitative and molecular genetics (Lundborg and Stenberg 2010; Plomin et al. 2013). Quantitative geneticists aim to determine the proportion of trait variation attributable to genetic variation (heritability) versus environmental variation. Traditionally, they used classical twin designs, comparing monozygotic twins (sharing 100% of genes) with dizygotic twins (sharing 50% of genes) to decompose trait variation into genetic and environmental influences—assuming shared environments. Extended twin family designs, which include comparisons to other siblings, have also been used (Keller et al. 2010; see also Diewald, this issue). The principle remains the same: to use information about genetic relatedness for partitioning variation into genetic and environmental components. A key finding from quantitative genetics is that many cognitive, behavioral, and physiological traits have considerable heritability. A meta-analysis of over 17,000 traits found an average heritability of nearly 50% (Polderman et al. 2015).

Molecular geneticists use candidate-gene studies to identify specific genetic variants associated with (behavioral) traits. However, candidate-gene studies have identified few significant genetic influences on complex traits, leading to the “missing heritability” problem. This is due to the polygenic nature of traits (multiple genes contribute to a phenotype) and pleiotropy (one gene affects multiple traits; Plomin et al. 2013, pp. 62, 66). Since the early 2000s, genome-wide association studies (GWAS) have increasingly gained traction. They scan the complete genome for gene associations with particular phenotypes (Yang et al. 2011); GWAS are highly powered, now often including samples of several million individuals, and thus allow to capture even small statistical associations between genes and phenotypic traits

¹ According to Brown et al. (2011), a few “nontrivial points of contention” remain between the approaches. “For instance, researchers disagree on the extent and the nature of evolved psychological mechanisms, differ in their willingness to accept a role of genetic variation in behavioral diversity, and diverge in their acceptance of socially transmitted information as a key component of the evolutionary process” (Laland and Brown 2011, pp. 321 f.).

(Polderman et al. 2015). The associations of all genes relevant for a particular trait can be added up and summarized in so-called polygenic (risk) scores (PGS). They roughly indicate an individual's genetic "propensity" for a trait and can be used as variables in statistical analyses (Mills 2022).

Additionally, *epigenetics*, as an area of biomedical research, explores the mechanisms by which genes are regulated, that is, "how the activity of producing proteins is controlled" (Landecker and Panofsky 2013, p. 333). Genes themselves do not "do" anything, as Diewald pointedly states. Rather, it is the mechanisms of gene expression that turn genes on or off, or regulate them up or down. These regulatory mechanisms, which are not fixed as genes are, are affected by environmental influences. Thus, the epigenome, which is a collection of chemical changes to an organism's DNA and proteins that affect gene expression, mediates the association between genes and the environment (Diewald et al. 2024). This mediation, as well as the inheritance of environmentally induced epigenetic effects without altering the DNA code, makes epigenetics, too, potentially relevant to sociology (Landecker and Panofsky 2013; Walsh 2014).

The brain and endocrine system are more directly upstream of behavior than genes are. At the same time, genes are involved in brain development and in the design of the endocrine system, such as in affecting the number of hormone receptors. Genetic effects on brain development may thus be greater than those on behavior (Plomin et al. 2013: p. 156). The *neurosciences*, which focus on the brain, encompass a range of scientific fields, including affective, behavioral, cognitive, and social neuroscience (von Scheve 2011). Behavioral and cognitive neuroscience focus on behaviorally or psychologically relevant phenomena (Thompson 2001). Social neuroscience combines a neuroscientific with a psychological perspective (Kalkhoff et al. 2016). In these fields, imaging techniques play a crucial role for tracing neural correlates of psychological processes or behavior, assigning functions to specific brain areas, and comparing brain activity in individuals with and without brain damage. For instance, significant differences in brain activity between aggressive and nonaggressive individuals have been observed, with different brain areas implicated in the development of aggression (Schnettler and Nelson 2015). Additionally, neuroscientific methods also include the measurement of neurotransmitters and other neuroactive messengers. With regard to aggression, as an example, this would involve research on neurotransmitters that promote or inhibit aggression (Wahl 2009). A highly topical field of research is concerned with the neurological foundations of perception and action. Stanislas Dehaene called the brain a "superb Bayesian machine" (2013). A promising conceptualization of a Bayesian predictive brain model, i.e., the "active inference model," has been developed by Karl Friston (2009; see also Parr et al. 2022 and Cheadle et al. in this issue).

When it comes to measuring neurotransmitters, behavioral neuroscience overlaps with *behavioral endocrinology*, which investigates the relationship between hormonal processes and behavior. Although early insights into hormonal relationships date back to Aristotle, modern behavioral endocrinology emerged as a distinct field in the mid-twentieth century. Hormones are chemical messengers produced in various glands and transported through the blood to interact with receptors in different parts of the body, activating genetic or nongenetic cellular processes (Nelson 2011).

There are two types of hormonal processes: organizational and activational. Organizational processes involve hormone exposure in utero and at specific developmental stages in early childhood and adolescence, which can have lasting impacts on brain development and influence life-course strategies. Activational processes involve hormones circulating in the blood that modulate behavior based on cues about the social and physical environments (Arnold and Breedlove 1985; Del Giudice and Belsky 2011; Del Giudice et al. 2009). While circulating hormone concentrations are now inexpensive to measure, they are primarily used in small experimental and clinical studies due to the difficulty of obtaining reliable measurements in surveys, given daily, monthly, and seasonal fluctuations in hormone levels (Taylor 2012). Given the difficulty of direct measurement of hormone concentrations in utero, researchers, in order to gain insight into organizational hormonal effects, have also resorted to indirect measures that are thought to proxy hormone exposure in utero and to be stable across the life course (Breedlove 2010).

3 Bio/Evo Thinking in Sociology

Against this background on the variety of scientific approaches dealing with human behavior outside of sociology, we want to ask to what degree sociology has drawn on bio/evo explanations and has been influenced by these fields to date. Scholars within and outside of the discipline have amply complained about sociology's widespread ignorance of and oftentimes open disdain for bio/evo approaches to human behavior (e.g., Barkow 2006; Ellis 1996; Lopreato and Crippen 1999), and much has already been written about this topic. Therefore, we give only a brief overview of the history of bio/evo thinking in sociology in Sect. 3.1. Instead, in Sect. 3.2, we will focus more on recent advances in sociology and the current variety of sociological and interdisciplinary work involving sociologists that integrates bio/evo concepts. The contributions to this issue are good examples of these research activities, and in Sect. 4 we provide brief introductions to each of them.

3.1 Two Failed Revolutions? On the History of Bio/Evo Thinking in Sociology

Early sociologists such as Marx, Spencer, and Sumner used evolutionary concepts in their theories about human behavior and selectively applied Darwin's ideas to the phenomenon of sociocultural evolution (Baldus 2002; Degler 1991). But the application of evolutionary concepts was mostly limited to organismic analogies, followed an overly simplistic functional logic, and was characterized by a teleological orientation toward societal progress (cf. Baldus 2002, p. 317; Turner and Machalek 2018, p. 73 ff.; Pries 2021). Almost ironically, early proponents of a theory of social evolution, such as Spencer, contributed to discrediting and alienating evolutionary research in sociology with their crude interpretation of Darwinian evolutionary theory. This later led to an ignorance of biological and evolutionary theoretical approaches, criticized by representatives both within and outside the field (e.g., Barkow 2006; Ellis 1996), fueled by the still prevalent suspicion that these approaches could justify

social Darwinist thinking, which in the past had promoted inhumane ideologies and criminal and genocidal sociopolitical practices (Marshall 2018, p. 38 ff.).

Philosopher and sociologist Herbert Spencer (1820–1903) was a contemporary of Charles Darwin and, like him, was exposed to a variety of evolutionary theories, even before the publication of Darwin's "Origin of Species." Later, Spencer adapted Darwin's concepts of nature and applied them to human society, asserting with the term "survival of the fittest" a progression from "lower" to "higher" and more complex stages of existence (Spencer 1864, p. 444). This gave reason for many misinterpretations and in fact does not correctly capture the level of sophistication of Darwin's theory, as it was reduced to the issue of competition (cf. Huinink and Schnettler 2024). Spencer proposed a microfounded approach explaining social change as a sequence of stages in social development and social order. The survival of the fittest was perceived as a "natural process" not to be tampered with and served as a justification of an unequal social order. Even more radically than Spencer, Sumner and Galton proposed a view of social development supporting the rise of eugenics and racist thinking (Baldus 2017, p. 53 ff.). This way of thinking later became associated with the term "social Darwinism"—although, given the misinterpretation of Darwinian evolutionary principles in Spencer's theory, "social Spencerism" might be a more appropriate term (Delaney 2009; Gondermann 2007)—and has since served as a signifier to sociologists of the risks of applying bio/evo thinking to human behavior and society.

Other classical sociologists also referred to Darwinian evolutionary principles. This can be illustrated with reference to theories about social inequality (cf. Huinink and Schnettler 2024). Whereas Spencer viewed social inequality as a just reward for the performance of competing individuals, essential for the common good and as a necessary element of social structures, American anthropologist Lewis Morgan, who was also influenced by Darwin's ideas, shared a more critical view of the societal development toward more inequality and warned of increasingly unequal and uncontrollable property and power relations (Morgan 1877, p. 561). This perspective influenced Karl Marx's and Friedrich Engels's ideas on the origins of social inequalities (Marx and Engels 1962 [1892]). Engels later adapted Morgan's stage model of societal development and developed his own version of a theory of social change, with an emphasis on the role of the division of labor and surplus production in agricultural and industrial societies and a focus on the formation of antagonistic social classes (Baldus 2017, p. 62; Marx and Engels 1962, p. 160 f.). It is not without irony that Marx and Engels, who welcomed the replacement of theological teleology by Darwinian evolution, replaced it with their own teleological story of social change in which capitalism was to inevitably be replaced by socialism (Skordoulis 2019).

A major contribution to evolutionary thinking in sociology can be attributed to Finnish sociologist Edward Westermarck (1862–1939), whom Segerstråle (2016) describes as the first sociologist who introduced Darwinian reasoning into the field (Segerstråle 2016, p. 85). This is seconded by Hopcroft and Schnettler (2024), who state that Westermarck among early sociologists most comprehensively integrated bio/evo concepts into his sociological work, and thus they consider him the intellectual originator of evolutionary sociology and biosociology. What makes his contribution different from those of other classical sociologists is that Westermarck

did not just apply analogies from genetic evolution to social change. Instead, he more directly referred to genetic evolution and interactions between genetically evolved traits and social contexts. This is the case, for instance, in his work on incest avoidance, best known today as the “Westermarck effect,” which states that children who grow up together generally do not find each other sexually attractive as adults (Tanskanen and Danielsbacka 2018, p. 25). Also, in his work “The Origin and Development of the Moral Ideas,” he applied an evolutionary perspective in his explanation of human morality. Particularly, he emphasized the biological basis of emotions that he saw as influencing moral ideas and judgments and the interaction between evolved predispositions and social contexts (Hopcroft and Schnettler 2024; Westermarck 1906).

In the late 1920s, however, Westermarck’s prominence in sociology began to wane (Hopcroft and Schnettler 2024), and during much of the twentieth century, bio/evo approaches hardly played a role in sociology (Degler 1991; Schnettler 2016). One frequently cited reason is the growing influence of Emile Durkheim’s foundational appeal for sociology to explain social facts through social facts, despite Durkheim himself being influenced by evolutionary writings of his time (Degler 1991; Runciman 2008; Udry 1995, p. 1267). Although Durkheim did not follow an explicitly evolutionary argument, his theory of the social division of labor adhered to Spencer’s organismic understanding of society and differentiation thesis (Durkheim 1996 [1893]). Besides Durkheim’s assignment of sociology in the disciplinary division of labor, and the fears of negative repercussions of social Spencerism, it was also that biology seemed to have become superfluous. Sociology was heavily influenced by culturalist and social constructivist perspectives with their focus on cultural variation, which left little room for the idea of universal behavioral mechanisms (cf. Degler 1991; Schnettler 2010). Taken together, these developments may have contributed their share to the marginalization of biological and evolutionary explanations in sociology for much of the twentieth century (Degler 1991; Hopcroft and Schnettler 2024).

Evolutionary principles continued to play a role in sociology largely with regard to societal evolution and sociocultural change, that is, where biological mechanisms resulting from genetic evolution or the interaction between genetic and social processes do not figure in (cf. Niedenzu 2024). In this sense, evolutionary considerations play a role, for instance, in the system-functionalist theory of Talcott Parsons, with his concept of evolutionary universals (Parsons 1964, p. 341 f.; Wenzel 1998). Later, Niklas Luhmann, as part of his system theory of society, presented a nonteleological evolutionary theory of social change that—in analogy to genetic evolution—is driven by processes such as variation, selection, and recombination. Yet these processes are to be understood on the level of communication rather than the level of genes, and together are taken to explain the increasing degree of complexity in the development toward modern societies (Luhmann 1998). Inspired by the emergence of sociobiology in the 1970s, Bernhard Giesen in Germany explored the potential of sociobiology for sociological theory (Giesen 1981; Giesen and Lau 1981). Like others before him, but without a lengthy tribute to earlier sociological attempts at social evolution (Holzer 1981), he applied concepts analogous to genetic evolution to cultural and social evolution (Giesen 1980). Yet, according to Holzer (1981), this

attempt remained largely unfinished and did not get beyond new terminology for longstanding problems.

Beyond applications of evolutionary theory to sociocultural change, the emergence of sociobiology in the 1970s also led to a renewed sociological engagement with the role of biology for sociology, albeit in most cases a short-lived one, and, as an exchange in “The American Sociologist” signifies, from the beginning also a very controversial one (cf. Wiegele 2019 [1982]). Ellis (1996) predicted the decline of sociology if it did not incorporate the program of sociobiology. Although some fellow sociologists shared the openness to incorporate biological explanations to human behavior expressed therein, they questioned Ellis’s bleak prediction about the discipline’s future, his too strong version of scientific reductionism, and his exaggerated optimism about the promises of sociobiology, including the assessment of the state of empirical evidence to its core propositions (Kunkel 1977; Lenski 1977; Mazur 1977; see also Barash 1977 for an outside view by a biologist and psychologist). Other sociologists outright rejected sociobiology more generally or were agnostic toward its use for sociology (Eckberg 1977; Homans 1977). Some even reciprocated Ellis by predicting the imminent “decline and fall of sociobiology” (Clawson et al. 1977).

Among the few sociologists who systematically and continuously applied sociobiological concepts in their work was U.S. sociologist Pierre van den Berghe (1979). He applied sociobiological concepts to explain the forms and variations of human families as well as ethnic groups in different types of societies (Van den Berghe 1979, 1981). With the advent of sociobiology, Van den Berghe also endeavored to reevaluate the work of Westermarck, noting that in his classic “The History of Human Marriage,” Westermarck presented an almost modern version of parental investment theory (cf. Hopcroft and Schnettler 2024). Other U.S. sociologists have also consistently utilized bio/evo concepts for decades, such as Allan Mazur, who investigated the relationship between hormones and behavior. Early on he proposed that in face-to-face encounters, physiological mechanisms such as changes in hormone concentrations would likely also play a role in humans (Mazur 1983). In subsequent years, he pursued a research program in “biosociology,” empirically examining the role of testosterone in social behavior, particularly in competitive behavior (for summaries see Booth et al. 2006; Mazur 2017). In Germany, Peter Meyer began in the 1970s to apply bio/evo concepts in his sociology of violence and war and continuously worked toward a biosociological synthesis (Reimann et al. 1977; Meyer 1981, 1982, 2000, 2010, 2011).

