



The dark side of niche construction

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Accepted: 26 July 2023 / Published online: 23 August 2023
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Abstract

Niche construction denotes the alteration, destruction, or creation of environmental features through the activities of an organism, modifying the relation between organism and environment. The concept of niche construction found application in various fields of research: evolutionary biology, enculturation, ontogenetic development, and local organism-environment coordination. This is because it provides a useful tool emphasizing different aspects of the dynamic interplay between organisms and their actively constructed environment. Traditionally, niche construction is considered a positive mechanism in the complementarity of organism and environment. In contrast, this paper sheds light on the dark side of niche construction, that is, the different manners in which organisms may modify environmental features that are in some way or another harmful to them. First, the paper introduces a paradigmatic distinction of four kinds of niche construction as commonly addressed in recent literature, using more or less extended spatio-temporal scales as the distinguishing feature. Second, the paper elaborates on the concept of negative niche construction, providing normative criteria of (mal)adaptation that are suitable for the evaluation of environmental alterations, given the chosen spatio-temporal scale. Of particular interest are inter-scale conflicts: those cases of environmental constructions which appear adaptive concerning one spatio-temporal scale but maladaptive concerning another. Third, the paper distinguishes the concept of niche construction as a valuable instrument to better understand central aspects of modern medicine and the entangled contribution of evolutionary, socio-cultural, personal, and situational aspects to different health issues, using chronic pain as an illustrative case study.

Keywords Phylogenetic niche construction · Sociogenetic niche construction · Ontogenetic niche construction · Organism-niche coordination · Negative niche construction · Chronic pain

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1 Introduction

In evolutionary biology, *niche construction* denotes the alteration, destruction, or creation of environmental features through the activities of organisms. Niche construction theories are primarily concerned with the question of how these modifications affect the relation between organisms and their environment, that is, how organisms themselves can influence the selection pressures acting upon them (e.g., Laland et al., 2000; Odling-Smee et al., 2003). Organisms are not only shaped by but actively shape their living conditions, thus, co-determining their evolutionary fate (e.g., Aaby & Ramsey, 2019; Trappes et al., 2022). For example, many species of animals build burrows, holes, nests, and dams, changing the selective challenges that members of the respective population are exposed to. While the concept of niche construction originated in the study of phylogenetic processes, it has been systematically broadened and employed in different areas of research, including socio-cultural innovation (e.g., Laland & O'Brien, 2011; Laland & Sterelny, 2006; Stotz, 2017), ontogenetic development (e.g., Colombetti, 2017; Krueger, 2014; Sutton, 2010), and coordination with the local environment (e.g., Bertolotti & Magnani, 2017; Clark, 2005; Constant et al., 2020).

The central aim of this paper is to investigate the dark side of niche construction: the conditions under which niche construction, which is commonly considered adaptive, can turn maladaptive. Such maladaptive cases, referred to as *negative niche construction*, are so far mentioned only sporadically in the literature (e.g., Aaby & Ramsey, 2019; Laland et al., 2000; Trappes et al., 2022). The concept of negative niche construction, however, offers much greater potential, especially when humans and modern developments in human history come into focus (e.g., Bertolotti & Magnani, 2013, 2015). The paper aims to fill this gap in the literature, developing a comprehensive framework to address various forms of negative niche construction and explore applications in which this framework provides a useful research perspective. The focus of the paper is on multifaceted *health issues* and the challenges they pose for *modern medicine*.

As a first step, the paper addresses what niche construction is and in which different manners it has been conceptualized. In recent literature, the concept of niche construction found application in various research areas beyond evolutionary biology. For the sake of the argument, we may accept that in all these areas it makes a fruitful contribution by emphasizing different aspects of the dynamic interplay between organisms and their actively constructed environment (e.g., Clark, 2008; Krueger, 2014). What we lack, however, is a systematic analysis of how these, often isolated, strands of research relate to each other (e.g., Fabry, 2021). The paper develops a comprehensive framework, taking into account different kinds of niche construction characterized along different *spatio-temporal scales* (e.g., Coninx & Stephan, 2021; Sinha, 2015). On that basis, it addresses the concept of negative niche construction, discussing the most suitable *normative criteria* to distinguish between adaptive and maladaptive cases, given the more or less spatio-temporally extended perspective we employ. Of particular interest are

inter-scale conflicts: cases of environmental modification which appear adaptive concerning one spatio-temporal scale but maladaptive concerning another.

As a second step, the paper distinguishes this framework of (negative) niche construction as a useful instrument to research central aspects of contemporary human life, especially issues of modern medicine and healthcare. Eating disorders (e.g., Anorexia Nervosa) and affective disorders (e.g., depression) function as illustrative examples together with *chronic pain* as a more detailed case study. In particular, the niche construction framework fosters examinations on the role that the active manipulation of external conditions plays for health issues by generating complex feedback cycles in the interaction of individuals and social groups with their environment. Taking multiple spatio-temporal scales into account enables us to systematically explore the entangled contribution of phylogenetic, socio-cultural, personal, and situational aspects to this. Integrating inter-scale conflicts allows us to consider mismatches between ancient evolutionary contexts and modern social constructions or to explain why we often modify our environment in a manner that is beneficial in the situation but harmful in longer terms. The paper thereby draws on existing research concerning inter-scale conflicts in health issues (e.g., Büchel, 2021; Williams, 2016; Eaton et al., 1988) and locates the niche construction framework in the broader tradition of multifactorial approaches to medicine (e.g., Engel, 1977).

The objective of this endeavor is *not* to prove that the niche construction framework uncovers yet unknown inter-scale conflicts or that it has a monopoly position in addressing multifaceted health issues. The framework, however, provides a distinct perspective that may serve several purposes. First, developing a more nuanced picture of niche construction does not only enable us to exploit the full conceptual potential of the framework, but also to facilitate and motivate communication between related research strands and to explore possibilities of integrating corresponding results. In particular, as acknowledging the complex dynamics in the interaction of organisms and their environment and the intertwining of phylogenetic, socio-cultural, personal, and situational aspects is an integral part of the framework. Second, the niche construction framework emphasizes that we are not only passively molded by external challenges but that we actively contribute, as individuals and members of social groups, to different health issues. While this is not a matter of blaming anyone, it may open up possibilities to research intervention options that have received little attention so far.

The paper proceeds as follows: Sect. 2 sets the stage for the overall project, introducing a pragmatic distinction between four kinds of niche construction based on different spatio-temporal grains of analysis: phylogenetic, sociogenetic, ontogenetic, and microgenetic niche construction. Section 3 explores the concept of negative niche construction and discusses the most suitable normative criteria to distinguish between adaptation and maladaptation, depending on the considered spatio-temporal scales and stakeholders whose interests are taken into account. The focus is on the different ways in which conflicts can arise between the identified normative criteria. Section 4 addresses the question of how the concept of niche construction and the different criteria of (mal)adaptation can help

us to better understand central aspects of modern medicine and healthcare with chronic pain as an illustrative case study. Section 5 summarizes these results.

