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DISCUSSION

Taking the Historical-Social Dimension Seriously: A Reply to Bandini et al.

E. Bandini, J. S. Reeves, W. D. Snyder, C. Tennie: Clarifying Misconceptions of the Zone of Latent Solutions Hypothesis: A Response to Haidle and Schlaudt (Biological Theory 2021)

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Abstract
In our recent article, "Where Does Cumulative Culture Begin? A Plea for a Sociologically Informed Perspective" (Haidle and Schlaudt in Biol Theory 15:161–174, 2020) we commented on a fundamental notion in current approaches to cultural evolution, the “zones of latent solutions” (henceforth ZLS), and proposed a modification of it, namely a social and dynamic interpretation of the latent solutions which were originally introduced within an individualistic framework and as static, genetically fixed entities. This modification seemed, and still seems, relevant to us and, in particular, more adequate for coping with the archaeological record. Bandini et al. (Biol Theory, 2021) rejected our proposition and deemed it unnecessary. In their critique, they focused on: (1) our reservations about an individualistic approach; (2) our objections to the presumption of fully naive individuals; and (3) our demand for an extended consideration of forms of social learning simpler than emulation and imitation. We will briefly reply to their critique in order to clarify some misunderstandings. However, the criticisms also show that we are at an impasse on certain crucial topics, such as the meaning of ZLS and the scope and nature of culture in general. Thus, we consider it necessary to make an additional effort to identify the conceptual roots which are at the very basis of the dissent with Bandini et al.

Keywords Cultural evolution · Cultural niche · Cumulative culture · EECC model · Habitus · Ratchet effect · Social learning · Zone of latent solutions

Introduction

In our recent article, "Where Does Cumulative Culture Begin? A Plea for a Sociologically Informed Perspective" (Haidle and Schlaudt 2020), we commented on a fundamental notion in current approaches to cultural evolution, the “zones of latent solutions” (henceforth ZLS), and proposed a modification of it, namely a social and dynamic interpretation of the latent solutions which were originally introduced within an individualistic framework and as static, genetically fixed entities (Tennie et al. 2009). This modification seemed, and still seems, relevant to us and, in particular, more adequate for coping with the archaeological record. Bandini et al. (2021, this issue) rejected our proposition and deemed it unnecessary. In their critique, they focused on: (1) our reservations about an individualistic approach; (2) our objections to the presumption of fully naive individuals; and (3) our demand for an extended consideration of forms of social learning simpler than emulation and imitation. We will briefly reply to their critique in order to clarify some misunderstandings. However, the criticisms also show that we are at an impasse on certain crucial topics, such as

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the meaning of ZLS and the scope and nature of culture in general. Thus, we consider it necessary to make an additional effort to identify the conceptual roots that are at the very basis of the dissent with Bandini et al. (see the fourth section).

In Cultural Evolution the Individual Level is Necessary, but not Sufficient

In its original conception, ZLS explains behavioral patterns of individuals and groups in terms of properties of individuals. We described this approach as individualistic, and Bandini et al. accept this label. In order to underline their individualistic commitment, they align themselves with "Nobel prize-winning work in economics" and approaches of agent-based modelling (ABM). This self-description is helpful. It clearly shows what is at stake in this controversy, because today's mainstream neoclassical economics with its focus on *Homo economicus* and its maximization of individual utility is an extreme case of reductionism to the level of individuals. With this methodological choice, neoclassical economics places itself in sharp contrast to the majority of the other social sciences (cf. Vlachou and Christou 1999; Hunt and Lautzenheiser 2015). Pointing to the parallelism with ABM underlines the problems of the individualistic approach in the original ZLS conception. ABM itself has been criticized for excluding social structures and thereby not providing an adequate model of an open world the models are created to explain (O'Sullivan and Hacklay 2000).

In opposition to the individualistic approach taken by Bandini et al., we advocate a holistic one. According to Bandini et al., it is not "justified to categorically exclude individual approaches." They accuse us of being incoherent because, although we subscribe to holism and thus, according to them, are committed to "an exclusively group-level approach," we refer to individuals in our approach. They state that they also refer to the importance of the group level, since "group-level patterns are also an explanatory target of the ZLS." So, does holism have to exclude individual elements? Does speaking of individuals automatically make you an individualist? And do individualistic approaches recognize the importance of the group level since they aim at explaining group-level patterns?