For other sociologists, their engagement with sociobiology was a brief exception to their otherwise biology-free work (e.g., Hettlage 1984). And despite pleas by some scholars for sociology to incorporate ideas from sociobiology, and despite the occasional examples of constructive engagement with the new field, sociology largely remained stubbornly resistant to any incorporation of biology, a tendency that was later dubbed sociology’s “biophobia” and strongly criticized by fellow sociologists who advocated for a stronger interdisciplinary engagement (Ellis 1996; Lopreato and Crippen 1999; Van den Berghe 1990). However, for some time, these pleas were in vain: By the 1990s, biology had largely disappeared from sociology (Machalek and Martin 2004). A few exceptions can be mentioned. In Germany,

Hartmut Esser, in his introductory handbook to sociology, devoted considerable attention to the anthropological foundations of human behavior, referencing a—for that time—surprisingly broad range of bio/evo subfields (Esser 1993). And in the 1980s, another German sociologist, Michael Schmid, outlined an evolution-based approach to social change that followed the principle of methodological individualism and aimed to integrate a model of “structural selection” with an action-theoretic underpinning (Schmid 1982, pp. 210 ff.). But apart from these exceptions, evolutionary approaches and sociobiology for many scholars in sociology merely served as a negative foil with the primary aim of sociology’s self-assertion (Richter 2005; Scherger 2008). Hopcroft and Schnettler (2024) thus conclude in saying that attempts to make biological and evolutionary concepts useful for sociology failed twice in the twentieth century, each time immediately following significant turning points in the biology of human behavior: in the decades after Darwin’s “Origin of Species” and in the years following Wilson’s “Sociobiology.”

3.2 Current Bio/Evo Approaches in Sociology

Even though the sociobiology movement had not left a lasting mark on sociology, a small circle of evolutionary sociologists continued to write programmatic statements calling for increased notice of bio/evo concepts in sociology throughout the 1990s and early 2000s in the United States, and warning of a potentially waning relevance of sociology as a scientific discipline if scholars failed to follow this call (Crippen 1994; Ellis 1996; Van den Berghe 1990). In the early 2000s, bio/evo approaches seemed to again enter the stage more prominently in sociology, potentially inspired by advances in sequencing the human genome and discovering the genetic correlates of many (social) behaviors (Hopcroft and Schnettler 2024, p. 66).

A milestone in American sociology was a widely cited article by Freese et al. (2003) that appeared in the prestigious “Annual Review of Sociology” and advocated for a stronger inclusion of biology in the discipline (Hopcroft and Schnettler 2024, p. 66f.), while taking into account a broader variety of bio/evo approaches than just sociobiology, including evolutionary psychology, neuroscientific, and behavioral genetics approaches (Freese et al. 2003). The publication of this article roughly coincided with a number of other developments in U.S. sociology that signified a slowly increasing engagement with bio/evo concepts, going beyond a limited or even biased version of sociobiology and in an increasingly constructive way: In 2001, then-president of the American Sociological Association (ASA) Doug Massey pleaded for a stronger inclusion of biological explanations in the discipline in his opening speech (Massey 2002; see also Massey 2000). Originating from a small group of evolutionary sociologists (e.g., Crippen and Machalek 2014; Dietz et al. 1990; Machalek and Martin 2004; Maryanski 2006), the “Evolution, Biology, and Society” section of the ASA was founded in 2004 (Schnettler 2016, p. 516). Special issues in two of the field’s three leading journals, “Social Forces” and “American Journal of Sociology” (Bearman 2008; Guo 2006), as well as pertinent articles in prestigious sociology journals were published, exploring the potential of genetic, epigenetic, and hormonal explanations for sociological research (Freese and Shostak

2009; Guo et al. 2008; Landecker and Panofsky 2013; Morning 2014; Udry 2000, 2001).

A similar development could be observed in German-language sociology, albeit delayed by a few years (Schnettler 2016). Since around the 2000s, more and more programmatic contributions have been published that engage with a bio/evo foundation of sociology and, like Freese et al., 2003, consider a broader diversity of biological approaches than previous accounts, which often focused on a limited and strongly stylized version of sociobiology (e.g., Baldus 2002, 2018; Gilgenmann and Schweitzer 2006; Mayntz 2006). Additionally, more and more introductory textbooks covering a variety of sociological subfields started to include at least one chapter on bio/evo approaches relevant to the respective subject (e.g., Hank and Kreyenfeld 2015; Hill and Kopp 2013, 2015; Hurrelmann et al. 2015; Melzer et al. 2014; Schnettler 2016; Steinbach 2015). Although the developments in German-language sociology have not resulted in the emergence of a new section like the ASA section of “Evolution, Biology, and Society,” bio/evo research was debated at two thematically relevant conferences of the Austrian and German Sociology Associations in 1995 and 2006, respectively (Meleghy et al. 1997; Rehberg 2008), and repeatedly in thematic sessions on evolutionary sociology and sociogenomics at multiple occasions during the biannual congress of sociology in Germany (Schnettler 2016).

Overall, it seems fair to say that insight into the potential relevance of bio/evo approaches has made its way into the sociological mainstream (Hopcroft and Schnettler 2024; cf. Schnettler 2016), even though there are signs that the new embrace of bio/evo concepts is not shared unanimously by all parts of the field, as the acceptance seems to fall within well-known factions of the field (cf. Volland and Meißelbach 2021) and as it still invites criticism from inside the discipline (Bartram et al. 2024; Bliss 2018). In the following, we want to provide readers with an overview of the variety of sociological research that is part of this new wave of engagement with bio/evo research. Sociologists have built on a number of approaches outside of sociology, and in part, new sociological and interdisciplinary subfields have emerged, building on these.

Roughly following the ultimate/proximate distinction introduced earlier, there are approaches in sociology that use concepts from sociobiology, evolutionary psychology, behavioral ecology, and cultural evolution research, all of which follow an ultimate perspective on evolutionary principles and questions about adaptation and function. According to Hopcroft and Schnettler (2024, p. 60), these are best subsumed under the term “evolutionary sociology.” Other approaches, which focus more on the proximate—that is, hormonal, genetic, epigenetic, neurophysiological, and other physiological pathways—can be subsumed under the term “biosociology.” The latter has in recent years become further differentiated into “social science genomics,” or “sociogenomics,” which arguably is the most institutionalized new bio/evo subfield in sociology, and “neurosociology,” as well as work on hormones and other biomarkers and their relation to health, social context, and social behavior (Hopcroft and Schnettler 2024; Schnettler 2016).

3.2.1 *Evolutionary Sociology*

Sociological contributions that can be roughly subsumed under the term “evolutionary sociology,” as defined earlier, include both theoretical and empirical accounts. On the one hand, we have a small set of authors who contribute to theory building, with an explicit focus on integrating concepts from evolutionary theory into sociological theory. On the other hand, we see a theoretical and empirical engagement with evolutionary concepts in special sociologies. This type of engagement can be characterized by an import of concepts from sociobiology, behavioral ecology, and evolutionary psychology, and the empirical testing of hypotheses derived from basic propositions of these approaches in modern societies.

Overarching Theoretical Perspectives. Contemporary theoretical approaches in evolutionary sociology provide a solid basis for studying the emergence and change of social structures and cultures among humans over the last millions of years, extending to the present day and beyond. These approaches take into account the evolutionary heritage of humanity’s predecessors and the role of biological evolution in changing environments. However, they emphasize that understanding sociocultural evolution in all its diversity requires essential extensions and modifications, as sociocultural evolution is in various ways different from biological evolution.

One strand of evolutionary theory in sociology challenges the prevailing view in biological evolutionary research that selection processes occur solely at the genetic level, as most biologists, including Dawkins, claim (Ågren 2021). This perspective is argued to be far too restrictive for sociological research. Instead, it is proposed that the study of human societies must also consider selection processes involving other kinds of replicators, such as attributes of social structures and cultural systems, as well as higher level units, including social groups and larger social entities. To some extent, this argument aligns with the cultural evolutionary approach (Sect. 2.3) and other proponents of group or multilevel selection among evolutionary biologists (Wilson and Wilson 2008), but sociologists have introduced more sophisticated concepts of selection levels beyond genes.

A prominent example is the theory of Jonathan Turner and Alexandra Maryanski, who present perhaps the most comprehensive approach to evolutionary sociology in their extensive body of work, which includes numerous articles, books, and edited volumes (e.g., Turner 2003; Turner and Maryanski 2008; Turner and Machalek 2018; Abrutyn and Turner 2021; Maryanski and Turner, this issue). They explicitly connect to biological evolution by introducing cladistic (comparative) analyses to study the development of humans and their sociality in comparison to other primates (Maryanski) and by developing a theory of the development of human emotions and the brain (Turner). However, in contrast to biological theories, Turner and colleagues propose a differentiated hierarchy of “levels of selection,” starting from the genotype and human bodies but including several supraindividual levels of social units (social groups, organizations), institutions, and, finally, societies as part of an intersocietal system (Turner and Machalek 2018, p. 253; for an interesting specification, see also Hodgson and Knudsen 2010, pp. 170 ff.). Turner demonstrates how

selection pressures can and do occur at these levels, leading to sociocultural and institutional change due to the necessity of minimizing the risk of a social system collapsing (“dying”) from unsolved problems in the core dimensions of production, reproduction, distribution, and regulation.

The British sociologist Walter Runciman (2009), in his attempt to “reconstruct” the “agenda of a comparative sociology” by introducing an evolutionary perspective, also proposed supraindividual levels of selection. However, as compared to Turner, Runciman distinguishes among natural, cultural, and social selection, which he assumes correspond to different kinds of behavior: the “natural” level corresponds to “evoked,” that is, direct instinctive behavior; the cultural level to “acquired,” that is, imitation or learned behavior; and the social level to “imposed,” that is, role-related or institutionally induced behavior (Runciman 2009, p. 8). He cites analytical and historical reasons for the distinction between social and cultural selection, arguing that the former, in comparison to the latter, refers only to formalized, institutionalized interpersonal relationships, such as a formal superior–subordinate relationship, that emerged much later in human history than culture did. However, all three kinds of selection are interdependent in a complementary but also competitive manner.

A second strand of evolutionary theories in sociology primarily addresses what, from a sociological perspective, is diagnosed as another problem of sociobiology and neo-Darwinian approaches. Proponents of this strand argue that individual agency, creativity, and behavioral flexibility—which humans are particularly capable of—play a much more decisive role in sociocultural evolution than is accounted for in nonsociological approaches. This is related to the insight that evolution is a highly contingent, context dependent, and nonlinear process in both biology and the social sphere. This perspective also explains the extremely wide variety of social structures and cultural patterns observed throughout history.

One representative of such an approach is Bernd Baldus (this issue; see Sect. 4 for more details). Human agency, itself a result of human evolution, enables people to act intentionally and intervene purposefully in natural and social processes. In his evolutionary approach to the analysis of social change, Baldus introduces “internal selection” as another type of selection, in addition to the genetic level, that is largely independent of the genetic one. This internal selection is based on experiences, cognition, and the mental exploration of opportunities through rational reasoning (inner action) or trial and error. Within the context of a complex, multilevel model of evolutionary processes, this can be seen as another mental inner-individual level of selection. There is a strong emphasis on a microfoundation of sociocultural processes comparable to the principle of methodological individualism.

While approaches from these two strands of evolutionary theory in sociology overlap in many fundamental aspects, they can be distinguished according to the theoretical traditions of sociological theory. They all follow a multilevel approach to selection processes, but the first group adheres to what might be called a postfunctionalist concept, whereas the second group more explicitly follows the approach of methodological individualism. This second group bases its theories either on versions of a rational-choice model or on the tradition of interpretative microsociology. The latter, for instance, is followed by German sociologist Ludger Pries, who recently offered a more elaborated micro-based approach that integrates evolutionary

and interpretative sociological concepts with the intention of explaining current and future social change in the era of the Anthropocene, based on a broad reception of the literature (Pries 2021, 2022). A recent attempt to provide a theoretical foundation for the evolutionary study of social and “ideational” change has been published by the Chinese biologist and social scientist Shiping Tang (2020). In his book, Tang, who emphasizes both perspectives, offers a comprehensive and largely critical overview of previous foundations of evolutionary sociology in the literature, one that is based on a system-theoretic model of societies. He highlights the influence of social power and social inequality on selection processes in social evolution as a particularly relevant aspect (cf. Abrutyn and Turner 2021). Tang, like other authors, argues that this can lead to maladaptations or mismatches detrimental to the social system in the medium and long term because they might only serve short-term particular interests at the expense of a society’s overall ability to reproduce (cf. Baldus 2017; Huinink and Schnettler 2024).

All recent contributions to evolutionary sociology agree that an interdisciplinary agenda is required (cf. Maryanski and Turner, Baldus, this issue). This is confirmed by the evolutionary sociologist Marion Blute, who demonstrates in her book on “sociocultural evolution” how considering evolutionary theories helps to resolve “dilemmas” she identified in cultural and social theories. Among others, she addresses the relationship between history and necessity, between conflict and cooperation, and between “micro versus macro issues” as unresolved problems of sociological research (Blute 2010, pp. 17 ff.). For each “dilemma”, she shows how (biological) evolutionary concepts can contribute to social science approaches, leading to a better understanding. Consequently, she calls for an integrated social science connected by a common evolutionary perspective and a common methodology based on that perspective.

Testing Evolutionary Hypotheses in Special Sociologies. Sociologists have also applied concepts from evolutionary behavioral science to a number of middle-range domains and have tried to integrate sociological and evolutionary perspectives, such as in studies on social capital (Meißelbach 2019) and the phenomenon of love (Müller-Schneider 2019). Arguably, the most developed evolutionary perspective is in family sociology, particularly Finnish family sociology, where scholars have worked toward establishing an evolutionary family sociology (Rotkirch 2018; see also Tanskanen and Danielsbacka 2018). Building on earlier bio/evo work on family-sociological issues by Westermarck and van den Berghe, the new evolutionary family sociology seeks to place the study of human families in the context of broader between-species comparisons and within the long history of hominid evolution. It complements traditional nonevolutionary sociology with concepts from the evolutionary behavioral sciences and tests whether predictions derived from them hold in modern developed societies.

For instance, family scholars have tested how well predictions from inclusive fitness theory predict relationship quality in adoptive families, biological families, and stepfamilies (Hamilton et al. 2007; Schnettler and Steinbach 2011). Building on the same concept, researchers have studied patterns of grandparental investment (Tan-

skanen et al. 2020). When this is coupled with the concept of paternity uncertainty from evolutionary psychology, a clear gradient of grandparental investment is predicted that often matches empirical observations: Since men can, on average, be less certain about their paternity than mothers can, and considering the number of ties with paternity uncertainty between both the grandparent and parent and the parent and child generations, maternal grandmothers are predicted to show the highest degree of investment. They are followed by paternal grandmothers and maternal grandfathers, who are indistinguishable in terms of degrees of paternity uncertainty, and then paternal grandfathers (Coall and Hertwig 2010).

Drawing on the evolutionary psychological idea of specialized mental modules that evolved for certain adaptive tasks potentially expands this narrow focus on genetic relatedness and its relevance for social behavior. From this perspective, one could argue that a set of mechanisms has likely evolved that modulates a broad range of family-related behaviors, starting from mechanisms that increase the likelihood of having biological offspring at all—for instance, by means of sexual desire or the general desire to have children (cf. Foster 2000; Silk 1990)—to attachment mechanisms regulating the attendance to offspring needs (Bowlby 1997) and mechanisms enabling the reliable recognition of close genetic kin (Lieberman et al. 2007; Tal and Lieberman 2007). Sociologists have made few efforts so far to take such mechanisms into account, but there is some research in evolutionary family sociology on “baby fever” as a mechanism driving fertility intentions (Rotkirch 2007, 2012) and on co-residence duration during childhood as a mechanism for sibling recognition². This again leads back to Westermarck (1891), who proposed a role for co-residence in regulating incest avoidance. Empirical research, for instance, on children who grew up together in an Israeli kibbutz and on future spouses who grew up together as part of the Taiwanese “sim-pua” tradition, has shown, if indirectly, that co-residency during childhood lowers sexual attraction, thus lending some support for Westermarck’s proposition (e.g., Shepher 1971, 1983).