2 Four kinds of niche construction

This section outlines the general concept of niche construction and provides a systematic analysis of its different applications and their relation to each other. A four-fold division is introduced based on different spatio-temporal scales representing different grains of analysis. This section provides the overarching conceptual framework based on which the dark side of niche construction is to be investigated in the upcoming sections.

In evolutionary biology, a *niche* is commonly considered a set of environmental features suitable for an organism with certain traits, abilities, skills, interests, and needs. *Niche construction* denotes those alteration, destruction, or creation of environmental features actively changing the relation between organism and environment (Laland et al., 2000; Odling-Smee et al., 2003).¹ As such, organisms are no longer considered as merely passively molded by the external selection pressures they are exposed to. In contrast, organisms may actively alter environmental sources of selection pressures, intentionally or non-intentionally. Thus, organisms co-evolve with their environment and must be considered as effects as well as causes within evolutionary dynamics (Laland et al., 2011, 2015).

The environmental features to be modified are manifold: material objects, arrangements, events, other organisms, epistemic systems, cultural structures, social practices, norms, or conventions (Jablonka & Lamb, 2005; Odling-Smee et al., 2003). Niche construction plays a crucial role in addressing a variety of challenges related to survival and reproduction, such as foraging, mating, breeding, sheltering, or protection from predators by modifying the material environment (e.g., by building dams or using tools) and/or interacting with other organisms (e.g., cross-species synergies or pack hunting). The effects of niche construction are not limited to the sources of selection pressure directly acting upon the members of a species. The respective modifications also have effects on the broader ecosystem, biome, and biosphere which reciprocally affect the niche constructing organisms and pose new challenges to be addressed (Aaby & Ramsey, 2019; Archetti, 2015). Niche construction is by no means limited to *humans*, but they are the focus of this paper as especially potent and extreme niche constructors (Sterelny, 2018).

In recent literature, the concept of niche construction found fruitful application in research areas beyond evolutionary biology, concerning enculturation, situated cognition, or extended functionalism (e.g., Clark, 2005; Colombetti, 2017; Constant





¹ There are multiple niche-alternating mechanisms (Archetti, 2015; Odling-Smee et al., 2003; Trappes et al., 2022). Besides actively modifying factors in the environment, organisms might also permanently, periodically, and episodically change their environment (e.g., bird migration) or adjust their phenotype (e.g., timing reproductive phases with ambient temperature). In this paper, the focus is on active modifications of environmental features as most relevant for humans.

et al., 2020; Fabry, 2021; Menary, 2018; Stotz, 2017). This paper follows the work of Fabry (2021) in that to avoid misunderstandings and further the overall debate, it is necessary to distinguish the different applications of the concept of niche construction: each application comes with a different scope and epistemic interest and thus proves useful to address different research questions. Based on this idea, a distinction is suggested referring to different processes of the interaction between populations, subpopulations, or individuals with their constructed environment over more or less far-reaching time spans. That is, these different kinds of niche construction are distinguished based on more or less extended *spatio-temporal scales* in the analysis of how humans actively modify their environment. Accordingly, we may refer to *four kinds of niche construction* labeled (a) phylogenetic, (b) sociogenetic, (c) ontogenetic, and (d) microgenetic – each providing a different perspective on the reciprocal relationship between organisms and their environment to be examined in more detail in the following (for an illustration see Table 1).²

- (a) *Phylogenetic (or selective) niche construction* refers to the collective modification of environmental features through the activities of a population, leading to alterations in the genetic pool of that population (Flynn et al., 2013; Laland & O'Brien, 2011; Laland et al., 2000, 2015; Odling-Smee et al., 2003; Stotz, 2017; Uller & Helanterä, 2019). Phylogenetic niche construction characterizes the central mechanism of gene-culture co-evolution (Sterelny, 2010): collective alterations of environmental features constrain and direct selective pressures on the members of a species, affecting the internal genetic inheritance transmitted by parents to their offspring via reproduction, constraining and directing their further alterations of environmental features. For present purposes, the evolutionary process along which the genus *homo* and its traits evolved is of most interest. Thus, the relevant unit of analysis is humanity as such or relatively coarse-grained human populations. The relevant time spans to consider are thousands or even millions of years, as genetic accommodations are typically relatively slow processes. Food processing is an illustrative case showing how the human ability to externalize steps of digestion or to make certain nutrition more easily accessible through niche construction led to genetic modifications. For example, the human digestive system co-evolved with the culturally developed and maintained capacity to use fire for cooking, and populations with a history of dairy farming show genes relevant for dairy consumption (Sterelny, 2010).
- (b) *Sociogenetic (or developmental) niche construction* refers to the collective modification of environment features through the activities of a (sub)population, leading to alterations in heritable phenotypical properties of such (sub) population (Laland et al., 2015; Stotz, 2010, 2017; Uller & Helanterä, 2019).

² In the work of Fabry (2021), we find a classification of three kinds of niche construction. Here, a more fine-grained distinction is made concerning the interaction of individuals with their environment as ongoing or occurrent, referring to the work of Sinha (2015). A similar taxonomy relying on spatio-temporal scales can be found in Coninx & Stephan (2021).

Table 1 Four kinds of niche construction

	Phylogenetic	Sociogenetic	Ontogenetic	Microgenetic
Spatial Scope	Species, populations	(Sub)populations	Individual	Individual
Temporal Scope	Up to thousands and millions of years	Multiple generations	Developmental stages	Here-and-now
Inheritance	Genetic—exogenetic	Exogenetic	Intra-individual	Situation-bound
Depiction				
Example	Co-evolution of the human digestive system and the capacity to use fire for cooking	Culturally variant development of institutional structures facilitating language acquisition	Structuring of the material and social environment to facilitate emotion regulation	Local arrangements of objects in space to support memory

This kind of niche construction often provides an evolutionary shortcut (Laland & O'Brien, 2011; Menary, 2018): while sociogenetic niche constructions can in principle lead to genetic adaptations, they often enable much faster, purely exogenetic adaptations. For example, food taboos or social conventions concerning food processing can reduce the effects of poisoning within a period in which genetically inherited changes in the digestion of toxic substances could not take place (Henrich, 2015; Henrich & Henrich, 2010). The concept of sociogenetic niche construction particularly highlights that environmental modifications do not only play a central role for selection and survival but also allow for ecological inheritance that, alongside genetic inheritance, constraints and directs the development of future generations and accounts for inter-cultural variations in phenotypic traits (Stotz, 2010, 2017). Sociogenetic niche construction is collective, not individualistic, and typically spans multiple generations (Sterelny, 2018). It involves the inheritance of cultivated land, property, and artefacts as well as phenotypical variations resulting from the transition of knowledge, practices, or norms (Menary, 2018; Odling-Smee & Laland, 2011; Sterelny, 2009; Stotz, 2017). This includes the manipulation of the educational environment, such as creating institutional structures to facilitate language acquisition or the development of emotional skills (Bertolotti & Magnani, 2017; Kendal, 2011; Stotz, 2010).³