Following the holistic model of the evolution and expansion of cultural capacities (EECC; Haidle et al. 2015), cultural performances develop in three interdependent dimensions interacting with the specific functional environment or resource space.

- The evolutionary-biological dimension expresses the genetically assigned range of the anatomical structure and the physiological processes determining the baseline of a species' behavior, cognitive competences, and emotions. The mechanisms of change of this dimension are genetic mutation and selection, the latter of which is based on an interaction with the specific social (other individuals) and material environment.
- Within the genetically inherited range, each organism unfolds its characteristics throughout its lifetime based on ongoing personal experiences with the specific social and material environment influencing epigenetics, individual learning, and invention (see also Heyes 2018). These constitute the developmental factors of the ontogenetic-individual dimension.
- A third dimension, the historical-social dimension, comes into play in social organisms. Through being a model for performances of similar organisms, providing information about beneficial or unfavorable performances, and tolerating a range of behavioral variants, members of the same group foster learning, group conformity, the establishment of traditions, and their replacement by innovations. Learning shifts from a purely individual to an increasingly interactive process with a focusing of the content.

Thus, the performance of an individual is based on an evolutionary-biological development and is ontogenetic-individually unfolded, influenced by historical-social constraints and scaffolds. The performances of individuals act and react on a specific environment and transform it continuously through these interactions. They create a cultural niche (Laland and O'Brien 2011), which provides a cultural feedback loop for new experiences and learning (for a more detailed discussion of different processes linking the dimensions, see Haidle 2019, pp. 134–136).

This holistic approach explicitly integrates individual elements as vital parts of the cultural system. Speaking about the role of individuals, however, does not make this model an individualistic one. Individualistic approaches aim at explaining group-level patterns by focusing on the sum of contributions of independent (though interacting) individuals. In particular, they accept the individuals as static, prefixed entities that possess their essential characteristics prior to, and independently of, culture and society. Put as bluntly as this, our account might seem overstated. At some point in the discussion, however, we must agree on a clear and unambiguous criterion, which can only be this one: according to individualism, the whole is entirely determined by its preexisting parts (the individuals), while according to holism, the parts (the individuals) are determined, at least in some of their properties, by the whole which they form (cf. McLaughlin 2006). Such holistic approaches as ours do not see individuals as independent entities, but as parts of a larger unit that develops qualities and capacities beyond the sum of its parts—by additive, complementary, or exclusive interactions, feedback loops, and extended affordances.

Additionally, by growing up in groups with those extended qualities, capacities, and environments, the individuals receive a historical-socially informed feedback.

In its original individualistic conception defended by Bandini et al., the ZLS could be located within the evolutionary-biological sphere, by and large expressed individually. Although interested in explaining the group-level outcome, they barely consider the group-level input. The performances of other individuals as components of a social environment may trigger a behavior, as does the assignment of tasks in the experiment (cf. Tennie et al. 2017, p. 652), but Bandini and colleagues do not expect any historical-social impact on their expression. The crucial question with regard to the methodological choice between holism and individualism is: does the social environment also influence the individuals, and on which level?

We will come back to this point in the third and fourth sections. For the moment, let us sum up that, even though we advocate for the group level, we have never denied, and actually need not deny, the importance of the individual level. However, seeking an understanding of the individual level in social species needs a constant reflection of the interplay with the group level. The individual level cannot be understood independently without taking the influences of the group level into account.

The Assumption of a Naive Status, and Does Culture Entail Difference?

In their second section, Bandini et al. raise three different objections, which we will address one after the other.