Other research in family sociology focuses on sex-biased parental and grandparental investment, particularly its interaction with parental socioeconomic status. This research is potentially also highly relevant to sociological inequality research, as it predicts that sons and daughters are “selected” into different social strata at birth with different probabilities and receive varying amounts of support at home. This prediction stems from the Trivers–Willard hypothesis in sociobiology. According to this hypothesis, it is evolutionarily advantageous for parents in good conditions to have male offspring and favor them with greater parental investment, while the opposite applies to parents in poorer conditions (Trivers and Willard 1973). This logic can also be extended to sex-biased grandparental investment (Coall and Hertwig 2010, p. 6). Drawing on research from the animal kingdom, where “condition” is defined as physiological (e.g., glucose or hormonal concentrations), it is argued that in human societies socioeconomic status is an appropriate indicator of “condition” (Schnettler 2017). However, while the preconditions formulated by Trivers and Willard (1973) for the hypothesis likely also apply in contemporary human societies, the research

² Outside of sociology, there is also some preliminary evidence that olfactory cues may play a role as a kin-detection mechanism that can bias human parental investment (Dubas et al. 2009).

findings on this are highly mixed (cf. Freese and Powell 2001; Schnettler 2010). Sociologists contributed to this field by providing nuanced operationalizations of parental socioeconomic status, large data sets, and sophisticated statistical designs, but they have not been able to settle the issue empirically (Huinink and Schnettler 2024; e.g., Hopcroft 2005; Kolk and Schnettler 2013, 2016; Schnettler 2013, this issue).

Overall, a difficulty of empirical approaches in evolutionary sociology, as in evolutionary behavioral science in general, is that deriving hypotheses from assumptions about some kind of prehistoric past must overlook a long, unobserved causal chain, especially since biological factors are likely heavily shaped by other social and cultural processes or interact with them (Huinink and Schnettler 2024; cf. Runciman 2009). So, for one, evolutionary hypotheses can often only provide heuristic orientation. They direct our research focus to previously unconsidered aspects of established phenomena or to entirely new but relevant social phenomena (Huinink and Schnettler 2024). Another difficulty is that sociology often focuses on a completely alternative set of explanations, but the current level of detail of our theories is too coarse to conclusively determine where the different perspectives complement each other or are potentially at odds with each other (cf. Coall and Hertwig 2010). For example, in the case of parent–child ties in stepfamilies and grandparental investment, sociological explanations focus on normative expectations and structural features such as household complexity, residential proximity, and relationship duration (see, e.g., Schnettler and Steinbach 2011, 2022). However, a closer focus on mechanisms may help resolve the at times apparent incommensurability of biological and sociological accounts. Genetic similarity, often highlighted as an important driver of social behaviors, influences behavior not in a deterministic way but through intermediate mechanisms. These mechanisms (e.g., duration of co-residence or length of exposure for parental attachment) are sometimes the same as those identified by sociologists (e.g., de Leeuw et al. *in press*; Schnettler and Steinbach 2011). Thus, isolating these mechanisms might be an important step toward integrating bio/evolutionary and sociological perspectives into an interdisciplinary theory. A clearer focus on mechanisms is also a future challenge for research on the Trivers–Willard hypothesis (cf. Kolk and Schnettler 2013).

3.2.2 *Biosociology*

Building on developments in the life sciences over the past decades, new approaches in sociology are focusing on (epi)genetic, hormonal, neurological, and other physiological processes that underlie human thinking, feeling, and acting (cf. Schnettler 2016). Recent research in all these areas shows that the old duality between “nature” and “nurture” is long considered outdated, as nature and nurture interact and work together in all areas (Huinink and Schnettler 2024). This is evidenced by gene–environment interactions, social influences on hormonal processes that in turn modulate social behavior, and social processes that “get under the skin,” leaving various traces in the body and explaining differences in health and life expectancy between social groups (e.g., Goosby et al. 2018; Guo 2006; Taylor 2014).

Arguably, the most visible biosociological field is “*sociogenomics*.” Although some sociologists had already thematized the relevance of behavior genetics for sociology (e.g., Eckland 1967; Freese et al. 2003; Shanahan et al. 2000) and used genetic data in their sociological analyses (e.g., Guo and Stearns 2002), sociogenomics as a new interdisciplinary research field emerged roughly over the last decade, combining social science with behavior genetics models and methods (Mills 2022). Especially in the field of stratification research, scholars have quickly jumped on the bandwagon and started to participate in this highly active field (e.g., Baier et al. 2022; Erola et al. 2023). Relevant traits that stratification researchers look at from a sociogenomic perspective include, for instance, educational attainment, cognitive performance, and household income (Mills 2022). The latest study on educational attainment, using data from just over 3 million individuals, identifies almost 4000 relevant gene regions, which together account for a heritability of 12% to 16% (Okbay et al. 2022).

The methodological innovations in behavioral genetics described in Sect. 2.5 spurred this development, particularly the advent of GWAS and PGS and the relative ease with which these can be integrated with standard quantitative social research routines (cf. Freese 2006; Guo 2005). Once a set of relevant genes for a specific phenotype of interest is established from a GWAS, this information can be used to calculate a PGS as a rough indicator of the additive genetic proclivity for a trait (Mills 2022). Polygenic scores are available for an increasing number of surveys commonly used by sociologists, including, for instance, the German Socioeconomic Panel, the Wisconsin Longitudinal Study, the U.S. Health and Retirement Study, and the U.S. National Longitudinal Study of Adolescent Health (AddHealth; Belsky et al. 2018; Koellinger et al. 2023). One result from stratification research based on AddHealth data illustrates the predictive significance of PGS. Only about 7.3% of respondents in the lowest decile of the corresponding PGS for educational attainment have a college degree, whereas the respective proportion is nearly 71% for the highest decile (Okbay et al. 2022, p. 440). The popularity of GWAS and PGS notwithstanding, twin designs continue to play an important role in sociogenomics research (Diewald et al. 2015; Mönkediek et al. 2019), and new, more complex family and twin designs play an increasingly important role because they may be a route to overcome weaknesses of the other approaches (cf. Turner et al. 2020).

Sociogenomics and stratification scholars emphasize the importance of taking genetic data into account by noting that social correlations are often biased by unobserved genetic influences (Diewald et al. 2015; Harden 2021). According to this argument, this is relevant even for sociologists who—in Durkheimian fashion—are purely interested in studying the effects of social facts on social facts: All they need to do—at the very least—is statistically control for potential genetic confounding (Diewald et al. 2015; Harden 2021). Burt (2023) warns, though, that GWAS and PGS are far from being a panacea for this kind of confounding problem. In fact, GWAS and PGS themselves can be confounded by environmental effects (cf. Bartram et al. 2024). This can be the case in cross-cultural comparisons if genetic differences correlate with cultural differences that are non-causally related. For example, a GWAS comparing individuals of diverse ancestry could yield significant genetic association with chopstick-eating skills, but this association would mostly

be due to random “variants that differed in frequency between East Asia and the rest of the world and had nothing to do with ‘genetic propensity’ for chopstick use skills” (Burt 2023, p. 9). Also, within families PGS can be confounded. To again use an example from stratification research, this can, for instance, be the case when genes that are advantageous for educational achievement are passed on simultaneously with a home environment beneficial for educational achievement (e.g., large number of books at home; Burt 2023). Researchers try to get a handle on these and related issues by combining PGS with more complex twin and family designs (e.g., Nivard et al. 2024).

Another important issue is that genetic associations can be artificial in the sense that they come about through some social selection mechanism that selects individuals based on traits that are genetically influenced (for example, skin pigmentation) into different environments relevant to social outcomes. Examples are past discrimination processes that abound in human history and may be relevant for a number of spurious genetic associations (Burt 2023). This speaks for care in using causal and deterministic language when reporting genetic associations from GWAS and PGS. Core proponents of the new approach are generally highly sensitive to these and related issues. They explicitly distance themselves from earlier abusive interpretations of supposed genetic differences between population segments that were sometimes used to naturalize and justify existing inequalities, and they debunk earlier misinterpretations of empirical observations, such as intelligence differences between demographic groups (Huinink and Schnettler 2024). But they also insist that full knowledge about the interaction of genetic and social causes of social inequality is necessary to inform the development of effective interventions and policies to reduce or eliminate inequalities and discrimination (cf. Harden 2021).

A challenge for future research will be to improve our understanding of the interplay of genes and environments. Genes and environments can interact and correlate for multiple reasons, both over human development and across time and place. For example, individuals are selected by others and select themselves into social contexts based on their genes, and social contexts can trigger genetic risks or protect from them (Diewald 2008; Guo et al. 2008; Plomin et al. 2013; Shanahan and Hofer 2005). Neither GWAS nor PGS yet contribute to solving this intricate puzzle, as they are focused on additive genetic effects (cf. Burt 2023). But scholars recently pointed out the need to pay attention to gene–environment–trait correlations to better account for the findings from GWAS (Avinun 2020). And more complex research designs and the explicit implementation of gene–environment interactions may in the future provide more insights into this complex interplay between nature and nurture (cf. Plomin et al. 2022).

Beyond just looking at genetics, *biosociologists* are also involved in research that takes into account neurophysiological, endocrinological, and other physiological processes, and especially their interactions with social processes. The brain and endocrine systems are more immediate to cognition, motivation, and behavior than genes are. Thus, they provide a more proximate window into the bidirectional interplay between nature and nurture and are thus in focus for their own sake (cf. Schnettler 2016). Also, as mentioned in Sect. 2.5, genetic associations with our neurophysiological and endocrinological architecture are likely much stronger than

for complex social traits (Plomin et al. 2013, p. 156), thus offering another possible future route for process tracing in sociogenomics research.

Besides sociogenomics, scholars have attempted to establish another subfield of biosociology dubbed *neurosociology*, even though sociology was late to the game after several disciplines had already experienced their neuroscientific turns, as evidenced by neuroscientifically informed research areas in anthropology, economics, law, and philosophy (von Scheve 2011). According to von Scheve (2011), TenHouten and Kaplan introduced the term “neurosociology” into the sociological discourse in 1973. But—for reasons similar to those concerning the overall reception of bio/evo research in sociology—it was not until about the 2000s that more and more publications using this label were published. Jonathan Turner and David Franks were very active in pushing neurosociology as a new subdiscipline, as some relevant publications under the new label indicate (Franks 2010, 2019; Franks and Turner 2013). Neurosociology is inspired by developments in the neurosciences and focuses on neurophysiological processes and their relevance to sociological questions, with a strong focus on emotions and also on sociological theory. Even earlier, in some areas of the neurosciences, scholars had done work on key sociological issues such as cooperation, norms, and intersubjectivity. Yet this research had neglected decades of relevant social science research, resulting in concepts that are similar but do not necessarily match the ones developed by sociology (von Scheve 2011). So, a more active role of sociology in these neuroscientific debates about questions of sociological relevance seems long overdue, but theoretical integration will require work on quite a level of detail.

Arguably, neurosociological work has not found its way into the sociological mainstream to the same degree as sociogenomics. Part of the reason for this may be that neuroscience methods (cf. Sect. 2.5) do not integrate well with the common workflow in quantitative empirical sociological research. Specifically, brain imaging techniques do not integrate like genetic indices with the main workhorse of quantitative social science: the social survey coupled with regression techniques to analyze it. Nevertheless, neurosociology scholars argue that the field holds the potential to validate and finetune sociological theories. By adding, one might say, a radical micro level to the common analytical toolbox of sociology oscillating between micro and macro analytical levels, neuroscientific data can be used to elucidate the neural underpinnings of well-established sociological phenomena and thereby help to confine and advance key sociological concepts such as the mind, the self, emotions, knowledge, basic mechanisms of human social behavior, etc. (cf. von Scheve 2011). In addition, neurophysiological measures can be used to validate findings from other sources, especially as these do not rely on subjective survey responses and are thus not subject to social desirability and other response biases (von Scheve 2011). An interesting finding in this regard is that although individuals with high socioeconomic status tend to report higher empathy in self-reports than individuals with lower socioeconomic status, this pattern is reversed when looking at neural indicators of empathy (Kwon et al. 2017, pp. 385–386). Finally, neurophysiological processes during human development link social context and behavior. This can be illustrated with examples from stratification research that indicate how status may affect neural process and how these in turn affect behavioral propensities (cf. Huinink and

Schnettler 2024): Studies point to differences in neural structures between people of different social statuses, and these differences emerge at an early age (Noble and Giebler 2020). An overview of neuroscientific findings on social inequality shows that the stress and uncertainty associated with low social status are linked to changes in various brain areas, which can ultimately affect the regulation of behavior (Davis 2013). An interesting finding in this context is the prediction that status can modulate the ratio of reflexive to more automated behaviors, which would, in turn, be relevant for the further development of sociological action theories (Huinink and Schnettler 2024).

Besides sociogenomics and neurosociology, additional biosociological research also considers hormonal and other physiological processes. Sociologists Alan Booth and Allan Mazur in the United States were pioneers in this branch of biosociology, studying the role of hormones in social behaviors at a time when such bio/evo research was largely ignored in sociology (e.g., Booth et al. 1989; Mazur 1976). Many early biosociological studies on *hormones and behavior* focused on the steroid hormone testosterone, sometimes in conjunction with the stress hormone cortisol, and how their concentrations correlated with status in sports competitions (cf. Booth et al. 2006). Overall, these studies showed associations of testosterone levels with aggressive, competitive, risky, and status-seeking behavior. However, reflecting on this period in a personal research memoir, Mazur (2017) noted that many of these early studies were underpowered and often purely correlational, limiting the potential for causal inference (cf. Mazur 2017). A similar assessment applies to studies on the associations between hormonal concentrations and health, family, and gendered behavior (e.g., Booth et al. 2000; Mazur and Michalek 1998; Udry 1994, 1995; Udry et al. 1995). The reaction to a paper by John Udry (2000) in the “American Sociological Review”, in which he argued for the role of hormones in gendered behavior and in limiting the extent of gender construction, illustrates the backlash that sociobiological research could provoke until very recently. The article received extraordinarily sharp criticism from within sociology, beyond just methodological criticism, particularly from feminist scholars, prompting the journal’s then-editor to defend, in writing, his decision to accept the article (cf. Ariansen 2021).

Overall, even today, sociological studies implementing hormonal measurements are still rare. This may have to do with the fact that they are less easy to integrate with social surveys, given the difficulty in obtaining reliable hormonal measures of activational hormone concentrations (see Sect. 2.5). Current research on hormones and behavior in sociology and adjacent fields, however, illustrates potential routes for future research: First, scholars have focused on indicators for organizational hormonal effects, which are easier to integrate with survey research but are limited in scope to early hormone exposure and its association with later-life outcomes (cf. Booker and Schnettler 2014, 2015). Second, longitudinal studies on testosterone and family behavior outside of sociology not only show how testosterone might modulate trade-offs between mating and reproduction over the life course but also illustrate what an empirically more rigorous implementation of hormonal measurements in family sociological studies could look like (Gettler et al. 2011). Third, a study by sociologist Catherine Taylor (2014) shows how hormonal measurements can be implemented in laboratory experiments to shed light on contextual effects on

hormone concentrations. Her study illustrates how gender composition in a group that was experimentally manipulated strengthened the stress response in males, but not females, in a competitive task.

Another significant area of biosociology, particularly relevant for stratification scholars, examines how persistent discrimination and inequality, as well as other social forces, can “get under the skin.” By incorporating *biomarkers for stress and inflammation* and studying specific segments of physiological causal pathways, this research demonstrates how large-scale health disparities between subpopulations, differentiated by class or skin color, result from the constant experience of discrimination and racism (e.g., Cheadle et al. 2020; Goosby et al. 2018). Goosby et al. (2018) summarize research on stress-related biosocial mechanisms of discrimination, illustrating how exposure to discrimination increases the physiological wear and tear on the body and elevates the risk for various morbidities. Using wearable sensors coupled with daily surveys, Cheadle et al. (2020) empirically trace racism-related stress reactivity in real time, showing that racism-related experiences predict a heightened stress response among college students, measured by increased electrodermal activity.

Landecker and Panofsky (2013) summarize *epigenetic research*, arguing that this research is highly relevant to sociologists because epigenetic changes “are environmentally mediated and can persist across the lifespan or into further generations.” In this way, social forces, or one might say social facts, become embodied at the molecular level, altering gene expression, and thereby affect behavior and health. For a long time, sociologists have not engaged in research on how social conditions affect epigenetic processes. However, as epigenetic markers have become increasingly embedded in social science surveys, these, like PGS in sociogenomics, can be easily implemented in standard quantitative research workflows using regression analysis. One example is that of markers serving as epigenetic clocks that measure whether a person’s biological age is higher or lower than their chronological age (Simons et al. 2021a). Two studies involving sociologists used the GrimAge instrument for this purpose and found how various adverse life conditions (e.g., low income, discrimination experience) can speed up biological aging (Simons et al. 2021a, b). But a focus on epigenetics is relevant not only to uncover patterns in physiological processes like biological aging, which can help predict aggregate health and life expectancy differentials between population segments, but is also relevant to behavior. Certain epigenetic processes, affected by early life conditions, can have behavioral consequences, such as influencing the perception of and reaction to a broad range of stressors (Diewald et al. 2024, pp. 8–9). The range of social conditions and experiences that are relevant for epigenetic processes is broad, and many stressors are associated with patterns of social inequality, highlighting the relevance of these processes to sociologists. Among these are physical stressors, threatening life experiences, material deprivation, various forms of discrimination, experiences of failure, and negative influences on the development of the organism such as smoking, poor nutrition, and alcohol consumption by the mother during pregnancy (Diewald et al. 2024, pp. 10–11).