- (c) *Ontogenetic (or personal) niche construction* refers to an individual's idiosyncratic engagement with their environment, leading to alterations in phenotypical properties along their life-span (Sutton, 2016; Trappes et al., 2022).⁴ Ontogenetic niche construction emphasizes inter-individual differences in how organisms alter their environment, shaping their ongoing engagement with the world. This is expressed in and maintained by relatively stable patterns of interaction, which dynamically develop with different stages of an individual's life. Ontogenetic niche construction enables intra-individual inheritance as the abilities of an organism co-evolve with the construction of their personal niche. Humans actively manipulate their environment (e.g., furnishing their apartment or building up significant relationships) to diachronically manipulate, for example, their affective states, providing a reliable standing source for emotional regulation (Colombetti & Krueger, 2015; Colombetti & Roberts, 2015; Krueger, 2014). Similarly, individuals may alter their material, symbolic, or social environment in a manner that facilitates their ability to remember or forget past events and

³ In terms of more recent sociogenetic processes, modern financial markets or social media constitute techno-social niches relevant to multiple aspects of human life (Bertolotti & Magnani, 2013, 2015; Krueger & Osler, 2019; Nagatsu & Salmela, 2022).

⁴ As a terminological remark, ontogenetic niche construction is not understood as the phylogenetic and sociogenetic legacies that create the developmental environment for future generations (Stotz, 2017; West & King, 1987). Furthermore, not only individuals but also smaller social groups could in principle come into focus from an ontogenetic perspective, for example, when considering the changing dynamics of a couple. Here, the focus is on individuals in relation to their physical and social environment while collective forms of niche construction are addressed only from a phylogenetic or sociogenetic perspective.

thus shape their self-narrative (Caravà, 2020; Fabry, 2023; Heersmink, 2018, 2020; Sutton et al., 2010). Characteristic for all cases of ontogenetic niche construction is that the environmental alterations are maintained by an individual over a longer period and form more or less stable sources to develop or shape certain abilities.

- (d) *Microgenetic (or local) niche construction* denotes singular environmental modifications in the here-and-now, leading to local alterations in the dynamic organism-environment coordination (Bertolotti & Magnani, 2017; Clark, 2005, 2006; Constant et al., 2020; Menary, 2013). As illustrations for microgenetic niche construction, we may think of cases of arranging objects in space to support memory in a particular context (Clark, 2005, 2006), the interaction of infants and caregivers that allows for local social coordination (Krueger, 2014; Varga & Krueger, 2013), the modification and creation of concrete emotional episodes through engagements with music (Krueger, 2015, 2018a) and art (Saarinen, 2019), or the use of a pedagogical aid in a particular learning step. The distinctive feature of microgenetic niche construction is its spatial and temporal locality as it does not necessarily allow for inheritance, inter- or intra-individually, beyond the respective situation in which the environmental construction is used. The focus is on the modulation of environmental features in real-time concerning a specific task.⁵

Finally, it shall be noted that these four kinds of niche construction are *partly overlapping* and *dynamically intertwined* (Laland & O'Brien, 2011; Stotz, 2017). Any form of niche construction leads to new feedback cycles and this often opens up new challenges that a population, subpopulation, or individual needs to adapt to (Laland et al., 2000). For example, the phylogenetic development of joint hunting may trigger the development of more enhanced socio-cognitive competencies of cooperation that are inherited as phenotypical properties of a subpopulation (Whiten & Erdal, 2012). Similarly, cultural changes may increase the pressure on certain individuals to develop more or less stable patterns of behavior in interaction with these new environmental factors. The other way around, sociogenetic developments might foster genetic assimilation. For example, it seems reasonable to assume that the knowledge to use fire for cooking has been transmitted over several generations before leading to genetic changes related to the human digestive system. Similarly, local adaptations of environmental features can slowly become entrenched and integrated into rather stable forms of ontogenetic niche construction when repeatedly performed (Caravà & Scorolli, 2020). That is, more extended processes emerge as less extended processes scale up across individuals and over time while less extended processes are constrained by more extended processes (Laland et al., 2015; Trappes et al., 2022).

⁵ In principle, directly interacting social groups could also be addressed from a microgenetic perspective, while the focus here remains, again, on individuals.

In sum, the different kinds of niche construction characterize spatio-temporally more or less extended aspects of the ongoing evolving interaction between humans and their environment which enables us to answer different questions concerning the same phenomena (Fabry, 2021). For example, we may consider the role of niche construction for emotion regulation in terms of the phylogenetic context of tribal life, the structures of modern societies, the creation and maintenance of significant interpersonal relationships, or rather local social interactions. While the processes singled out by the respective perspectives cannot be analyzed as fully separate, some of them are slower and concern a significantly larger group of individuals. Therefore, the four kinds of niche construction determine each other in different manners and allow for different kinds of intervention (Coninx & Stephan, 2021). For example, phylogenetic niche construction necessarily constrains forms of ontogenetic niche construction as an individual's interactions with the environment are at least partly determined by evolutionary history. In contrast, although processes of phylogenetic niche construction are determined by the niche construction of a multiplicity of individuals (Trappes et al., 2022), a particular individual usually plays only a subordinate role in the overall development of humankind. At the same time, phylogenetic processes are very slow. Thus, pragmatically speaking, interventions must address faster collective or individual changes in environmental features (Laland et al., 2000).

3 Negative niche construction

Niche construction is paradigmatically treated as a way to make the environment more beneficial for a population, subpopulation, or individual. However, this does not exclude the possibility that organisms sometimes alter environmental features in a manner that is harmful to them. The process of niche construction as such only characterizes the modification of external features through the activities of an organism, changing their relation to the environment. Whether this change is for better or worse requires an additional evaluation. Thus, although it seems plausible that positive kinds of niche construction in general prevail, *negative niche construction* may occur in different forms.

So far, there is only little discussion on the topic of negative niche construction. In the literature on evolutionary biology, we can find some examples of organisms that strip their environment of survival relevant resources, leading to systematic habitat degradation or ultimately even their extinction (e.g., Laland et al., 2020; Trappes, 2021; Trappes et al., 2022). However, the notion of negative niche construction might find useful application beyond evolutionary biology. For example, Bertolotti and Magnani (2015) introduce the notion of a 'terminator niche', characterizing the social construction of hyper-technological environments that ultimately turn out as maladaptive, although they previously proved (or were thought to prove) beneficial. Furthermore, although not explicitly relying on the concept of negative niche construction, it has been recognized that individual modifications of the environment and the ability to do so can play a relevant role in the emergence and treatment of

psychopathologies (e.g., Glackin et al., 2020; Krueger & Colombetti, 2018; Krueger, 2018b; Osler & Krueger, 2021).

To further exploit the conceptual potential of the niche construction framework and bring together promising but previously isolated strands of research, the dark side of niche construction deserves closer examination, in particular concerning the different spatio-temporal perspectives that we might employ in the evaluation of adaptation and maladaptation. Section 3.1 introduces the general concept of negative niche construction as well as *four normative criteria* that enable us to evaluate different forms of niche construction as positive or negative. Section 3.2 addresses those kinds of negative niche construction resulting from *inter-scale conflicts*, that is, conflicts in the evaluation of environmental modifications from different spatio-temporal perspectives.

3.1 Criteria of (mal)adaptation

In the discussion of negative or positive niche construction, the concepts of *adaptation* and *maladaptation* are key. Broadly construed, adaptation is a change in the relation between organism and environment. Narrowly construed, adaptation is a change for the better with maladaptation as its counterpart: adaptive processes serve the interests, concerns, and needs of a stakeholder while maladaptive processes counteract them. When a process is to be considered adaptive or maladaptive is a complex issue and we should rarely expect dichotomous classifications of universally beneficial or universally harmful processes. Our corresponding evaluations should be sensitive to different epistemic perspectives, allowing for conflicts of different interests, concerns, and needs. Thus, in the distinction between positive and negative niche construction, different normative criteria are required to indicate when environmental constructions are beneficial or harmful for certain stakeholders concerning certain spatio-temporal scales.

Traditionally, adaptation and maladaptation are understood in terms of *fitness*. That is, the decisive criterion for the evaluation of benefit or harm is whether environmental modifications prove contributory or detrimental to survival and ultimately reproduction (e.g., Odling-Smee et al., 2003). Independent of how we exactly define and measure fitness, it is of primary relevance for explanations in evolutionary biology. In contrast, when studying sociogenetic, ontogenetic, and microgenetic niche construction in humans, our scientific interests seem to be different from, or at least not exhausted by, considerations on biological self-maintenance and genetic inheritance. In employing a sociogenetic perspective, we are rather interested to know whether environmental modifications allow a society to thrive in terms of epigenetic, ecological, cultural, political, financial, or epistemic inheritance (e.g., Stotz, 2010). In employing an ontogenetic perspective, we are primarily interested in whether a person can benefit from niche construction in terms of their well-being, that is, in terms of their ability to lead a decent, dignified, and meaningful life related to their personally determined concerns and needs (e.g., de Haan, 2021). Humans do not only strive to self-maintain and reproduce but to prosper and progress in their personal development, for example, by sustaining and amplifying their affective life

(e.g., Colombetti & Krueger, 2015). In employing a microgenetic perspective, the focus is on whether agents can successfully engage with their environment in the here-and-now (e.g., Clark, 2006), regardless of whether the respective local challenges are of physical, cognitive, affective, or social character.

Based on these considerations, we may conclude that while the evaluation of niche construction always seems to be about the relation between organism and environment, fitness in its traditional understanding cannot function as the universal normative criterion to evaluate the benefit or harm of all kinds of niche construction. By itself, it is not sufficient to do justice to the complexity of human life and the differences in the areas in which the concept of niche construction has been applied. For present purposes, we thus need to understand (mal)adaptation in a broader sense: each spatio-temporal scale requires its own *normative criterion of (mal)adaptation* that is suitable for the respective grain of analysis and the corresponding epistemic perspective. As so far missing in the literature, four criteria of (mal)adaptation are introduced in the following. While these criteria are quite broadly construed, they are considered sufficiently fine-grained for current purposes. Furthermore, they are developed in consideration of the previously introduced phylogenetic, sociogenetic, ontogenetic, and microgenetic scales and, as such, are dependent on the particular epistemic perspective that we adopt, including certain interests and norms. The goal is to use these criteria to explain *why* different stakeholders act the way they do, intentionally or unintentionally.⁶

Phylogenetic Criterion of (Mal)Adaptation: Alterations of environmental features are considered adaptive when they enhance and maladaptive when they decrease the fitness of members of a certain species or population through the dynamic modification of external selection pressures and genotypic properties. Fitness is understood in terms of self-maintenance and reproductive success.⁷

Sociogenetic Criterion of (Mal)Adaptation: Alterations of environmental features are considered adaptive when the corresponding modifications of heritable phenotypical properties in a (sub)population (e.g., epistemic, cultural, or economic practices) promote prosperity and reduce deprivation. They are considered maladaptive if they counteract these goals.⁸

Ontogenetic Criterion of (Mal)Adaptation: Alterations of environmental features are considered adaptive when the corresponding modifications of idi-

⁶ Note that this is not about defining how people *should* act in an ethical or moral sense. For example, certain environmental modifications that are here evaluated as adaptive from a certain perspective might plausibly be regarded as immoral.

⁷ Although niche construction always involves individual organisms, the relevant selection processes are typically assumed to operate on species or populations (e.g., Odling-Smee et al., 2003). This understanding is adopted here in the consideration of phylogenetic niche construction. For a detailed discussion of the relationship between population-level and individual-level niche construction in evolutionary biology see Trappes et al. (2022).

⁸ When focusing on paradigmatic examples of cultural evolution, such as the development of new farming techniques, the success of reproduction still appears as a decisive factor (Stotz, 2010). When focusing on modern societies the quality of life might play a more central role, related to life expectancy, availability of luxury goods, cultural offerings, knowledge accumulation, or economic stability.

osyncratic phenotypical properties (e.g., cognitive, affective, or interpersonal practices) enhance and maladaptive when they reduce a person's well-being. Well-being is understood in terms of a person's physical, psychological, and social integrity, including their ability to lead a personally fulfilling and meaningful life.⁹

Microgenetic Criterion of (Mal)Adaptation: Alterations of environmental features are considered adaptive when the corresponding dynamic coordination of a person and their environment enables, facilitates, or enhances their ability to address a local challenge (e.g., memory, emotion regulation, or social understanding). They are considered maladaptive if they prevent or complicate the solution of a local challenge.

3.2 Inter-scale conflicts

Based on the four normative criteria for evaluating (mal)adaptation from different spatio-temporal perspectives introduced above, we can address the question of *how* cases of negative niche construction arise. The examples to be addressed in the following are the subject of various existing debates. The aim is to embed and systematize them within a niche construction framework, showing that there are at least three different options of how cases of negative niche construction can be brought about.¹⁰

First, a modification of environmental features can have heterogeneous effects concerning the *same* spatio-temporal scale due to potentially conflicting interests, concerns, and needs of the *same* stakeholder. Different aspects of an individual's physical, psychological, and social well-being might in principle come into conflict with each other when environmental modifications contribute to only one of these aspects but prove detrimental concerning another. For example, an extensive feast with the family for holidays might be rather bad for a person's physical health, but very central to a person's psychological and social well-being. The distinction between physical, psychological, and social well-being is thereby to a certain degree artificial as these are of course closely intertwined.

Second, a modification of environmental features can have heterogeneous effects concerning the *same* spatio-temporal scale due to potentially conflicting interests, concerns, and needs of *different* stakeholders. In human history, we hardly run short of examples in which the prosperity of one social group is based on the exploitation of another, especially when the privileges and welfare of one group rely on the marginalization and deprivation of the other. As a currently pressing and increasingly studied example, we might think about the generation and maintenance of niches

⁹ Only with regard to the ontogenetic perspective health and well-being are relevant for evaluation. From an evolutionary perspective, those traits are relevant that maximize survival and reproduction, independent of the organisms' overall health or well-being (Nesse & Stearns, 2008). From a sociogenetic perspective, health and well-being may only become relevant when affecting in some way the entire (sub)population, for example, in terms of socio-economic costs.