4 Contributions in this Special Issue

The existing variety of bio/evo research in sociology summarized in the previous section served as the background when planning this special issue and selecting potential contributions to it. With the overall aim of showcasing the existing variety of approaches in sociology that already engage in some form of bio/evo research, we wanted to provide representative examples from evolutionary sociology and biosociology, including different approaches within these, such as evolutionary family sociology, neurosociology, sociogenomics, and approaches that consider hormonal and epigenetic processes. In addition, we aimed to provide a mix of theoretical, review, and empirical papers.

The contributions are organized into six sections. Section 4.1 includes programmatic articles, while Sects. 4.2 to 4.5 feature thematic overviews and empirical studies in the various fields of bio/evo sociology. The last section, Sect. 4.6, contains three contributions from colleagues in neighboring disciplines that provide an outside view from adjacent fields of research, namely cultural evolution research, cross-cultural psychology, and developmental psychology, and thus complement the sociological papers.

4.1 Behavioral Foundations

The first section of our special issue contains two papers that address the foundation of a theory of human behavior from two quite different perspectives. Both articles in this section provide ideas for how the currently dominant sociological theories of action with their still descriptive bias could be further developed by underpinning them with relevant evolutionary insights and a “materialistic,” deeper view on how human brains come to decisions about what to do next. They could help in coming considerably closer to an explanation of human behavior and provide a deeper insight into relevant mechanisms as they abandon a still too ephemeral view of human decision-making.

Andreas Tutič, in the first of the two articles, starts from existing sociological action theories and takes these as a reference point for a comparative discussion with prominent approaches from evolutionary psychology and dual-process theory. The latter has already been referred to in sociological action theory in frame selection theory (Esser and Kroneberg 2015). Tutič elaborates on how dual-process theories in sociology are compatible with evolutionary adaptationist arguments from evolutionary psychology. In concluding, he provides preliminary ideas on how one could proceed toward an integrated action theory, a suggestion that can stimulate further discussion.

In the second article, *Jacob Cheadle*, *K. J. Davidson-Turner*, and *Bridget Goosby* present their attempt at an integrated model of human behavior. They introduce a new approach aiming for no less than the comprehensive explanation of how humans behave and interact with each other in their social and natural environments. It is a modified version of the Bayesian predictive brain concept, which ultimately traces perception and behavior back to an optimization problem based on an individual's goal of efficiently maintaining themselves, their health, and their ability to act.

The “active inference framework” takes us a step further to the biological and neurological level of “enculturating brains” with their shared models of the world, which enable their carriers to interact and are steadily updated to minimize the risk of surprise. It gives up dualities such as mind vs. body and biological vs. social.

4.2 Evolutionary Sociology

There are five contributions in this second subsection that deal with evolutionary approaches in sociology. The first two articles present more general considerations on what makes evolutionary sociology distinct, acknowledging its roots in Darwinian thinking but recognizing the need for conceptual extensions or modifications to study cultural and social evolution. These articles follow quite different but complementary perspectives. They are followed by three articles with a more middle-range focus: a theoretical article and two empirical ones. Together, the entries in this section demonstrate that evolutionary thinking provides relevant concepts, if not a general basis, for explaining social processes. They emphasize the need for greater consideration of evolutionary approaches in sociological research. At the very least, these contributions can serve as a starting point for a necessary and intense discussion of evolutionary approaches in sociology, complementing other literature in which these ideas have been addressed (cf. Dennett 2017; Runciman 2009; Tang 2020).

In the first article in this section, *Alexandra Maryanski* and *Jonathan Turner* demonstrate how bio/evo research significantly contributes to the study of human and social development. They introduce cladistic analysis to identify humans’ evolutionary heritage, as well as continuities and adaptive discontinuities in their evolution compared to the great apes, starting from the last common ancestor. Their work is combined with insightful network-analytical and comparative neuroanatomical findings. At the same time, the authors address the limitations of a bio/evo perspective when it comes to sociocultural change. In their plea for “alliances” of sociology with evolutionary approaches such as evolutionary psychology, they strongly emphasize the original contribution of sociology. They introduce the concept of the “sociocultural phenotype” and highlight an emerging social dynamic that should be understood as the result of an evolutionary mechanism in which the teleological aspect plays a larger role as opposed to Darwinian evolution because it is “driven by human capacities for thinking and the agency of a collective.” They position themselves in the tradition of the “first masters of sociology” from the nineteenth century.

Bernd Baldus, in the second article in this section, takes quite the opposite direction. After discussing Darwin’s point of departure, he criticizes neo-Darwinian approaches of cultural evolution in human biology and anthropology, and their concept of gene–culture co-evolution, for significant limitations in explaining the complexities and huge variability of cultures. Instead, he concurs with influential contributions in sociology that acknowledge the high degree of contingency in cultural evolution, and he highlights the relevance of humans’ extraordinary cognitive capabilities for mastering the uncertainties of this process. He proposes a “new paradigm of internal selection,” highlighting human creativity in inner-individual selection processes that involve fictitious, internal trial-and-error thinking. Accordingly, his focus lies

on individual, agency-based evolutionary processes, termed “lived evolution,” which align with the microfoundational approach to macro-level change in sociology.

With a focus on human sociality and cooperation, which are still not completely understood (cf. Sect. 2.2), in the next article *Michael Windzio* provides an overview of answers from different approaches in the bio/evo literature to this central question in sociological research. Windzio supports a multilevel model connecting gene-based evolution of emotional and cognitive capacities with group-level selection among human social groups supporting successfully cooperating protective alliances. He follows the distinction between “ultimate” and “proximate” explanations (see Sect. 2.3) to systematize different theories. For the same purpose he focuses on core concepts such as the “social brain” approach (proximate) and group selection (ultimate). This model aids social categorization (in-group vs. out-group) and commitment, reducing transaction costs in social interactions. Special attention is given to friendship as a particularly close and trustful social relationship and cultural differences with regard to friendship among human societies.

The fourth article overall in this section, and the first of two empirical articles, is contributed by *Anna Rotkirch, Anna H  gglund, Antti Tanskanen, and Mirkka Danielsbacka*. In their study in evolutionary family sociology, they investigate how partnership histories shape what they call the “grandparenting happiness bonus.” Theoretically, their study is inspired by the evolutionary life history approach, which considers age-specific investment strategies in different life domains. The authors focus on the trade-off between different types of living arrangements resulting from different partnership histories and grandparenting among individuals aged 50 and older, with individual well-being as the outcome variable. Using data from the Survey of Health, Ageing and Retirement in Europe, they show that grandparenting can make a difference when it comes to potential welfare losses due to living without a partner.

In the final article of this section, *Sebastian Schnettler* revisits the longstanding Trivers–Willard hypothesis from sociobiology, which suggests that parents with higher socioeconomic status are more likely to have and invest in male offspring, while those with lower socioeconomic status favor female offspring. He summarizes the inconclusive research on the Trivers–Willard hypothesis in modern societies and highlights the need to better understand the underlying mechanisms that might drive discriminatory parental investment. Using a factorial survey experiment, Schnettler examines underlying gender preferences in evaluations of parental investment scenarios that may be an evolutionary legacy of a potential Trivers–Willard mechanism. His analysis provides only weak evidence for the Trivers–Willard hypothesis, yet main effects of respondent socioeconomic status align with sociological research on status-dependent parental investment preferences. The methodological approach presented here is broadly applicable to comparative Trivers–Willard and parental investment research.

4.3 Sociogenomics

Of the four articles in this section on sociogenomics, the first is by *Martin Diewald*. He provides an overview of sociogenomics studies and methods from the perspec-

tive of an “integrated life-course research,” which has long been an interdisciplinary undertaking (cf. Bernardi et al. 2019). First, he introduces the main concepts in sociogenomics and the life-course approach. He then presents several studies demonstrating how genetically informed research enhances understanding of social inheritance, social conditions, and individual agency in shaping lives. Diewald addresses core issues related to life-course dynamics in detail. What follows is a comparative introduction of methodological designs, such as ACE decomposition in twin research and methods in molecular genetics and epigenetics, advocating for a smart combination of both. The potential of genetically informed research for advancing life-course research becomes apparent, but so do the challenges, as longitudinal designs in the field of sociogenomics are particularly demanding.

The second article, by *Tina Baier* and *Torkild Hovde Lyngstad*, reviews recent advances in sociogenomics that combine modern molecular genetics approaches with extended family designs to better disentangle the relative contributions of genetic and environmental factors in the transmission of education. The article summarizes prior sociogenomics work on the intergenerational transmission of educational achievement and introduces the concept of “genetic nurture.” According to this concept, parents not only pass on genes to their children that directly affect their children’s characteristics relevant to educational achievement, but parents’ genes also indirectly influence their children’s educational outcomes by shaping parental behavior, which is a crucial part of the home environment. The authors review recent empirical research on genetic nurture that use PGS in fixed-effects models on the level of parental siblings. The research on genetic nurture illustrates the intricacies in interpreting genetic and/or environmental effects. What sociologists have traditionally viewed as purely environmental is, according to the concept of genetic nurture, partly genetic.

The third article in this section is an empirical study by *Bastian Mönkediek*, *Pia Schober*, *Martin Diewald*, *Harald Eichhorn*, and *C. Katharina Spiess*. It focuses on externalizing problems in young children, which are significant from both life-course and stratification perspectives due to their impact on later school careers and academic achievement. To better understand the drivers of these behaviors, the authors use data from the German Twinlife study coupled with information on early childhood education and care (ECEC) quality. This study examines how ECEC characteristics moderate the contributions of genetic and environmental influences on externalizing behaviors, a rare approach in sociogenomics. The analysis is based on 713 same-sex twins in 364 daycare centers in Germany. Using variance decomposition in di- and monozygotic twins, the results show that few ECEC quality indicators moderate genetic and environmental influences. Notably, staff training reduces the genetic contribution to externalizing behavior in children.

The authors of the fourth article in this section, *Muna AnNisa Aikins*, *Yayouk Eva Willems*, *Deniz Fraemke*, and *Laurel Raffington*, take on the elephant in the room when it comes to the significant issue of genetic influences on behavior and the integration of genetic measures in social science research in Germany. They confront the historical misuses of “racialized pseudo-science disguised as genetic research” and the resulting silence on race-related research, which is part of what they call “race evasiveness” in German science and politics. The authors argue that a race-

critical biosocial science that breaks this silence can help prevent the misapplication of sociogenomics in Germany. Aikins et al. take a big step in that direction by offering a biosocial perspective on sociogenomics and racism in Germany. They review the history of racism in Germany, including the atrocities committed during the colonial and Nazi eras. This is followed by a review of recent genomic science that demonstrates that there is no biological basis for the socially constructed concept of race. Additionally, they examine research showing how racial and socioeconomic inequalities are linked to physiological processes, illustrating how racism “gets under the skin,” affecting behavior and health and contributing to the persistence of racialized inequalities.

4.4 Neurosociology and Emotions

The two papers with reference to neurosociology are highly interdisciplinary endeavors with author teams involving sociologists, neuroscientists, and psychologists. Both studies provide empirical examinations of neural correlates of social processes and thus provide insights into potential mechanisms underlying the link between social context and behavior.

In the first study, *Gesche Schauenburg, Arash Aryani, Chun-Ting Hsu, Tobias Schröder, Markus Conrad, Christian von Scheve and Arthur M. Jacobs* draw on affect control theory (ACT), a sociological theory with roots in symbolic interactionism. According to ACT, the social world is made up of a web of shared meanings describing institutions, roles, and identities where each concept has a denotative and an affective meaning. Actors, according to ACT, strive to maintain affective coherence in social situations. The theory provides formal models that allow prediction of the degree to which social interactions deviate from established patterns, but propositions from the theory have been rarely tested empirically. To close this gap, the authors use neuroimaging methods to study the neural processing of affective incongruency in scenarios that describe social interactions. Consistent with the theory, neural activity increases in incongruent situations, “supporting the assumption that affective language content influences meaning-making already at very early semantic processing stages.” By revealing the neural underpinnings of social situations, the results help to provide nuance for fine-tuning the underlying theory.

In the second paper in this section, by *Jordan L. Mullins, Dana E. Díaz, Rengin B. Firat, and Kalina J. Michalska*, the authors examine the neural traces of repeated ethnic-racial discrimination experiences among 9-year-old Latina girls in California. Existing theories predict that ethnic-racial discrimination, defined as the differential treatment of individuals based on ethnic or racial group membership, predicts poor mental health outcomes such as anxiety. In the current study, the authors measure the prevalence and severity of discrimination experiences based on self-reports. Using neuroimaging methods, they reveal that discrimination experiences are associated with a higher volume of the left amygdala, thus suggesting that the amygdala is sensitive to racialized threats during childhood. Given that the amygdala belongs to the stress-sensitive neurocircuitry, they thus highlight a potential mechanism to mediate the influence of discrimination on anxiety.

4.5 Hormones and Other Biomarkers

The first article in this section, by *Laura Josephine Botzet, Tobias L. Kordsmeyer, Sabine Ostermann, Johannes Ruß, and Lars Penke*, provides both a brief primer on behavioral endocrinology to an audience not trained in endocrinology and a summary of relevant research with a focus on four steroid hormones—cortisol, estrogen, progesterone, and testosterone—that are particularly relevant for the social sciences. As the authors show in their review, which draws heavily on psychological work involving hormones but also takes into account the little research that exists in sociology, these hormones play a key role in modulating social behavior. Also, as opposed to other hormones, the behaviorally relevant levels of these hormones can be measured in blood, urine, hair, and saliva samples, making empirical research involving these hormones feasible. The authors outline how the hormones are influenced by social roles and contexts (e.g., parenthood, mating, competitive situations) and how they in turn influence key social outcomes (e.g., social status, health, reproduction, romantic relationships, sexuality). This pivotal role of hormones as an interface between social context and behavior makes endocrinology highly relevant to sociology.

Laia Sánchez Guerrero, Pia S. Schober, and Birgit Derntl, in the second article of this section, present results from a sociological study that also involves hormones. But different from the previous article, they do not focus on activational hormonal processes involving levels of currently circulating hormones but instead draw on brain organization theory and implement an indicator of prenatal hormone exposure. Using data from the Avon Longitudinal Study of Parents and Children for 9-year old children, they explore how early androgen exposure and parental socialization interact in shaping gender differences in academic interests. Whereas their results do not provide evidence for a main effect of early androgen exposure as brain organizational theory would predict, they do find evidence for such an interaction effect, thus demonstrating the importance of an interdisciplinary perspective that combines insights from behavioral endocrinology, psychology, and sociology.

Bridget J. Goosby and Jacob E. Cheadle, in the third contribution in this section, present another complex interdependence between physiological functions, specifically the immune system, and stressful social experiences. The authors provide a comprehensive concept to explain the consequences of what they refer to as systemic racism in the United States for severe health issues of those afflicted. Following a detailed introduction to the functioning of the human immune system as an interdependent part of a complex multilevel process, they demonstrate the deteriorating impact of the experience of racism and discrimination on the immune system, the consequences for inflammatory morbidity, and the implications for health inequities in marginalized populations, supported by corresponding empirical evidence. By highlighting the analogy between systemic racism and the immune system, both being highly complex yet operating on very different levels, the authors illustrate the significant task ahead in understanding the interdependencies between these two systems.