¹⁰ Note that the classification as adaptive or maladaptive is not necessarily an all-or-nothing decision; instead, we should rather think about these evaluations in a more nuanced way.

– online and offline – constructed in the context of radicalization processes (Haq et al., 2020; Valentini et al., 2020).

Third, a modification of environmental features can have heterogeneous effects concerning *different* spatio-temporal scales. This last variant of *inter-scale conflicts* is the focus of the remaining paper as a particularly interesting case of negative niche construction. The processes addressed in terms of phylogenetic, sociogenetic, ontogenetic, and microgenetic niche construction are dynamically interwoven and the introduced normative criteria are not entirely independent. Modifications that are evaluated as adaptive with respect to one spatio-temporal scale might often prove adaptive with respect to others. Nonetheless, there is potential for conflict: *modifications that appear adaptive with respect to one spatio-temporal scale may prove maladaptive with respect to another*. This is due to the fact that the indicated criteria of (mal)adaptation are always *relative*: whether something counts as adaptive or maladaptive depends on the perspective we employ. Starting from biology, we might think about obvious cases in which population-level interests might be detached from individual-level interests, such as in the case suicidal reproductive strategies. However, inter-scale conflict can be found in various different debates, which are to be set in relation to one another. The following comparisons of spatio-temporal perspectives, each in reciprocal consideration, are therefore intended as rough illustrations of different inter-scale conflicts that might give rise to negative niche construction.¹¹

Phylogenetic—Sociogenetic: Concerning this potential conflict, we may think of those kinds of niche construction that have become established through relatively slow phylogenetic processes, turning maladaptive in the light of more rapidly changing sociogenetic conditions. These are typically cases in which traits for niche construction were adaptive in the historical context in which they evolved, but recently lost this benefit for certain populations due to how they (more recently) modified their environment. Thus, organisms are ‘trapped’ by their evolutionary heritage (Schlaepfer & Sherman, 2002). For example, a fundamental building block of human evolution is the creation of social niches, accompanied by genetically heritable changes in the human affective repertoire. This might include dispositions for (overly) aggressive behavior to overcome social restrictions or segregate one’s own social group from others, which has been considered beneficial in ancient contexts (e.g., tribal life), but detrimental to the structures, practices, and norms of modern societies (Greene, 2014; Hufendiek, 2018). The other way around, we may think of populations structuring their environment in a manner that is of benefit to them but comes with tremendous effects for the entire species (Laland et al., 2000). For example, we may think of industrial and technological achievements that appear adaptive in the light of the historic flourishing of some nations, while they might be evaluated as rather maladaptive in the light of their potentially harmful contribution to

¹¹ Note that the niche construction framework is not supposed to be privileged in uncovering inter-scale conflicts. The aim is to incorporate existing debates on inter-scale conflicts in the niche construction framework to explain the emergence of maladaptive cases and to develop a useful systematization of the discussed examples. In which manners the niche construction framework further contributes to the relevant debates and, for example, complements existing approaches in medicine and healthcare is the subject of Sect. 4.3.

the future of humankind, for example, in their contribution to pollution and climate changes.

Sociogenetic—Ontogenetic: Concerning this potential conflict, we may think of cases in which the modification of environmental features is beneficial for a (sub) population as a whole but not necessarily for each member. The benefit for a population might misalign with the quality of life for certain individuals. Collectively maintained environmental structures influence an individual's ability to thrive and as such societies might, among others, create niches that are detrimental to the developmental trajectories of children from different social groups (de Carvalho & Krueger, 2023). For example, it has been shown that shy children grow more self-confident in China while shy children tend to experience more frustration and distress in North America (Flynn et al., 2013). In both cases, the dominance of the respectively opposite personality trait might be considered beneficial from a sociogenetic perspective depending on whether the society is rather individualistic or collectivistic. At the same time, we can easily imagine that individuals with personality traits that do not correspond to prevailing conventions suffer from the resulting peer rejection in their personal development. The other way around, forms of negative niche construction can emerge when an individual structures their environment in a manner that is of benefit to themselves but only at the expense of the prosperity of the (sub)population as a whole. Paradigmatically, this includes forms of ontogenetic niche construction that socio-institutional structures are ideally designed to prevent, such as corruption, fraud, or the inappropriate individual use of collectively shared resources.

Ontogenetic—Microgenetic: Concerning this potential conflict, we might think of environmental modifications that prove beneficial for an organism's general well-being but complicates or hinders their problem-solving in a particular context. In a nutshell, a person's overall interests are not always compatible with their local interests. For example, actively constructed social relationships that provide a sustainable source of support might in concrete situations prevent an agent to use environmental structures most efficiently. Imagine an old couple relying on each other in regulating emotions or memorizing past events (Sutton, 2010). Overall, such relation is beneficial for both partners from an ontogenetic perspective while this might still lead to poorer performance in situations in which they have to face corresponding challenges in isolation. The other way around, we may consider modifications of the environment that might seem adaptive in the here-and-now but can have harmful effects when evaluated from an ontogenetic perspective. This might apply to singular instances of coordination with the local environment as well as repeated encounters that gradually shift into more and more stable patterns of behavior. For example, everyday behaviors, such as avoiding confrontation in social interaction, can be adaptive strategies in a local context but in the longer term have a negative impact on the person's overall well-being.¹²

¹² Similar conflicts might arise when considering larger social groups as relevant stakeholders. For example, niche constructions that are beneficial for a social group from a rather local perspective might prove harmful to the same social group in the long run. Again, this more fine-grained temporal distinction is made only for individuals in the comparison of ontogenetic and microgenetic niche construction, but not for social groups. For a more detailed discussion of this topic see Bertolotti & Magnani, (2013, 2015).

The concept of negative niche construction and the approach of studying possible conflicts in the evaluation of adaptation and maladaptation from different spatio-temporal perspectives remains the subject of the next section but with a narrower focus on the consequences of these conflicts for *contemporary human life*. As such, the outlined framework may find application in multiple areas of research: the handling of behaviors that are evolutionarily adaptive but considered unacceptable in modern societies, conflicts between older generations driving policy and future but not yet mature individuals, or those forms of harmful environmental alterations which we bring mostly unintentionally upon ourselves. The next section addresses a specific pattern of conditions that is of most interest to understand how certain challenges in *modern medicine* and *healthcare* are brought about. The application of the concepts of negative niche construction and inter-scale conflicts proves particularly fruitful in this research area, as it highlights the interplay of phylogenetic, sociogenetic, ontogenetic, and microgenetic processes and thus the plurality of ways in which we might intervene on the relevant phenomena. We then turn to an even more specific case study: *chronic pain*. The following procedure can thus be characterized as gradually zooming in on possible fields of application to fill the previously presented theoretical construct with life, demonstrating not only the conceptual value of this general framework but its usefulness in concrete application.

4 Niche construction in modern medicine and healthcare

In this section, a specific pattern of negative niche construction should come into focus that proves particularly insightful in its application to issues in modern medicine and healthcare. Pain, or more precisely chronic pain, functions as an illustrative case study, showing that considerations of different spatio-temporal perspectives can bridge the gap between different research areas and provide a better understanding of why humans, in general, and some individuals, in particular, are left vulnerable to certain medical conditions. Chronic pain constitutes an interesting research object, as it is still commonly approached from a biomedical perspective, focusing primarily on the search for and treatment of an underlying physiopathology while neglecting other influential factors (Cormack et al., 2022; Mescouto et al., 2020). In contrast, the previously developed framework of niche construction enables us to emphasize the entangled contribution of biological, social, psychological, and situational aspects while humans are no longer portrayed as being only passively molded by external conditions.

In Sect. 4.1, a particular pattern of negative niche construction is introduced that is considered most relevant to understanding pressing challenges in medicine and healthcare. In Sect. 4.2, this general structure is applied to and outlined in more detail along the example of chronic pain. In Sect. 4.3, the particular contribution of the concept of negative niche construction to our understanding of chronic pain and other health issues is highlighted and further practical implications are derived.

4.1 A paradigmatic pattern of negative niche construction

Many different inter-scale conflicts are possible in the evaluation of niche construction. A particularly interesting and recurring *pattern of negative niche construction* can be characterized as follows: a human trait has evolved in the interplay of passive selection and active environmental construction along relatively slow phylogenetic processes, (mostly) adaptive in such ancient context. More rapidly changing sociogenetic alterations of environmental features take place that are of immediate benefit to a society. The respectively constructed environment however has a negative impact on the overall well-being of some members of the population. This is partly because the sociogenetically constructed features of contemporary human life are substantially different from ancestral contexts, turning the respective trait into something potentially maladaptive from an ontogenetic perspective. Usually, it is a complex interplay of social factors that are, or at least appear, adaptive from a sociogenetic perspective but contribute in combination to a collectively maintained niche promoting maladaptive ontogenetic developments. At the same time, certain modifications of environmental features that appear adaptive from a microgenetic perspective might fuel harmful long-term effects on the subject's well-being. That is, local constructions that seem adaptive in the here-and-now can have tremendous consequences, especially when performed repeatedly. Interestingly, the respective microgenetic processes are typically fostered by the interplay of phylogenetically developed traits and social influences while the ontogenetic restrictions on the well-being of individuals might in turn have a negative impact on an individual's ability to successfully address local challenges.

Due to the complexity of the outlined pattern of negative niche construction, it is further divided into three interrelated mechanisms. It is important to note that in this pattern multiple kinds of niche construction combine and interact with an overall negative outcome concerning certain individuals and their well-being. To understand however why this outcome is brought about, we need to consider the benefits of the involved environmental constructions given other spatio-temporal perspectives.

First, the outlined pattern partly relies on a mismatch between the hunter-gatherer context in which human traits have evolved and how we have constructed our modern material and social niches. *Mismatch accounts* are quite prevalent in the explanation of certain pathological conditions that harm the well-being of certain members of a population. We may think of the ability to experience sadness in the face of special life circumstances to be an evolutionary adaptive trait (Nesse & Stearns, 2008) which can substantially affect the life quality of people in form of depressive episodes, given that such trait has not evolved to function in our modern settings (Horwitz & Wakefield, 2007). Mismatch accounts particularly highlight in which manner certain sociogenetic constructions can divide from the evolutionary contexts in which human traits have evolved. Still, mismatch accounts can only provide one part of the puzzle. By themselves, they fail to account for the complexity of how social structures, practices, and norms contribute to the development of pathologies as well as for inter-individual and intra-individual differences in the vulnerabilities to such pathologies (Varga, 2012).

Second, there is a multiplicity of social factors characterizing the collectively constructed niche of a population that enables or facilitates the emergence or persistence of certain pathological conditions, against the background of our universally shared phylogenetic traits. In the case of obesity, a mismatch is commonly postulated between the evolutionary adaptive trait to crave fat and sugar-rich food and the modern industry that allows us to obtain such food in a rather effortless manner (Wheeler & Clark, 2008). There are however further social factors at play. For example, it has sometimes been suggested that collectively performed practices and norms of weight stigmatization can promote the general adoption of healthier behavior; however, it shows that these practices and norms instead create health disparities, impairs effective interventions, and thus are rather harmful to obese individuals (Puhl & Heuer, 2010). In principle, efforts of sociogenetic niche construction may be pursued for two reasons despite their maladaptive effects on ontogenetic developments. Either the respective modifications of environmental features prove beneficial for the majority of members, even if this is the opposite for some (e.g., food industry, arguably); or, parts of the population might mistakenly assume that its structures, practices, and norms have a positive impact for individuals, while the opposite is true (e.g., weight stigmatization). In both cases, it is the collectively constructed niche that is, or at least appears, adaptive from a sociogenetic perspective but proves maladaptive for certain individuals.

Third, as individuals, we co-construct our own personal niches. The corresponding patterns of behavior might in some cases prove useful from a microgenetic perspective, as they enable us to solve local problems, but are harmful to our overall well-being. For example, Osler and Krueger (2021) outline how disordered eating practices in the case of Anorexia Nervosa can be supported and sustained by (ongoing) engagement with Pro-Anorexia websites which do not only provide information but also resources for interpersonal support and a sense of belonging. In engaging with them more local epistemic and affective challenges are addressed, but with potentially serious long-term consequences. In the case of Pro-Anorexia websites, it is the individual that makes these websites a more or less central part of their life through repeated microgenetic processes. At the same time, there are certain features of these websites, created by others, that make it particularly difficult for the individual to leave. Finally, it should be noted that the restrictions on subjective well-being can in turn negatively impact an individual's ability to address local challenges. For example, conditions such as depression can affect the ability to engage in microgenetic niche construction which can further contribute to the maintenance and aggravation of said conditions (Krueger & Colombetti, 2018; Varga & Krueger, 2013).

4.2 A case study of chronic pain

In this subsection, the previously outlined pattern of negative niche construction is systematically applied to the case of chronic pain. As an initial characterization, we may define pain in accordance with the *International Association for the Study of Pain* as an “unpleasant sensory and emotional experience associated with,

or resembling that associated with, actual or potential tissue damage” (Raja et al., 2020). We might further state that pain provides an indisputable biological benefit related to the maintenance of an organism’s integrity in the protection and recovery from physical threats. Pains typically motivate a variety of purposive behaviors that initially contribute to this goal (Coninx, 2020): active avoidance behavior (e.g., withdrawal of a limb, escape from a stressful situation), passive avoidance behavior (e.g., refraining from using a limb, reduction of explorative activities), stimulation behavior (e.g. rubbing or warming a body part), expressive and communicative behavior (e.g., vocalization or gestures), and fear generalization (e.g., future avoidance of stimuli associated with pain). Thus, the ability to experience pain in certain situations is adaptive and most likely not only found in humans, as it significantly contributes to survival and reproductive success, despite the complications that it causes (Williams, 2016; Nesse & Stearns, 2008).