Hannah Landecker traces the scientific history of biomedical research, elucidating how society goes “under the skin” and highlighting a shift in perspectives toward

one in which inequalities in the social world are reflected as inflammatory states. These inflammatory states precede, rather than follow, the social signals previously considered important for health and health disparities. Landecker begins with the common and still relevant theoretical “outside-in” approach, which perceives social experiences as signals to which the body reacts through physiological and molecular–biological mechanisms that contribute to social disparities in health. However, she argues for a further step toward what she calls the “metabolic turn”—a more refined perception of the intraindividual chemical processes that sustain the life of an organism in a particular environment. Social environments are metabolized and are not just the origin of signals that trigger predetermined physiological reactions. The “metabolized-world thinking” much more considers an interdependence between environment and organism. According to Landecker, this can be illustrated by studying the issue of industrial food production.

4.6 Views from the Outside

We close this issue with three contributions from scholars in other disciplines dealing with evolutionary approaches of sociocultural dynamics, who are therefore working on topics that are highly relevant for sociology.

The evolutionary anthropologist and psychologist *Rita Anne McNamara* is a proponent of the cultural evolution or the gene culture co-evolution approach (see Sect. 2.3). Like Windzio (in this issue), she also addresses the issue of social cooperation. She follows a historical “map” of cultural “innovations,” starting with rituals and leading to systems of religious beliefs and forms of spirituality, the latter of which are gaining importance in contemporary societies. She demonstrates that religious thinking has played a crucial role in sustaining cooperative social structures, for example through the belief in a supernatural, all-seeing, and punishing god or by serving as a focal point for group identification. Cultural group selection has significantly supported these cooperative structures (and genetic underpinnings), which are unique to human societies and result from human adaptations to enhance survival and reproduction. McNamara provides several reasons for closer cooperation between her evolutionary approach and sociology, for instance, when it comes to explain the decline or transformation of religious thinking during modernization, applying a multilevel selection perspective.

In the second part of this section, evolutionary and intercultural psychologists *Ulrich Kühnen* and *Shinobu Kitayama* address another topic that is at the core of sociological research and combine it with an approach they call “socioecological psychology” from a comparative perspective. They show that culture, social class membership, and individual self-construal interact with each other. After introducing the distinction between individualistic and collectivist cultures, they report findings from studies investigating the relationship between socioeconomic status and independent versus interdependent self-construal across these two cultural contexts. Generally, there is much evidence for the fact that higher social status is associated with an independent self and lower social status with a more interdependent self, net of cultural differences. However, regarding the endorsement of self- or other-orientation or anger expression, culture-specific effects of socioeconomic status were

found. This research considerably contributes to a better understanding of the relevance of social class not only from a psychological but also from a sociocultural perspective.

In the final article, developmental psychologists *Henrike Moll* and *Qianhui Ni* investigate what makes humans so unique in the animal world and refer to what Michael Tomasello called “shared intentionality.” They argue that shared intentionality is not only due to abilities that humans possess in addition to their close animal relatives but that a complete “transformation” of the form of life and the cognitive structure leading to their particularly pronounced sociality must be considered. Their main argument in support of their transformation thesis is that a shared intentionality or social orientation is present in child development from the beginning, albeit at different levels of complexity that increase in three (or four) steps during the first five years of life: from what they call “primary intersubjective” in dyadic interactions to the ability of “theoretical” perspective-taking, which means that children become generally aware of the fact that people perceive the world from different perspectives. The authors present many studies supporting this view. Even though they admit that it does not directly support their transformation thesis, they convincingly argue that children’s development is fundamentally different from that of nonhuman animals from the beginning. Since current research seems to emphasize that the difference between humans and nonhuman animals is a matter of continuity rather than qualitative change, this could be perceived to be a provocative perspective.

5 Conclusions

Overall, the contributions to this special issue illustrate the variety of bio/evo approaches reviewed in Sect. 3, as well as adjacent fields of research that are highly relevant to core sociological questions. We have seen that sociologists who are engaged in bio/evo work, along with those collaborating in interdisciplinary teams, employ a broad range of methodological approaches and theoretical perspectives. Besides showcasing the variety of existing bio/evo work involving sociologists or sociologically relevant topics, and thereby providing interested scholars with entry points into relevant research, we are convinced that the contributions in this issue clearly demonstrate how evolutionary, social, and biological processes are intricately interwoven. Once this is recognized, not only does adopting an interdisciplinary perspective become essential to yield unbiased estimates of social forces, but in many areas of interest to sociologists it also becomes increasingly evident how difficult, if not impossible, it is to even isolate social facts alone.

To foster a discussion in sociology on how and where the discipline can more systemically integrate bio/evo research, and to specify which sociological research areas would benefit most from such an integration, we propose developing an analytical model that extends the well-known Coleman “boat” or “bathtub”—that is, his two-level model of explaining social change, introduced in his seminal work, “Foundations of Social Theory” (Coleman 1990). In addition to, or as a complement to, the process level of overt individual action, it is crucial to explicitly consider an intra- or inner-individual process level encompassing the physiological and mental modes of

operation in humans, which include “state variables like genetic, biological, physiological and psychological attributes” (Bernardi et al. 2019, p. 2). Coleman himself was aware that intraindividual levels are relevant; he discussed and considered them when he introduced a concept of the actor’s self and the relevance of the internalization of social norms. However, he generally adhered to a strict rational-choice approach to explain individual action and, for clarity and simplicity, abstracted from the complexity of intraindividual processes and states (Coleman 1990, pp. 503 ff.). This reduction might be acceptable in cases where inner-individual processes do not systematically interact or correlate with social categories and appear randomly distributed at higher levels. In fact, in classical rational-choice models, the inner-individual level is implicitly recognized when it comes to actor preferences. Once preferences are known—which often is not fully the case—further treatment of the inner-individual level seems unnecessary in this approach.

In contrast, many articles in this issue, along with our review of bio/evo research in sociology, illustrate how intraindividual processes such as polygenic risk scores, inflammation states, and neurophysiological processes are often socially patterned, particularly in relation to socioeconomic status. For example, research has shown how experiences of discrimination and other adverse conditions can leave traces “under the skin,” leading to changes in hormone levels, inflammation states, biological aging, and other epigenetic processes. Societal conditions directly influence these intraindividual processes, as evidenced by research demonstrating how discrimination and other adversities impact health through stress, inflammation, and epigenetic mechanisms (e.g., Goosby et al., Aikins et al., Landecker; all in this issue), thereby contributing to socially patterned health disparities at the aggregate level of society.

Other research included and mentioned in this volume highlights how societal processes influence inner-individual processes, which in turn impact behavior. When aggregated, these behaviors can help explain supraindividual phenomena. As to mental processes, Cheadle et al. (this issue) discuss the “active inference” model as one promising conceptual basis for modeling the inner-individual process of the perception of the action situation and its consequences for overt action, based on the Bayesian brain concept (cf. Parr et al. 2022). Additionally, the effects of situational characteristics on hormone concentrations are addressed in the literature (e.g., Taylor 2014). If individuals with certain traits are more likely to repeatedly encounter or be selected for specific situations within a society—such as more stressful or more competitive environments—this can, through changes in behavioral propensities driven by hormone levels, leave an impact at the supraindividual level. Examples include family transitions such as the birth of a child or divorce, which can alter behaviorally relevant hormone levels (e.g., Gettler et al. 2011), or discriminatory processes that, mediated through inflammation, affect mental health and behavior (Goosby et al., this issue). While a purely correlational analysis may ignore it, only considering the inner-individual level enables empirical analyses to uncover the underlying causal mechanisms.

A historical example that illustrates a more complex cross-level interaction is shown by Henrich, a proponent of the cultural evolution approach. He describes a three-level interaction in the cultural evolution of globalization, highlighting the interplay between the occurrence of monogamy, moral psychology, and changes

in testosterone regulation (Henrich 2020). Henrich demonstrates that it is essential to consider inner-individual processes because there is an interaction between social and inner-individual processes mediated by changing patterns of individual behavior: In this case, social change—specifically, the transition to homogamy and the introduction of a marriage regime—has consequences for inner-individual processes, such as the regulation of testosterone production among men due to inherent endocrine mechanisms. This, in turn, supports the functioning of the monogamous family system. The physiological processes affect individual behavior, and this again supports the change in norms and institutions of partnership and parenthood. This typically looks like a nonlinear process of an emerging new (social) structure through reciprocally influencing processes and different intraindividual and societal levels. Generally, this case is also a good example of the way evolutionary approaches consider the interdependence between inner-individual processes, overt individual action/behavior, and the processes on societal levels that are at the core of sociological research. As several contributions in this volume show, explanations of sociostructural and cultural change could heavily profit from an evolutionary approach of sociology (Maryanski and Turner; Baldus; McNamara, all this issue; see also Runciman 2009; Tang 2020).

Although these are just a few examples of cross-level pathways that heavily involve inner-individual-level processes, they are sufficient to illustrate the fruitfulness for sociology to take into account the inner-individual level through participating in bio/evo research. Many details of the respective iterations of the multilevel model hinted at here have to be fleshed out in more detail (e.g., the relation of overt and inner action, cf. von Mises 1940, p. 15; Esser 1999, pp. 164f.).

Extending the model of Coleman by explicitly including the inner-individual processes has consequences for sociological theory and research, which helps our discipline to focus on the very issues we should deal with. One consequence is that sociological action-theoretic models must be refined, as they are more or less well parametrized systems of assumptions but unavoidably remain incomplete and are insufficient to explain individual behavior or action, and thus societal change, completely. This is surely true for the RC approach à la Coleman, which only allows backward plausibility checks of the fact that a person should have acted in a somewhat objectively rational way. This is also true for more refined approaches using the dual-process theory such as theory of frame selection (Esser and Kroneberg 2015; cf. Tutič, this issue). It allows the formulation of rough expectations of, for instance, how likely it is that automatic behavior occurs. But it does not explain when and why which mode occurs at a certain point in time.

Another consequence is that sociology needs more intensive collaborations with other disciplines such as psychology and neuroscience to achieve a better explanatory approach concerning human behavior. Sociology could be an integral part of an interdisciplinary human science. This resonates well with recent developments of theoretical consilience formulated outside sociology, with calls for a unified behavioral science (Bowles and Gintis 2013; Brown et al. 2011; Wilson 1998). Sociology, we are convinced, has much to offer in such an interdisciplinary collaboration. Yet if it does not partake in this endeavor, others will reinvent the field without any input from our discipline. Cultural evolution approaches are a case in point: They

share the same explananda with sociology, and the focus on grand theory building seems also to be quite similar, with the differences being that in cultural evolution research, theory building is more tightly coupled with empirical work that has enormous cross-cultural and historical breadth and that cultural evolution approaches follow an overall evolutionary/adaptationist framing.

Empirically, sociologists are well equipped, both conceptually and methodologically, to examine interactions between biological and social processes, particularly when the focus is on modern developed societies. In this volume we have seen the variety of approaches that are already in play, with a clear bias in frequency toward approaches that integrate well with the main workhorse of quantitative social science, that is, a coupling of social survey data and some form of regression analysis into which genetic scores and epigenetic markers can easily be added as variables. We encourage sociologists to also walk the less trodden methodological paths more often and use other research designs (e.g., experimental laboratory studies) to integrate neuroscientific findings and hormonal measurements. These types of biomarkers, which do not implement well with social surveys, are much more immediate to behavior than genes are, and are, in a way, interfaces between social context and behavior. Qualitative research, too, is clearly needed, as evolutionary research, particularly from behavioral ecology, suggests that relative comparisons with others in the immediate context (or niche) may be more relevant or at least complementary to a focus on comparisons (e.g. of socioeconomic position) with others in national representative surveys of unconnected individuals. Ethnographies, for instance, are well suited to elucidate the local norms and “currencies” that are associated with prestige in very specific social milieus.

Moreover, a lot of theoretical groundwork is necessary to integrate bio/evo perspectives with sociological theories, not just with regard to action theories as highlighted at the beginning of these conclusions. As in the ancient parable of “The Blind Men and the Elephant,” much of what we see in the contributions of this volume, along with the research cited in the introduction, seems complementary. Looking at long-term evolutionary change, gene–environment interactions and the biophysical processes that bring society “under the skin” are all parts of the puzzle and do not necessarily contradict each other. Integrating these different parts, and integrating them with the classical sociological core, will require greater cooperation between sociology and other disciplines of the “human sciences,” including on a theoretical level. Where are theories complementary and can thus be easily integrated? Where—on a detailed level—are contradictions revealed, and how can these, coupled with empirical work, be used to refine our integrated theoretical models? A strong focus on mechanisms may help the conciliatory effort of integrating theories. For instance, both family sociology and family research in evolutionary behavioral science find a step gap in parent–child relationships. Yet with a focus on co-residence duration as one core mechanism, potentially underlying kin selection, sociological and evolutionary perspectives do not seem to be as incommensurate as often assumed (cf. Schnettler and Steinbach 2011; de Leeuw et al. forthcoming).

Finally, many of the objections that sociologists previously raised regarding bio/evo work, such as concerns about determinism and the perceived irrelevance of biological and evolutionary processes to the study of modern societies, have

been effectively addressed. While the charge of misusing bio/evo research—though evident in the past—cannot be leveled against major contemporary proponents of bio/evo fields such as sociogenomics, who have clearly distanced themselves from such misapplication (e.g., Harden 2021), the risk of misuse is not entirely eliminated. Recent studies show how old concepts can resurface and how ideology can masquerade as “science” (see, critically, Sear and Townsend 2023).

However, we are convinced that the solution should not be to abstain from bio/evo research altogether, as Bartram et al. (2024) seem to suggest in their recent critical review of sociogenomics. Instead, we align with Aikins et al. (this issue; cf. Harden 2021), advocating for more rigorous science that helps us understand the complex interplay between nature and nurture, enabling us to confront bad science and ideological attempts to use pseudoscience to justify inequalities or mistreatment. This effort should be accompanied, as Aikins et al. (this issue) also suggest, by a critical review of past misuses and a solid understanding of systemic racism and other forms of discrimination and how these factors affect the scientific discovery process.

The endeavor to untangle the interplay between nature and nurture is, and will remain, highly complex and challenging, a point on which we agree with Bartram et al. (2024). However, the solution, in our view, cannot be to bury our heads in the sand and rely on a knowingly biased and incomplete treatment of social facts alone.

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References

- Abrutyn, Seth, and Jonathan H. Turner. 2021. *The first institutional spheres in human societies*. New York: Routledge.
- Ågren, J. Arvid. 2021. *The Gene's-Eye View of Evolution*. Oxford: Oxford University Press.
- Ariansen, Anja Maria Steinsland. 2021. “Quiet is the New Loud”: The Biosociology Debate's Absent Voices. *The American Sociologist* 52:477–504.
- Arnold, Arthur P., and S. Marc Breedlove. 1985. Organizational and activational effects of sex steroids on brain and behavior: A reanalysis. *Hormones and Behavior* 19:469–498.
- Aunger, Robert. 2007. Memes. In *Oxford handbook of evolutionary psychology*, eds. Robin I. M. Dunbar and Louise Barrett, 599–603. Oxford: Oxford University Press.
- Avinun, Reut. 2020. The E Is in the G: Gene–Environment–Trait Correlations and Findings From Genome-Wide Association Studies. *Perspectives on Psychological Science* 15:81–89.
- Baier, Tina, Volker Lang, Michael Grätz, Kieron J. Barclay, Dalton C. Conley, Christopher T. Dawes, Thomas Laidley and Torkild H. Lyngstad. 2022. Genetic Influences on Educational Achievement in Cross-National Perspective. *European Sociological Review* 38:959–974.
- Baldus, Bernd. 2002. Darwin und die Soziologie. Kontingenzt, Aktion und Struktur im menschlichen Sozialverhalten. *Zeitschrift für Soziologie* 31:316–331.