At first glance, it may seem that there is no inter-scale conflict, as the capacity to experience pain proves beneficial from all perspectives. This is most prevalent when considering the reduced life expectancy and quality of life of those born insensitive to pain (Nagasako et al., 2003). To understand the relevant inter-scale conflict between different criteria of (mal)adaptation, we need to take a closer look at *chronic pain* as one of the most prevalent and disabling medical conditions globally (Breivik et al., 2006). Chronic pain, in contrast to acute pain, is commonly defined as pain that persists or reoccurs for longer than three months (Treede et al., 2015). The decisive question for present purposes is in which manner the ability to feel prolonged or reoccurring pain might prove adaptive or maladaptive.¹³

As a first step, we may consider differences between ancient and modern contexts as one building block to account for the prevalence of chronic pain. Williams (2016, 2019) prominently addresses this issue hypothesizing that the ability to experience a phase of chronic pain might be considered evolutionarily beneficial as it promotes resource conservation, facilitates healing progress, and minimizes the risk for potential re-injury. However, such ability is only useful if it enables organisms to engage in essential activities, such as foraging, flight from predators, or interaction with significant others, and ultimately to return to a pain-free state when resource conservation is no longer required. Thus, a dynamic balance is needed between the biological benefit of protection and recovery, on the one hand, and return to normal activity, on the other, as prolonged or reoccurring avoidance behavior of reduces an organism’s overall fitness. A key role in this balancing process is played by pain modulation systems, which have preventive effects on pain persistence and are related to an organism’s activity level (Büchel, 2021; Carey & Freburger, 2016; Lesnak & Sluka, 2020). That is, even if it no longer serves its purpose, pain is more likely to remain in place if the organism does not become increasingly active at some point and fails to re-engage in normal behaviors.

¹³ The question is not whether chronic pain is adaptive but whether certain human traits that contribute to the prolonged or reoccurring experience of pain could plausibly be considered adaptive in relation to the environment in which the organism is located. Thus, it is not the experience of pain but the general ability to experience (acute or chronic) pain in certain situations that might prove beneficial or harmful.

In the ancient context in which traits involved in the chronification as well as the prevention of such evolved, humans lived as hunters and gatherers in small tribes and were forced to re-engage in survival-relevant activities at some point despite their pain (Büchel, 2021). In contrast, modern societies enable prolonged inactivity without immediate consequences, as basic human needs can be met by others (Williams). For example, many people experiencing chronic pain do not meet the minimal recommendations for physical activity and exercise (e.g., Damato et al., 2021). While this might not be an entirely new development in human history, the need for daily activity in the face of pain has decreased significantly given the environmental modifications in contemporary human life (Eaton et al., 1988). The corresponding constructions (e.g., supportive social institutions) might in general be evaluated as adaptive from a sociogenetic perspective, as they overall promote prosperity and reduce deprivation. However, these constructions—together with other aspects of modern environments (e.g., diet or microbiota)—may contribute to the prevalence of certain ‘diseases of civilization’ given the mismatch between ancient and modern contexts (Büchel, 2021; Eaton et al., 1988; Johnson, 2019; Williams, 2016).¹⁴

As a second step, we may further highlight that the influence of sociogenetic processes on chronification is particularly complex: prolonged inactivity in the light of pain is not only made *possible* as survival-relevant needs are compensated by others, but it is actively *promoted* by how socio-cultural groups modulate a multiplicity of environmental features. Chronic pain is partly iatrogenic in that collectively constructed and maintained practices, norms, and conventions that prevail in general society, socio-cultural groups, and clinical communities foster behaviors that can contribute to chronification (Johnson & Woodall, 2022; Loeser & Sullivan, 1995). For example, while potentially well-intended, messages of rest and sparing (e.g., ‘be careful’ or ‘don’t hurt yourself’) can contribute to detrimental circles of overgeneralized fear, avoidance, and pain persistence (Buchbinder et al., 2018), reinforced by blame and stigmatization (Slade et al., 2009). Interestingly, potentially harmful beliefs about pain (e.g., ‘the body is like a broken machine’ or ‘rest is best’) might often learned from healthcare providers (Setchell et al., 2017; Stilwell & Harman, 2017).

This highlights that we collectively create niches with material arrangements, but also socially inherited practices and convictions that we need to consider in order to understand the prevalence of chronic pain (Johnson & Woodall, 2022). Processes contributing to the generation and maintenance of chronic pain are not restricted to some evolutionarily determined traits, which we can hardly alter, or the inner workings of patients (Coninx & Stilwell, 2021; Stilwell & Harman, 2019). This becomes most prominent when studying the effects of individuals entering different socio-clinical niches. According to the work of Lin et al. (2013), Aboriginal Australians have long been considered protected from the disabling effects of chronic low back

¹⁴ Although current evidence is still sparse, this might account for the fact that while humans as well as dependent pet, laboratory, and farm animals show signs of chronic pain, these are hardly ever spotted in wild animals whose niches force them to timely re-engage in survival relevant activities, or do not allow them to survive otherwise (Williams, 2019).

pain due to their cultural conception of chronic pain as a well-accepted temporary state of weakness rather than a hindering health issue. Recent studies indicate an increase in disabling effects in this population. This is traced back to an increase in negative beliefs about chronic pain that arise from interaction with Western health-care professionals. While the outlined combination of indicated sociogenetic processes might be adaptive for a few, or more likely, only erroneously considered to be adaptive, it proves maladaptive for concerned individuals and their well-being. Chronic pain typically harms the physical, psychological, and social integrity of concerned individuals, associated with feelings of meaninglessness, helplessness, and hopelessness (Lima et al., 2014; Nichols et al., 2017).

In a third step, we may consider the relationship between the ontogenetic and microgenetic perspectives in the context of chronic pain. One central aspect is that actions that appear adaptive in particular situations, as they immediately reduce or prevent the experience of pain, may contribute to its chronification in the long run (Van Dieën et al., 2017). This includes local modifications of environmental features that enable the restriction of mobility (e.g., avoidance of strenuous exercise, engagement in less demanding substitute actions, refraining from social events that involve activity), which further contribute to an overgeneralization of avoidance behavior and prevent a timely return to normal physical activity (Meulders, 2019; Vlaeyen & Crombez, 2020). Thus, it is precisely the local interactions, which are in principle useful from an evolutionary perspective and often fostered by socio-clinical structures, that promote in their ongoing execution maladaptive ontogenetic developments. In turn, the effects on the well-being of individuals also impact their ability to successfully address situational tasks. Chronic pain is associated with the (felt) inability to successfully interact with the material and social environment. That is, it prevents subjects from flexibly adapting to the requirements of a situation and from altering environmental features in a manner that enables them to successfully address local challenges, thus, creating a vicious circle (Coninx & Stilwell, 2021).

4.3 Epistemic advantages & practical implications

In this section, the epistemic advantages of operating with the concepts of phylogenetic, sociogenetic, ontogenetic, and microgenetic niche construction and their conflicts are explicitly addressed and emphasized. The focus remains on chronic pain, although many of the aspects presented may find application in other medical fields and beyond. At the same time, it is to be shown that these considerations are not only of theoretical value but also have practical implications.