- Baldus, Bernd. 2017. *Origins of Inequality in Human Societies*. New York: Routledge.
- Baldus, Bernd. 2018. Wie relevant ist Social Genomics für die Soziologie? *Soziologische Revue* 41:545–555.
- Barash, David P. 1977. Reflections on a Premature Burial. *The American Sociologist* 12:66–68.
- Barkow, Jerome H. 2006. *Missing the revolution: Darwinism for social scientists*. Oxford University Press.
- Barkow, Jerome H., Leda Cosmides and John Tooby (eds.). 1992. *The adapted mind: Evolutionary psychology and the generation of culture*. New York: Oxford University Press.
- Bartram, Isabelle, Tino Plümecke and Peter Wehling. 2024. Soziogenomik: Ein neuer Versuch, die Soziologie zu biologisieren. *Soziologie* 53:20–45.
- Baumeister, Roy F. 2005. *The cultural animal: Human nature, meaning, and social life*. Oxford: Oxford University Press.
- Bearman, Peter. 2008. Introduction: Exploring genetics and social structure. *American Journal of Sociology* 114:v–x.
- Belsky, Daniel W., Benjamin W. Domingue, Robbee Wedow, Louise Arseneault, Jason D. Boardman, Avshalom Caspie, Dalton Conley, Jason M. Fletcher, Jeremy Freese, Pamela Herd, Terrie E. Moffitt, Richie Poulton, Kamil Sicinski, Jasmin Wertz and Kathleen Mullan Harris. 2018. Genetic analysis of social-class mobility in five longitudinal studies. *Proceedings of the National Academy of Sciences* 115(31):E7275–E7284.
- Bernardi, Laura, Johannes Huinink and Richard A. Settersten. 2019. The life course cube: A tool for studying lives. *Advances in Life Course Research* 41:100258.
- Binmore, Ken. 2007. *Game Theory: A Very Short Introduction*. Oxford University Press, USA.
- Bliss, Catherine. 2018. *Social by nature: the promise and peril of sociogenomics*. Stanford, California: Stanford University Press.
- Blute, Marion. 2010. *Darwinian sociocultural evolution: Solutions to dilemmas in cultural and social theory*. Cambridge: Cambridge University Press.
- Bogdany, Franz Josef. 1980. Soziobiologie-Möglichkeiten und Grenzen der neuen Synthesis. *Kölner Zeitschrift für Soziologie und Sozialpsychologie* 32:312–324.
- Booker, Cara, and Sebastian Schnettler. 2014. Assessing the effects of prenatal hormone exposure on the human life-course. In *Understanding Society Innovation Panel Wave 6: Results from methodological experiments, Understanding Society Working Paper Series*, ed. Tarek Al Baghal, 46–51. Colchester: University of Essex, Institute for Economic and Social Research.
- Booker, Cara, and Sebastian Schnettler. 2015. Digit ratios in the IP7 youth sample. In *Understanding Society Innovation Panel Wave 7: Results from methodological experiments, Understanding Society Working Paper Series*, ed. Tarek Al Baghal, 54–57. Colchester: University of Essex, Institute for Economic and Social Research.
- Boorman, Scott Archer, and Paul R. Levitt. 1980. The Comparative Evolutionary Biology of Social Behavior. *Annual Review of Sociology* 6:213–234.
- Booth, Alan, Greg Shelley, Allan Mazur, Gerry Tharp and Roger Kittok. 1989. Testosterone, and winning and losing in human competition. *Hormones and Behavior* 23:556–571.
- Booth, Alan, Karen Carver and Douglas A. Granger. 2000. Biosocial Perspectives on the Family. *Journal of Marriage and Family* 62:1018–1034.
- Booth, Alan, Douglas A. Granger, Allan Mazur and Katie T. Kivlighan. 2006. Testosterone and social behavior. *Social Forces* 85:167–191.
- Bowlby, John. 1997. *Attachment and loss: Attachment*. London: Pimlico.
- Bowles, Samuel, and Herbert Gintis. 2013. *A cooperative species: human reciprocity and its evolution*. 1. paperback print. Princeton, NJ: Princeton University Press.
- Breedlove, S. Marc. 2010. Minireview: Organizational Hypothesis: Instances of the Fingerpost. *Endocrinology* 151:4116–4122.
- Brewer, Joe, M. Gelfand, J. C. Jackson, I. F. MacDonald, P. N. Peregrine, P. J. Richerson, P. Turchin, H. Whitehouse and D. S. Wilson. 2017. Grand challenges for the study of cultural evolution. *Nature Ecology & Evolution* 1:0070.
- Brown, Gillian R., Thomas E. Dickens, Rebecca Sear and Kevin N. Laland. 2011. Evolutionary accounts of human behavioural diversity. *Philosophical Transactions of the Royal Society B: Biological Sciences* 366:313–324.
- Burkhardt, Richard W. 1985. Darwin on Animal Behavior and Evolution. In *The Darwinian Heritage*, 327–366. Princeton, NJ: Princeton University Press.
- Burt, Callie H. 2023. Challenging the utility of polygenic scores for social science: Environmental confounding, downward causation, and unknown biology. *Behavioral and Brain Sciences* 46:e207.

- Buss, David M. 1995. Evolutionary psychology: A new paradigm for psychological science. *Psychological Inquiry* 6:1–30.
- Cheadle, Jacob E., Bridget J. Goosby, Joseph C. Jochman, Cara C. Tomaso, Chelsea B. Kozikowski Yancey and Timothy D. Nelson. 2020. Race and ethnic variation in college students' allostatic regulation of racism-related stress. *Proceedings of the National Academy of Sciences* 117:31053–31062.
- Clark, Andrew D., Dominik Deffner, Kevin Laland, John Odling-Smee and John Endler. 2020. Niche Construction Affects the Variability and Strength of Natural Selection. *The American Naturalist* 195:16–30.
- Clawson, Dan, Meryl Fingrutd, Frank Sirianni, Mary Ann Clawson, Diana Powers, Don Palmer, Ed Royce, Linda Hartig, Mark Mizruchi, Michele Ethier and Steve Buechler. 1977. The decline and fall of sociobiology, 1975–1980. *American Sociologist* 12:199–200.
- Coall, David A., and Ralph Hertwig. 2010. Grandparental investment: Past, present, and future. *Behavioral and Brain Sciences* 33:1–19.
- Coleman, James S. 1990. *Foundations of social theory*. Cambridge, MA: Belknap Press.
- Corning, Peter A. 2020. Beyond the modern synthesis: A framework for a more inclusive biological synthesis. *Progress in Biophysics and Molecular Biology* 153:5–12.
- Crippen, Timothy. 1994. Toward a Neo-Darwinian Sociology: Its Nomological Principles and Some Illustrative Applications. *Sociological Perspectives* 37:309–335.
- Crippen, Timothy, and Richard Machalek. 2014. The future of evolutionary sociology. *Evolution, Biology & Society* 11:2–4.
- Davis, Jeff. 2013. Persistent Inequality: A Neurosociological Perspective. In *Handbook of Neurosociology, Handbooks of Sociology and Social Research*, eds. David D. Franks and Jonathan H. Turner, 333–348. Springer Netherlands.
- Dawkins, Richard. 2006. *The selfish gene: 30th anniversary edition*. 3rd ed. Oxford, UK: Oxford University Press.
- Dean, Lewis G., Gill L. Vale, Kevin N. Laland, Emma Flynn and Rachel L. Kendal. 2014. Human cumulative culture: a comparative perspective. *Biological Reviews* 89:284–301.
- Degler, Carl N. 1991. *In search of human nature: The decline and revival of Darwinism in American social thought*. New York: Oxford University Press.
- Dehaene, Stanislas. 2013. The Universal Algorithm For Human Decisions. In *This explains everything: Deep, beautiful, and elegant theories of how the world works.*, ed. John Brockman, 249–250. New York: Harper Perennial.
- Del Giudice, Marco, and Jay Belsky. 2011. The development of life history strategies: Toward a multi-stage theory. In *The evolution of personality and individual differences*, eds. David M. Buss and P. H. Hawley. New York: Oxford University Press.
- Del Giudice, Marco, Romina Angeleri and Valeria Manera. 2009. The juvenile transition: A developmental switch point in human life history. *Developmental Review* 29:1–31.
- Delaney, Tim. 2009. Social Spencerism. *Philosophy Now* 71:20–21.
- Dennett, Daniel C. 2017. *From bacteria to Bach and back: the evolution of minds*. First edition. New York: W.W. Norton & Company.
- Dietz, Thomas, Tom R. Burns and Frederick H. Buttel. 1990. Evolutionary theory in sociology: An examination of current thinking. *Sociological Forum* 5:155–171.
- Diewald, Martin. 2008. *Zwillings- und Adoptivkinder-Stichproben für soziologische Analysen*. Berlin: Deutsches Institut für Wirtschaftsforschung http://www.diw-berlin.de/documents/publikationen/73/diw_01.c.83471.de/rm27.pdf (Accessed: 6. May 2015).
- Diewald, Martin, Tina Baier, Wiebke Schulz and Reinhard Schunck. 2015. Status Attainment and Social Mobility: How can Genetics Contribute to an Understanding of their Causes? *Kölner Zeitschrift für Soziologie und Sozialpsychologie* 67:371–395.
- Diewald, Martin, Dmitry Kuznetsov and Yixuan Liu. 2024. Ungleiche Lebenschancen durch das Epigenom? Zum Zusammenwirken biologischer mit sozialen Mechanismen. In *Handbuch Sozialstrukturanalyse*, eds. Petra Böhnke and Dirk Konietzka, 1–24. Wiesbaden: Springer Fachmedien Wiesbaden.
- Dubas, Judith, Marianne Heijkoop and Marcel van Aken. 2009. A preliminary investigation of parent–progeny olfactory recognition and parental investment. *Human Nature* 20:80–92.
- Durkheim, Emile. 1996. *Über soziale Arbeitsteilung. Studie über die Organisation höherer Gesellschaften*. Frankfurt/M.: Suhrkamp.
- Eastwick, Paul W. 2009. Beyond the pleistocene: Using phylogeny and constraint to inform the evolutionary psychology of human mating. *Psychological Bulletin* 135:794–821.

- Eckberg, Douglas Lee. 1977. Sociobiology and the Death of Sociology: An Analytic Reply to Ellis. *American Sociologist* 12:191–196.
- Eckland, Bruce K. 1967. Genetics and Sociology: A Reconsideration. *American Sociological Review* 32:173.
- Eckland, Bruce K. 1976. Review: Darwin rides again. *American Journal of Sociology* 82:692–697.
- Elias, Norbert. 1978. *What is Sociology*. New York: Columbia University Press.
- Ellis, Lee. 1996. A discipline in peril: Sociology's future hinges on curing its biophobia. *The American Sociologist* 27:21–41.
- Erola, Jani, Tina Baier and Hannu Lehti. 2023. Genes and Equality of Opportunity: Lessons from a highly egalitarian country. *INVEST Working Papers* 80/2023.
- Esser, Hartmut. 1993. *Soziologie: allgemeine Grundlagen*. Frankfurt/Main; New York: Campus.
- Esser, Hartmut. 1999. *Soziologie. Spezielle Grundlagen 1: Situationslogik und Handeln*. Frankfurt/Main: Campus.
- Esser, Hartmut, and Clemens Kroneberg. 2015. An integrative theory of action. In *Order on the edge of chaos. Social psychology and the problem of social order*, eds. Edward J. Lawler, Shane R. Thye and Jeongkoo Yoon, 63–85. New York: Cambridge University Press.
- Fehr, Ernst, and Herbert Gintis. 2007. Human Motivation and Social Cooperation: Experimental and Analytical Foundations. *Annual Review of Sociology* 33:43–64.
- Foster, Caroline. 2000. The limits to low fertility: A biosocial approach. *Population and Development Review* 26:209–234.
- Franks, David D. 2010. *Neurosociology: The Nexus Between Neuroscience and Social Psychology*. 1st ed. 2010 edition. New York: Springer.
- Franks, David D. 2019. *Neurosociology: Fundamentals and Current Findings*. Dordrecht: Springer Netherlands.
- Franks, David D., and Jonathan H. Turner. 2013. *Handbook of Neurosociology*. Dordrecht; Heidelberg; New York; London: Springer.
- Freese, Jeremy. 2006. Commentary: The analysis of variance and the social complexities of genetic causation. *International Journal of Epidemiology* 35:534–536.
- Freese, Jeremy. 2007. The problem of predictive promiscuity in deductive applications of evolutionary reasoning to intergenerational transfers: Three cautionary tales. In *Intergenerational caregiving*, eds. Alan Booth, Ann C. Crouter, Suzanne Bianchi and Judith A. Seltzer, 45–78. Washington, D.C.: Urban Institute Press.
- Freese, Jeremy, and Brian Powell. 2001. Making love out of nothing at all? Null findings and the Trivers-Willard hypothesis. *American Journal of Sociology* 106:1776–1788.
- Freese, Jeremy, and Sara Shostak. 2009. Genetics and Social Inquiry. *Annual Review of Sociology* 35(1):107–128.
- Freese, Jeremy, Jui-Chung Allen Li and Lisa D. Wade. 2003. The potential relevances of biology to social inquiry. *Annual Review of Sociology* 29:233–256.
- Friston, Karl. 2009. The free-energy principle: a rough guide to the brain? *Trends in Cognitive Sciences* 13:293–301.
- Gettler, Lee T., Thomas W. McDade, Alan B. Feranil and Christopher W. Kuzawa. 2011. Longitudinal evidence that fatherhood decreases testosterone in human males. *Proceedings of the National Academy of Sciences* 108:16194–16199.
- Giesen, Bernhard. 1980. Gesellschaftliche Identität und Evolution. Ein Vergleich soziologischer Theorietraditionen. *Soziale Welt* 31:311–332.
- Giesen, Bernhard. 1981. Soziobiologie und soziologische Theoriebildung. In *Soziologie in der Gesellschaft: Referate aus den Veranstaltungen der Sektionen der Deutschen Gesellschaft für Soziologie, der Ad-hoc-Gruppen und des Berufsverbandes Deutscher Soziologen beim 20. Deutschen Soziologentag in Bremen 1980*, ed. Werner Schulte, 76–85. Bremen: Deutsche Gesellschaft für Soziologie.
- Giesen, Bernhard, and Christoph Lau. 1981. Zur Anwendung darwinistischer Erklärungsstrategien in der Soziologie. *Kölner Zeitschrift für Soziologie und Sozialpsychologie* 33:229–256.
- Gilgenmann, Klaus, and Bertold Schweitzer. 2006. Homo—sociologicus—sapiens. Zur evolutionstheoretischen Einbettung soziologischer Menschenmodelle. *Zeitschrift für Soziologie* 35:348–371.
- Gondermann, Thomas. 2007. Progression and retrogression: Herbert Spencer's explanations of social inequality. *History of The Human Sciences* 20:21–40.
- Goosby, Bridget J., Jacob E. Cheadle and Colter Mitchell. 2018. Stress-Related Biosocial Mechanisms of Discrimination and African American Health Inequities. *Annual Review of Sociology* 44:319–340.
- Guo, Guang. 2005. Twin Studies: What Can They Tell us About Nature and Nurture? *Contexts* 4:43–47.
- Guo, Guang. 2006. The linking of sociology and biology. *Social Forces* 85:145–149.