First, the generation and maintenance of chronic pain is the result of complex interconnections between evolved traits, socio-cultural processes, ontogenetic interaction patterns, and the handling of local challenges. In principle, this might apply to many different phenomena of human life—depending on the particular subject and interest of our research, these interconnections might come into focus in different ways. It should have been shown that chronic pain requires an integrative perspective when it comes to medicine and healthcare: we need to look at all the involved factors, not in isolation but in terms of how they constrain each other. Otherwise,

we are not able to fully understand why humans, in general, and some individuals, in particular, are left vulnerable to pain chronification. This motivates an interdisciplinary approach acknowledging the value of different epistemic perspectives and levels of analysis while focusing on the *complexities* and *dynamics* of involved processes along different spatio-temporal scales. Thus, if the niche construction framework is to be usefully applied to chronic pain and related phenomena, this cannot be done in terms of isolated research strands but requires a more nuanced overarching framework.

Constructed in this integrative manner, the niche construction framework is to be located in the tradition of multifactorial approaches in medicine, most prominently, the biopsychosocial model illuminating in its original version the multiple facets of health and illness (Engel, 1977). In recent research and practice on chronic pain and other health issues, the lack of a theoretical foundation for the biopsychosocial model has, however, led to various misapplications and misinterpretations and thus suboptimal patient care (Cormack et al., 2022; Mescouto et al., 2020). Often, we see a relapse to biomedical approaches, limited to only a few biological factors or failing to consider the multitude of relevant factors in their dynamic interaction. Laying a theoretical foundation for the biopsychosocial model goes far beyond this paper. Still, it should be emphasized that the niche construction framework preserves the original idea of the biopsychosocial model, as the acknowledgment of complexities and dynamics are a central part of it. As such, it aligns with a comprehensive approach to health issues that avoids oversimplification, motivates communication between different research areas, and indicates possibilities for connecting their results.

Second, in focusing stronger on the dark side of environmental modifications and integrating considerations on inter-scale conflicts, the niche construction framework can explain why agents construct and maintain certain niches despite their potentially negative effects: because they appear adaptive given a different perspective. In the case of pain, this becomes most apparent in the *paradox of (in)activity*. While the biological function of acute pain is strongly related to a reduction in physical activity, it shows that an increase in exercise is among the most efficient measure in the prevention and treatment of chronic pain (Law & Sluka, 2017; Steffens et al., 2016). This paradox might also be the reason why certain messages of rest and sparing are socially prevalent, even though they have potentially harmful consequences. Uncovering such paradoxes can be key in initiating a change in thinking about pain in society and in understanding the way we communicate with patients as a relevant factor. The particular contribution of the niche construction framework is to emphasize that we are not only passively molded by external challenges, but that we actively contribute as individuals and members of social communities, often unintentionally, to these challenges by constructing our niches and those that we share with others in a certain manner. Our interaction with the environment is both effect and cause of relevant processes developing along different spatio-temporal scales.

It is important to note, again, that this is not a matter of blaming anyone. Instead, considering health issues from the perspective of the niche construction framework might offer the possibility to identify intervention options that have received little attention so far. Our research program might be quite different depending on

whether we understand health issues as something simply ‘happening’ to people or as something that we are actively involved with. In particular, the concept of niche construction provides a useful tool to highlight modifications of environmental features that shape the development or implementation of specific abilities and thus may function as relevant targets for intervention, namely those collective and individual modulations of environmental factors that, for example, promote inactivity instead of activity in the light of persisting or reoccurring pain (see also Johnson & Woodall, 2022). Even if it is not the goal to re-create the conditions of hunter-and-gatherer societies, we may try to compensate for those processes that make the mismatch between ancient and modern contexts possible and counteract those processes that further promote the corresponding effects under the erroneous assumption of benefit. Further, we might support patients to restructure their own personal niche (e.g., change their working conditions) and to learn strategies to solve local challenges in a manner that is more adaptive for their overall well-being (e.g., engage in feared exercises).

Finally, it should be noted that the aim of these considerations is not to entirely reinvent pain research and therapy. Rather, the advantage of relying on the concepts of niche construction and inter-scalar conflicts is that this provides an overarching framework to connect different aspects that have so far mainly been considered in isolation and to focus more on the fact that we dynamically shape and are shaped by our environment. This includes a step away from monocausal approaches that focus alone on the concerned patients in ignorance of their environment and a step towards re-arranging socio-clinical and personal niches. Accounting for these aspects is surely not a unique property of the niche construction framework, however, they are integral parts of it – showing that this framework can be fruitfully applied to multifaceted phenomena and complement multifactorial approaches in medicine. That is, the developed framework might allow us to bring together promising strands of existing research on niche construction, shed light on the often neglected phenomenon of negative niche construction, systematize insights concerning health issues from different perspectives, and make particular aspects in medicine and healthcare more visible, at best, motivating new research findings.

5 Conclusion

Commonly humans are considered particularly potent or extreme niche constructors. The previous considerations aimed to highlight that this does not always turn out to their advantage, at least not given all the different perspectives we may employ for evaluation. With regard to the (mal)adaptation of niche construction, a decisive factor is the difference in spatio-temporal scales along which the respective processes unfold. In the particular consideration of challenges in modern human life, we have seen that some alterations of environmental features can pose new challenges that human genetics cannot respond to as it works too slowly with serious consequences for individual agents. Thus, much faster socio-cultural, personal, and local adaptations are required to address these issues. The concept of niche construction provides us with a starting point of how to do so: it emphasizes that active

modifications of environmental features, performed collectively or individually, can significantly contribute to the emergence of different health issues. As such, it enables us to better understand the dynamic interactions and potential conflicts between different factors and to identify potential targets for prevention and intervention in medicine and public health.

Acknowledgements The initial idea for this paper has been developed in discussion with Regina Fabry who substantially inspired and supported the elaboration of the main ideas and selection of relevant literature. My special thanks go to her. I would like to express my gratitude to Marta Caravà, Maja Griem, Peter Stilwell, and Somogy Varga, who provided detailed feedback on different versions of the paper as well as to Marco Viola for his helpful comments and inspiration for the table. Furthermore, I would like to thank Achim Stephan, Lucy Osler, Imke von Maur, Gregor Hörzer, Daniele Valentini, Hina Haq, Saad Shaheed, Ana Lorena Domínguez Rojas, and all other members of the Reading Club “Affectivity” of Osnabrück University for taking the time to discuss my paper. Furthermore, I would like to thank the participants of the GAP Satellite Workshop ‘Scaffolding and Niche Construction: Conceptualization and Applications’ at the HU Berlin in 2022 for their thoughtful questions and comments on my presentation based on this paper. Last, but not least, I would like to thank the anonymous reviewers whose comments enabled me to clarify central concepts and aspects of the paper and further enrich the literature to be integrated.

Funding The work of the author has been funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation)—Project Number GRK-2185/1 (DFG Research Training Group Situated Cognition).

Declarations

Conflict of interest The author has no further financial or non-financial interests to disclose that are relevant to the content of this article.

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