- Guo, Guang, and Elizabeth Stearns. 2002. The Social Influences on the Realization of Genetic Potential for Intellectual Development. *Social Forces* 80:881–910.
- Guo, Guang, Yuying Tong and Tianji Cai. 2008. Gene by Social Context Interactions for Number of Sexual Partners among White Male Youths: Genetics-Informed Sociology. *American Journal of Sociology* 114:S36–S66.
- Hamilton, William D. 1963. The evolution of altruistic behavior. *The American Naturalist* 97:354–356.
- Hamilton, William D. 1964a. The genetical evolution of social behaviour. I. *Journal of Theoretical Biology* 7:1–16.
- Hamilton, William D. 1964b. The genetical evolution of social behaviour. II. *Journal of Theoretical Biology* 7:17–52.
- Hamilton, Laura, Simon Cheng and Brian Powell. 2007. Adoptive parents, adaptive parents: Evaluating the importance of biological ties for parental investment. *American Sociological Review* 72:95–116.
- Hammerl, Manfred, Sascha Schwarz and Kai P. Willführ (eds.). 2024. *Evolutionäre Sozialwissenschaften: Ein Rundgang*. Wiesbaden: Springer Fachmedien Wiesbaden.
- Hank, Karsten, and Michaela Kreyenfeld (eds.). 2015. *Social demography: Forschung an der Schnittstelle von Soziologie und Demografie*. Wiesbaden: Springer VS.
- Harden, Kathryn Paige. 2021. *The genetic lottery: why DNA matters for social equality*. Princeton, NJ: Oxford: Princeton University Press.
- Henrich, Joseph Patrick. 2020. *The WEIRDest people in the world: How the West Became Psychologically Peculiar and Particularly Prosperous*. New York: Farrar, Straus and Giroux.
- Hettlage, Robert. 1984. Der lange Marsch der Biologie durch die Sozial- und Geisteswissenschaften. *Zeitschrift für Politik* 31:135–174.
- Hill, Paul Bernhard, and Johannes Kopp (eds.). 2015. *Handbuch Familiensoziologie*. Wiesbaden: Springer VS.
- Hill, Paul B., and Johannes Kopp. 2013. *Familiensoziologie: Grundlagen und theoretische Perspektiven*. Wiesbaden: Springer VS.
- Hodgson, Geoffrey M., and Thorbjørn Knudsen. 2010. *Darwin's conjecture: The search for general principles of social and economic evolution*. Chicago: University of Chicago Press.
- Holzer, Horst. 1981. Bernhard Giesen, Makrosoziologie – Eine Evolutionstheoretische Einführung. *Soziologische Revue* 4(1):3–11.
- Homans, George. 1977. A Sociologist's Reaction. *The American Sociologist* 12:69.
- Hopcroft, Rosemary L. 2005. Parental status and differential investment in sons and daughters: Trivers-Willard revisited. *Social Forces* 83:1111–1136.
- Hopcroft, Rosemary, and Sebastian Schnettler. 2024. Herausforderungen und Errungenschaften evolutionärer und biosozialer Ansätze in der Soziologie. In *Evolutionäre Sozialwissenschaften*, eds. Manfred Hammerl, Sascha Schwarz and Kai P. Willführ, 59–82. Wiesbaden: Springer Fachmedien Wiesbaden.
- Huinink, Johannes, and Sebastian Schnettler. 2024. Die Evolution sozialer Ungleichheit. In *Handbuch Sozialstrukturanalyse*, eds. Petra Böhnke and Dirk Konietzka. Wiesbaden: Springer VS.
- Hurrelmann, Klaus, Ullrich Bauer, Matthias Grundmann and Sabine Walper (eds.). 2015. *Handbuch Sozialisationsforschung*. 8. Auflage, vollständig überarbeitet. Weinheim: Beltz.
- Kalkhoff, Will, Shane R. Thye and Joshua Pollock. 2016. Developments in Neurosociology. *Sociology Compass* 10:242–258.
- Keller, Matthew C., Sarah E. Medland and Laramie E. Duncan. 2010. Are extended twin family designs worth the trouble? A comparison of the bias, precision, and accuracy of parameters estimated in four twin family models. *Behavior genetics* 40:377–393.
- Koellinger, Philipp D., Aysu Okbay, Hyeokmoon Kweon, Annemarie Schweinert, Richard Karlsson Linér, Jan Goebel, David Richter, Lisa Reiber, Bettina Maria Zweck, Daniel W. Belsky, Pietro Biroli, Rui Mata, Elliot M. Tucker-Drob, K. Paige Harden, Gert Wagner and Ralph Hertwig. 2023. Cohort profile: Genetic data in the German Socio-Economic Panel Innovation Sample (SOEP-G). *PLOS ONE* 18:e0294896.
- Kolk, Martin, and Sebastian Schnettler. 2013. Parental status and gender preferences for children: Is differential fertility stopping consistent with the Trivers-Willard hypothesis? *Journal of Biosocial Science* 45:683–704.
- Kolk, Martin, and Sebastian Schnettler. 2016. Socioeconomic status and sex ratios at birth in Sweden: No evidence for a Trivers-Willard effect for a wide range of status indicators. *American Journal of Human Biology* 28:67–73.
- Konner, Melvin. 2010. *The evolution of childhood: relationships, emotion, mind*. Cambridge, MA: The Belknap Press of Harvard Univ. Press.

- Kramer, Jos, and Joël Meunier. 2016. Kin and multilevel selection in social evolution: a never-ending controversy? *F1000Research* 5:776.
- Kunkel, John H. 1977. Sociobiology vs. Biosociology. *American Sociologist* 12:69–73.
- Kwon, Jung Yul, Ryan S. Hampton and Michael E. W. Varnum. 2017. The Cultural Neuroscience of Socioeconomic Status. In *Neuroscience and Social Science*, eds. Agustín Ibáñez, Lucas Sedeño and Adolfo M. García, 383–395. Cham: Springer International Publishing.
- Laland, Kevin N., and Gillian R. Brown. 2011. *Sense and nonsense: Evolutionary perspectives on human behaviour*. 2nd ed. Oxford: Oxford University Press.
- Laland, Kevin N., and William Hoppitt. 2003. Do animals have culture? *Evolutionary Anthropology* 12:150–159.
- Laland, Kevin, Blake Matthews and Marcus W. Feldman. 2016. An introduction to niche construction theory. *Evolutionary Ecology* 30:191–202.
- Laland, Kevin N., Tobias Uller, Marcus W. Feldman, Kim Sterelny, Gerd B. Müller, Armin Moczek, Eva Jablonka and John Odling-Smee. 2015. The extended evolutionary synthesis: its structure, assumptions and predictions. *Proceedings of the Royal Society B: Biological Sciences* 282:20151019.
- Laland, Kevin N., John Odling-Smee and Marcus W. Feldman. 2019. Understanding Niche Construction as an Evolutionary Process. In *Evolutionary causation: biological and philosophical reflections*, eds. Tobias Uller and Kevin N. Laland. Cambridge, MA: MIT Press.
- Landecker, Hannah, and Aaron Panofsky. 2013. From Social Structure to Gene Regulation, and Back: A Critical Introduction to Environmental Epigenetics for Sociology. *Annual Review of Sociology* 39:333–357.
- de Leeuw, Suzanne, Maaïke Hornstra and Matthijs Kalmijn. forthcoming. Relationships with Full, Half, and Stepsiblings in Adulthood: Does Coresidence Explain the Stepgap? *Journal of Marriage and the Family*.
- Lenski, Gerhard. 1977. The Decline and Fall of Sociology: An Alternative View. *Biology and the Social Sciences* 12:73–75.
- Lieberman, Debra, John Tooby and Leda Cosmides. 2007. The architecture of human kin detection. *Nature* 445:727–731.
- Lloyd, Elizabeth A. 1999. Evolutionary psychology: The burdens of proof. *Biology and Philosophy* 14:211–233.
- Lopreato, Joseph, and Timothy Alan Crippen. 1999. *Crisis in sociology: the need for Darwin*. New Brunswick, NJ: Transaction Publishers.
- Luhmann, Niklas. 1998. *Die Gesellschaft der Gesellschaft*. Berlin: Suhrkamp.
- Lundborg, Petter, and Anders Stenberg. 2010. Nature, Nurture and Socioeconomic Policy-What Can We Learn from Molecular Genetics? *Economics & Human Biology* 8(3):320–330.
- Machalek, Richard, and Michael W. Martin. 2004. Sociology and the second Darwinian revolution: A metatheoretical analysis. *Sociological Theory* 22:455–476.
- Marshall, Douglas A. 2018. Sociology's Contentious Courtship with Biology. In *The Oxford handbook of evolution, biology, and society*, vol. 1, ed. Rosemary L. Hopercroft, 33. Oxford: Oxford University Press.
- Marx, Karl, and Friedrich Engels. 1962. Marx-Engels Werke (MEW). Band 21. 4th ed. Berlin: Dietz Verlag.
- Maryanski, Alexandra. 2006. Greetings from the chair. *Evolution & Sociology* 3:1–2.
- Maryanski, Alexandra, and Jonathan H. Turner. 1992. *The Social Cage: Human Nature and the Evolution of Society*. Stanford, CA: Stanford University Press.
- Massey, Douglas S. 2000. What I don't know about my field but wish I did. *Annual Review of Sociology* 26:699–701.
- Massey, Douglas S. 2002. A brief history of human society: The origin and role of emotion in social life. *American Sociological Review* 67:1–29.
- Maynard Smith, John. 1995. Genes, memes, & minds. *The New York Review of Books* 42.
- Maynard Smith, John, and George R. Price. 1973. The Logic of Animal Conflict. *Nature* 246:15–18.
- Mayntz, Renate. 2006. Einladung zum Schattenboxen. *Die Soziologie und die moderne Biologie. Köln (MPIfG Discussion Paper 06/7)*.
- Mayr, Ernst. 1961. Cause and effect in biology. Kinds of causes, predictability, and teleology are viewed by a practicing biologist. *Science* 134:1501–1506.
- Mayr, Ernst. 1982. *The growth of biological thought: Diversity, evolution, and inheritance*. Cambridge, MA: Belknap Press.
- Mayr, Ernst. 2002. *What evolution is*. New York: Basic Books.
- Mazur, Allan. 1976. Effects of Testosterone on Status in Primate Groups. *Folia Primatologica* 26:214–226.

- Mazur, Allan. 1977. Comment on Ellis. *Biology and the Social Sciences* 12:75.
- Mazur, Allan. 1983. Hormones, Aggression, and Dominance in Humans. In *Hormones and Aggressive Behavior*, ed. Bruce B. Svare, 563–576. New York; London: Plenum Press.
- Mazur, Allan. 2017. Testosterone in biosociology: A memoir. *Hormones and Behavior* 92:3–8.
- Mazur, Allan, and Joel Michalek. 1998. Marriage, Divorce, and Male Testosterone. *Social Forces* 77:315–330.
- McGrew, William C. 1998. Culture in nonhuman primates? *Annual Review of Anthropology* 27:301–328.
- Meißelbach, Christoph. 2019. *Die Evolution der Kohäsion: Sozialkapital und die Natur des Menschen*. Wiesbaden: Springer Fachmedien Wiesbaden.
- Meleghy, Tomás, Heinz-Jürgen Niedenzu, Max Preglau, Franz Traxler and Bettina Schmeikal (eds.). 1997. *Soziologie im Konzert der Wissenschaften. Zur Identität einer Disziplin*. Opladen: Westdeutscher Verlag.
- Melzer, Wolfgang, Dieter Hermann, Uwe Sandfuchs, Mechthild Schäfer and Peter Daschner (eds.). 2014. *Handbuch Aggression, Gewalt und Kriminalität bei Kindern und Jugendlichen*. Bad Heilbrunn: UTB.
- Meyer, Peter. 1981. *Evolution und Gewalt: Ansätze zu einer bio-soziologischen Synthese*. Parey.
- Meyer, Peter. 1982. *Soziobiologie und Soziologie: eine Einführung in die biologischen Voraussetzungen sozialen Handelns*. München: Luchterhand.
- Meyer, Peter. 2000. Evolutionstheorie und Sozialwissenschaften, Akademie gemeinnütziger Wissenschaften. *Acta Academica Scientiarum* 5:109–127.
- Meyer, Peter. 2010. *Menschliche Gesellschaft im Lichte der Zweiten Darwinschen Revolution: evolutionäre und kulturalistische Deutungen im Widerstreit*. Münster: LIT Verlag.
- Meyer, Peter. 2011. Biologische Kriegstheorien. In *Handbuch Kriegstheorien*, eds. Thomas Jäger and Rasmus Beckmann, 25–35. Wiesbaden: VS Verlag für Sozialwissenschaften.
- Micheletti, Alberto, Eva Brandl, Hanzhi Zhang, Sarah Peacey and Ruth Mace. 2023. Cultural evolution research needs to include human behavioural ecology. In *Evolutionary Thinking Across Disciplines. Problems and Perspectives in Generalised Darwinism*, eds. Agathe du Crest, Martina Valković, André Ariew, Hugh Desmond, Philippe Huneman and Thomas A. C. Reydon, 501–528. Chicago: Springer.
- Micheletti, Alberto J. C., Eva Brandl and Ruth Mace. 2022. What is cultural evolution anyway? Ed. Leigh Simmons. *Behavioral Ecology* 33:667–669.
- Mills, Melinda C. 2022. Sociogenomics: theoretical and empirical challenges of integrating molecular genetics into sociological thinking. In *Handbook of Sociological Science*, eds. Klarita Gërkhani, Nan De Graaf and Werner Raub, 250–270. Cheltenham: Edward Elgar Publishing.
- von Mises, Ludwig. 1940. *Nationalökonomie. Theorie des Handelns und Wirtschaftens*. Genf: Edition Union.
- Mönkediek, Bastian, Volker Lang, Lena Weigel, Myriam A. Baum, Eike F. Eifler, Elisabeth Hahn, Anke Hufer, Christoph H. Klatzka, Anita Kottwitz, Kristina Krell, Amelie Nikstat, Martin Diewald, Rainer Riemann and Frank M. Spinath. 2019. The German Twin Family Panel (TwinLife). *Twin Research and Human Genetics* 22:540–547.
- Morgan, Lewis H. 1877. *Ancient society or researches in the lines of human progress from savagery through barbarism to civilization*. Chicago: Charles H. Kerr & Company.
- Morning, Ann. 2014. Does Genomics Challenge the Social Construction of Race? *Sociological Theory* 32:189–207.
- Müller-Schneider, Thomas. 2019. *Liebe, Glück und menschliche Natur. Eine biokulturelle Analyse der spätmodernen Paargesellschaft*. Gießen: Psychosozial-Verlag.
- Nelson, Randy J. 2011. *An introduction to behavioral endocrinology (4th edition)*. Sunderland, MA: Sinauer.
- Niedenzu, Heinz-Jürgen. 2024. Evolution, soziale. In *Grundbegriffe der Soziologie*, eds. Johannes Kopp and Anja Steinbach, 117–121. Wiesbaden: Springer Fachmedien Wiesbaden.
- Nivard, Michel G., Daniel W. Belsky, K. Paige Harden, Tina Baier, Ole A. Andreassen, Eivind Ystrøm, Elsie van Bergen and Torkild H. Lyngstad. 2024. More than nature and nurture, indirect genetic effects on children's academic achievement are consequences of dynastic social processes. *Nature Human Behaviour* 8:771–778.
- Noble, Kimberly G, and Melissa A Giebler. 2020. The neuroscience of socioeconomic inequality. *Current Opinion in Behavioral Sciences* 36:23–28.
- Okbay, Aysu, Yeda Wu, Nancy Wang, Hariharan Jayashankar, Michael Bennett, Seyed Moeen Nehzati, Julia Sidorenko, Hyeokmoon Kweon, Grant Goldman, Tamara Gjorgjieva, Yunxuan Jiang, Barry Hicks, Chao Tian, David A. Hinds, Rafael Ahlsgog, Patrik K. E. Magnusson, Sven Oskarsson, Caroline Hayward, Archie Campbell, David J. Porteous, Jeremy Freese, Pamela Herd, 23andMe Research Team, Social Science Genetic Association Consortium, Chelsea Watson, Jonathan Jala, Dal-

- ton Conley, Philipp D. Koellinger, Magnus Johannesson, David Laibson, Michelle N. Meyer, James J. Lee, Augustine Kong, Loic Yengo, David Cesarini, Patrick Turley, Peter M. Visscher, Jonathan P. Beauchamp, Daniel J. Benjamin and Alexander I. Young. 2022. Polygenic prediction of educational attainment within and between families from genome-wide association analyses in 3 million individuals. *Nature Genetics* 54:437–449.
- Parr, Thomas, Giovanni Pezzulo and K. J. Friston. 2022. *Active inference: the free energy principle in mind, brain, and behavior*. Cambridge, MA: MIT Press.
- Parsons, Talcott. 1964. Evolutionary Universals in Society. *American Sociological Review* 29:339–357.
- Pigliucci, Massimo, and Gerd B. Müller (eds.). 2010. *Evolution. The extended synthesis*. Cambridge, MA: MIT Press.
- Plomin, Robert, John C. DeFries, Valerie S. Knopik and Jenae M. Neiderhiser. 2013. *Behavioral genetics*. 6th ed. New York: Worth.
- Plomin, Robert, Agnieszka Gidziela, Margherita Malanchini and Sophie von Stumm. 2022. Gene–environment interaction using polygenic scores: Do polygenic scores for psychopathology moderate predictions from environmental risk to behavior problems? *Development and Psychopathology* 34:1816–1826.
- Polderman, Tinca J. C., Beben Benyamin, Christiaan A. de Leeuw, Patrick F. Sullivan, Arjen van Bochoven, Peter M. Visscher and Danielle Posthuma. 2015. Meta-analysis of the heritability of human traits based on fifty years of twin studies. *Nature Genetics* 47:702–709.
- Pollick, Amy S., and Frans B. M. de Waal. 2007. Ape gestures and language evolution. *Proceedings of the National Academy of Sciences* 104:8184–8189.
- Price, George R. 1970. Selection and covariance. *Nature* 227:520–521.
- Pries, Ludger. 2021. *Verstehende Kooperation Herausforderungen für Soziologie und Evolutionsforschung im Anthropozän*. Frankfurt/Main: Campus.
- Pries, Ludger. 2022. Toward a sociology of evolution in the Anthropocene–Shared intentionality and co-operation through understanding minds. *Frontiers in Sociology* 7:1079879.
- Quilley, Stephen, and Steven Loyal. 2005. Eliasian Sociology as a Central Theory for the Human Sciences. *Current Sociology* 53:807–808.
- Rehberg, Karl-Siegbert (ed.). 2008. *Die Natur der Gesellschaft: Verhandlungen des 33. Kongresses der Deutschen Gesellschaft für Soziologie in Kassel 2006*. 1st ed. Frankfurt/Main: Campus.
- Reimann, Horst, Bernhard Giesen, Dieter Goetze, Klaus Kiefer, Peter Meyer, Claus Mühlfeld and Michael Schmid. 1977. Biologische Grundlagen menschlicher Gesellschaft. In *Basale Soziologie: Hauptprobleme. Studienreihe Gesellschaft*, eds. Horst Reimann, Bernhard Giesen, Dieter Goetze, Klaus Kiefer, Peter Meyer, Claus Mühlfeld and Michael Schmid, 7–26. Opladen: Westdeutscher Verlag.
- Richerson, Peter J., and Robert Boyd. 2005. *The origin and evolution of cultures*. New York, NY: Oxford University Press.
- Richerson, Peter, Ryan Baldini, Adrian V. Bell, Kathryn Demps, Karl Frost, Vicken Hillis, Sarah Mathew, Emily K. Newton, Nicole Naar, Lesley Newson, Cody Ross, Paul E. Smaldino, Timothy M. Waring and Matthew Zefferman. 2016. Cultural group selection plays an essential role in explaining human cooperation: A sketch of the evidence. *Behavioral and Brain Sciences* 39:e30.
- Richter, Dirk. 2005. Das Scheitern der Biologisierung der Soziologie. *Kölner Zeitschrift für Soziologie und Sozialpsychologie* 57:523–542.
- Rotkirch, Anna. 2007. ‘All that she wants is a(nother) baby’? Longing for children as a fertility incentive of growing importance. *Journal of Evolutionary Psychology* 5:89–104.
- Rotkirch, Anna. 2012. Baby longing and men’s reproductive motivation. *Vienna Yearbook of Population Research* 9:283–306.
- Rotkirch, Anna. 2018. Evolutionary family sociology. In *The Oxford Handbook of Evolution, Biology, and Society*, vol. 1, ed. Rosemary L. Hopcroft, 451–477. Oxford: Oxford University Press.
- Runciman, Walter G. 2008. Forgetting the founders. *The Sociological Review* 56:358–369.
- Runciman, Walter Garrison. 2009. *The theory of cultural and social selection*. Cambridge: Cambridge University Press.
- van Schaik, Carel P., Marc Ancrenaz, Gwendolyn Borgen, Birute Galdikas, Cheryl D. Knott, Ian Singleton, Akira Suzuki, Sri Suci Utami and Michelle Merrill. 2003. Orangutan Cultures and the Evolution of Material Culture. *Science* 299:102–105.
- Scherger, Simone. 2008. Biologische Uhr oder biographische Pläne? Das Timing von erster Elternschaft im Lebenslauf als Testfall für soziobiologische Argumente. In *Die Natur der Gesellschaft. Verhandlungen des 33. Kongresses der Deutschen Gesellschaft für Soziologie in Kassel 2006*, ed. Karl-Siegbert Rehberg, 925–940. Frankfurt/Main: Campus.

- von Scheve, Christian. 2011. Sociology of neuroscience or neurosociology? In *Sociological Reflections on the Neurosciences*, vol. 13, *Advances in Medical Sociology*, eds. Martyn Pickersgill and Ira Van Keulen, 255–278. Leeds: Emerald Group Publishing Limited.
- Schmid, Michael. 1982. *Theorien sozialen Wandels*. Opladen: Westdeutscher Verlag.
- Schnettler, Sebastian. 2010. “Nature + nurture = love? A test of the Trivers-Willard hypothesis of differential parental investment on the basis of sociological and biological explanations.” Dissertation, Ann Arbor, MI: UMI: Yale University.
- Schnettler, Sebastian. 2013. Revisiting a sample of U.S. billionaires: How sample selection and timing of maternal condition influence findings on the Trivers-Willard effect. *PLoS ONE* 8:e57446.
- Schnettler, Sebastian. 2016. Evolutionäre Soziologie. *Soziologische Revue* 39:507–536.
- Schnettler, Sebastian. 2017. Maternal and Offspring Condition. In *Encyclopedia of Evolutionary Psychological Science*, eds. Todd K. Shackelford and Viviana A. Weekes-Shackelford, 1–3. Cham: Springer International Publishing.
- Schnettler, Sebastian. 2020. Sociobiology Wars, The. In *Encyclopedia of Evolutionary Psychological Science*, eds. Todd K. Shackelford and Viviana A. Weekes-Shackelford, 1–3. Cham: Springer International Publishing.
- Schnettler, Sebastian, and Samuel Nelson. 2015. Aggression und Gewalt. In *Die menschliche Psyche zwischen Natur und Kultur*, eds. Benjamin P. Lange and Sascha Schwarz, 150–159. Lengerich: Papst Publishers.
- Schnettler, Sebastian, and Anja Steinbach. 2011. How do biological and social kinship play out within families in the U.S.? An evolutionary perspective on perceived parental care and closeness in adolescents. *Zeitschrift für Familienforschung* 23:173–195.
- Schnettler, Sebastian, and Anja Steinbach. 2022. Is Adolescent Risk Behavior Associated With Cross-Household Family Complexity? An Analysis of Post-separation Families in 42 Countries. *Frontiers in Sociology* 7:802590.
- Sear, Rebecca, and Cathryn Townsend. 2023. “Dysgenic fertility” is an ideological, not a scientific, concept. A Comment on: ‘Stability and change in male fertility patterns by cognitive ability across 32 birth cohorts’ (2023), by Bratsberg and Rogeberg. *Biology Letters* 19:20230390.
- Segerstråle, Ullica Christina Olofsdotter. 2000. *Defenders of the truth: The battle for science in the socio-biology debate*. Oxford: Oxford University Press.
- Segerstråle, Ullica Christina Olofsdotter. 2001. World views and Trojan horses in the sociobiology debate. *Journal of Biosciences* 26:549–554.
- Segerstråle, Ullica Christina Olofsdotter. 2016. The Westermarck thesis as a thinking tool for sociobiology. In *Evolution, Human Behaviour, and Morality. The legacy of Westermarck*, eds. Olli Lagerspetz, Jan Antfolk, Ylva Gustafsson and Camilla Kronqvist. London: Routledge.
- Shanahan, Michael J., and Scott M. Hofer. 2005. Social Context in Gene–Environment Interactions: Retrospect and Prospect. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 60:65–76.
- Shanahan, Michael J., Frank J. Sulloway and Scott M. Hofer. 2000. Change and constancy in developmental contexts. *International Journal of Behavioral Development* 24:421–427.
- Shepher, Joseph. 1971. Mate selection among second generation kibbutz adolescents and adults: Incest avoidance and negative imprinting. *Archives of Sexual Behavior* 1:293–307.
- Shepher, Joseph. 1983. *Incest: a Biosocial View*. New York: Academic Press.
- Silk, Joan B. 1990. Which humans adopt adaptively, and does it matter? *Ethology and Sociobiology* 11:425–426.
- Simons, Ronald L., Man-Kit Lei, Eric Klopach, Mark Berg, Yue Zhang and Steven S. R. Beach. 2021a. (Re)Setting Epigenetic Clocks: An Important Avenue Whereby Social Conditions Become Biologically Embedded across the Life Course. *Journal of Health and Social Behavior* 62:436–453.
- Simons, Ronald L., Man-Kit Lei, Eric Klopach, Steven R. H. Beach, Frederick X. Gibbons and Robert A. Philibert. 2021b. The effects of social adversity, discrimination, and health risk behaviors on the accelerated aging of African Americans: Further support for the weathering hypothesis. *Social Science & Medicine* 282:113169.
- Skordoulis, Constantine D. 2019. Marx, Natural Science and the Materialist Conception of Nature. *Educazione Aperta: Rivista di Pedagogia Critica* 6:205–226.
- Spencer, Herbert. 1864. *Principles of biology*. London and Edinburgh: Williams and Norgate.
- Spörlein, Christoph. 2024. *Eine Soziologische Einführung in die Verhaltensgenetik*. 1st ed. Boston: De Gruyter.
- Steinbach, Anja. 2015. Stieffamilien. In *Handbuch Familiensoziologie*, eds. Paul B. Hill and Johannes Kopp, 563–610. Wiesbaden: Springer Fachmedien.

- Tal, Ilanit, and Debra Lieberman. 2007. Kin detection and the development of sexual aversions: Toward an integration of theories on family sexual abuse. In *Family relationships: an evolutionary perspective*, eds. Catherine Salmon and Todd K. Shackelford, 205–230. New York: Oxford University Press.
- Tang, Shiping. 2020. *On social evolution: phenomenon and paradigm*. First Edition. New York: Routledge.
- Tanskanen, Antti O., and Mirkka Danielsbacka. 2018. *Intergenerational family relations: an evolutionary social science approach*. 1 Edition. New York: Routledge.
- Tanskanen, Antti O., Mirkka Danielsbacka and Anna Rotkirch. 2020. Grandparental Childcare for Biological, Adopted, and Step-Offspring: Findings From Cross-National Surveys. *Evolutionary Psychology* 18:147470492090789.
- Taylor, Catherine J. 2012. A Sociological Overview of Cortisol as a Biomarker of Response to the Social Environment. *Sociology Compass* 6:434–444.
- Taylor, Catherine J. 2014. Physiological stress response to loss of social influence and threats to masculinity. *Social Science & Medicine* 103:51–59.
- Thompson, R. F. 2001. Behavioral neuroscience. In *International encyclopedia of the social & behavioral sciences*, eds. Neil J. Smelser and Paul B. Baltes, 1118–1125. Oxford: Pergamon.
- Trivers, Robert. 2006. Reciprocal altruism: 30 years later. In *Cooperation in Primates and Humans. Mechanisms and Evolution*, eds. Peter M. Kappeler and Carel P. Schaik, 67–83. Berlin: Springer.
- Trivers, Robert L. 1971. The Evolution of Reciprocal Altruism. *The Quarterly Review of Biology* 46:35–57.
- Trivers, Robert L., and Dan E. Willard. 1973. Natural Selection of Parental Ability to Vary the Sex Ratio of Offspring. *Science* 179:90–92.
- Turchin, Peter. 2018. *Historical dynamics: why states rise and fall*. Princeton, NJ: Princeton University Press.
- Turner, Jonathan H. 2003. *Human institutions. A new theory of societal evolution*. Lanham, MD: Rowman and Littlefield.
- Turner, Jonathan H., and Richard Machalek. 2018. *The new evolutionary sociology: recent and revitalized theoretical and methodological approaches*. 1 Edition. New York: Routledge, Taylor & Francis Group.
- Turner, Jonathan H., and Alexandra Maryanski. 2008. *On the origins of societies by natural selection*. Boulder: Paradigm Press.
- Turner, Jonathan D., Conchita D'Ambrosio, Claus Vögele and Martin Diewald. 2020. Twin Research in the Post-Genomic Era: Dissecting the Pathophysiological Effects of Adversity and the Social Environment. *International Journal of Molecular Sciences* 21:3142.
- Udry, J. Richard. 1994. The Nature of Gender. *Demography* 31:561–573.
- Udry, J. Richard. 1995. Sociology and biology: What biology do sociologists need to know? *Social Forces* 73:1267.
- Udry, J. Richard. 2000. Biological Limits of Gender Construction. *American Sociological Review* 65:443–457.
- Udry, J. Richard. 2001. Feminist Critics Uncover Determinism, Positivism, and Antiquated Theory. *American Sociological Review* 66:611–618.
- Udry, J. Richard, Naomi M. Morris and Judith Kovenock. 1995. Androgen Effects on Women's Gendered Behaviour. *Journal of Biosocial Science* 27:359–368.
- Van den Berghe, Pierre L. 1979. *Human family systems: An evolutionary view*. Westport, CT: Greenwood Pub Group.
- Van den Berghe, Pierre L. 1981. *The ethnic phenomenon*. New York: Elsevier.
- Van den Berghe, Pierre L. 1990. Why most sociologists don't (and won't) think evolutionarily. *Sociological Forum* 5:173–185.
- Voland, Eckart, and Christoph Meißelbach. 2021. Verständigungsbarrieren zwischen kulturalistischen Sozialwissenschaften und evolutionärer Anthropologie: Ursachen, Argumente und Auswege. *Kölner Zeitschrift für Soziologie und Sozialpsychologie* 73:85–107.
- Vollmer, Gerhard. 1998. *Evolutionäre Erkenntnistheorie: Angeborene Erkenntnisstrukturen im Kontext von Biologie, Psychologie, Linguistik, Philosophie und Wissenschaftstheorie*. Stuttgart: S. Hirzel.
- Wade, Nicholas. 1976. Sociobiology: Troubled Birth of New Discipline. *Science* 191:1151–1155.
- Wahl, Klaus. 2009. *Aggression und Gewalt: ein biologischer, psychologischer und sozialwissenschaftlicher Überblick*. 1. Aufl. Heidelberg: Spektrum Akademischer Verlag.
- Walsh, Anthony. 2014. *Biosociology: Bridging the biology-sociology divide*. New Brunswick: Transaction Publishers.
- Wenzel, Harald. 1998. Zeit, Prozeß, Evolution und Geschichte in Parsons' Sozialtheorie. In *Soziologische Theorie und Geschichte*, eds. Frank Welz and Uwe Weisenbacher, 155–196. Wiesbaden: Westdeutscher Verlag.

- Westermarck, Edward. 1891. *The History of Human Marriage*. London: Macmillan.
- Westermarck, Edward A. 1906. *The Origin and Development of the Moral Ideas*. London: Macmillan.
- Whiten, A., J. Goodall, W. C. McGrew, T. Nishida, V. Reynolds, Y. Sugiyama, C. E. G. Tutin, R. W. Wrangham and C. Boesch. 1999. Cultures in chimpanzees. *Nature* 399:682–685.
- Wiegele, Thomas C. (ed.). 2019. *Biology and the Social Sciences: An Emerging Revolution*. New York; Abingdon: Routledge.
- Wilson, Edward O. 1971. The Prospects for a Unified Sociobiology: This important branch of behavioral biology should be joined with population biology. *American Scientist* 59:400–403.
- Wilson, Edward O. 1998. *Consilience: the unity of knowledge*. 1st ed. New York: Random House.
- Wilson, Edward O. 2012. *The social conquest of earth*. 1. ed. New York: Liveright.
- Wilson, David Sloan, and Elliott Sober. 1994. Reintroducing group selection to the human behavioral sciences. *Behavioral and Brain Sciences* 17:585–608.
- Wilson, David Sloan, and Edward O. Wilson. 2008. Evolution “for the Good of the Group.” *American Scientist* 96:380–389.
- Winterhalder, Bruce, and Eric Alden Smith. 2000. Analyzing adaptive strategies: Human behavioral ecology at twenty-five. *Evolutionary Anthropology* 9:51–72.
- Yang, Jian, Teri A. Manolio, Louis R. Pasquale, Eric Boerwinkle, Neil Caporaso, Julie M. Cunningham, Mariza de Andrade, Bjarke Feenstra, Eleanor Feingold, M. Geoffrey Hayes, William G. Hill, Maria Teresa Landi, Alvaro Alonso, Guillaume Lettre, Peng Lin, Hua Ling, William Lowe, Rasika A. Mathias, Mads Melbye, Elizabeth Pugh, Marilyn C. Cornelis, Bruce S. Weir, Michael E. Goddard and Peter M. Visscher. 2011. Genome partitioning of genetic variation for complex traits using common SNPs. *Nature Genetics* 43:519–525.

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