1. By picking up the mention of instincts from our article and reframing the argument, Bandini et al. misinterpret this section. We do not think that ZLS consists of instincts. Mentioning the instinct discussion just points to a parallel problem if performances are reduced to purely individual origins. As in the outdated instinct discussion, the individualistic approach fails to incorporate in its reconstruction of ape and early hominin learning the subtle, but formative, influences of the social group and the specific environment formed by the group.
2. Bandini et al. go on defending their assumption of naive individuals. They admit the practical impossibility of an "island test," exposing naive individuals to novel situations, but, taking it as a mere thought experiment, they hope nevertheless to find information relevant to the underlying question of cultural evolution. They compare this to the case of Gregor Mendel, who "did not see genetic inheritance, but this did not stop him from investigating meaningful inheritance patterns." But this analogy misses the point. Our objection to the individualist reading of ZLS was not that the naive individual is inaccessible with current experimental means as genetic inheritance was for Mendel, but that the naive individual does not, and actually cannot, exist. We argued that the development of individuals is affected by interactions with their social environment, starting even in the uterus (Quintero and De Jaegher 2020). This influence is reciprocal. The members of a species alter their material and social environment, slowly or quickly, to a lesser or greater degree. They alter it in a cumulative way as the behaviors of each individual and their products become part of the environment of future interactions. The amount of these alterations and their impact can vary significantly due to the extent of experiences, the amount of learning required to acquire a behavior, and its operational time-depth. In social species, unexperienced organisms learn within the social context of a group-specific habitus. They adopt preferences of, for example, locations, ways, resources, times, rhythms, tastes, but also the perception of problems, or reactions to signals of danger. Depending on the species' capacities to learn and transmit experiences to others, the amount and fidelity of the behavioral elements acquired in a social context vary. However, an individual of a social species cannot be assumed to be a standalone, nor as without personal history of experiences, from which it can draw when facing new challenges. At the same time, it becomes clear that taking into account this influence of culture on individuals permits identifying basic mechanisms of cumulative evolution. Just as Mendel's work would have profited from knowledge about genetic inheritance, so would the ZLS approach profit from incorporating a serious social dimension.
3. Bandini et al. further stress the fact that chimpanzees show convergent behavior despite different backgrounds (in captivity and in the wild, for example), and they assume this empirically rules out a part of culture as it is implied by our approach. "If social life is so important for apes," they ask, "how come the same forms […] appear across different populations, including captive individuals?" Following a differential concept of culture, they continue: "Therefore, empirically, [social learning and social life] do not prove of importance for these forms in apes." This differential view of culture is purely pragmatic, though, with divergent traits being relatively easy to detect as cultural traits. As Schuppli and van Schaik (2019) explained, this does not allow for the reverse conclusion that a behavioral trait must be divergent to be counted as cultural. According to the substantial definition, which we pointed out, culture comprises all phenomena that incorporate a long-term influence of socially transmitted information, that is, a historical-social dimension of development (following the EECC model; Haidle et al. 2015). Bandini et al. commit an

error by taking convergent behavior as a proof against culture. There is nothing in the substantive notion of culture as socially transmitted behavior that rules out convergence, neither in common group behavior nor in individual inventions.

Convergence under differing circumstances, though not logically incompatible with our holistic approach, might still be surprising and of course in need of explanation.[1] This leads back to our main point, the idea that there are no naive individuals. There is much that individuals living in different circumstances can share with each other, in particular on a level below form-copying. Transferred to the case of zoo chimpanzees spontaneously developing the same behavioral patterns and techniques as their wild conspecifics when confronted with a problem, the EECC model points to some shared background features. Although not acquainted with the specific test situation, the individuals in captivity grew up in an environment with certain materials, role models, and challenges. Prior to the test, through interaction with this material and social-environmental context, they acquired a group-specific habitus, such as how to approach the surrounding world and ways of observing a problem, as well as bits of different skills, characteristics of materials, objects, and tools they can use to solve them. The test introduces a new problem to their environment, which they accept and try to solve based on what they have learnt so far.

The phenomenon of convergent inventions, which was the starting point of the ZLS, can help us get closer to the concept's heart. Convergent inventions are not restricted to chimpanzees and other nonhuman primates but are well-known throughout human history from Paleolithic to modern times (see, e.g., Groucutt 2020; O'Brien et al. 2018; Crassard et al. 2020). Bifacial, Levallois, and fluted-point technology in stone knapping, pottery, agriculture, pyramids, and numerous other phenomena developed independently at different times and in distinct areas. Comparing western Acheulean and Pleistocene East Asian bifaces, Ceri Shipton (2020) identified an example of such parallelism. While the western Acheulean spanning from South Africa to Europe seems to have spread from a single core region in East Africa, and was probably maintained through high-fidelity social transmission, the East Asian bifaces are likely to indicate an analog line of development. Shipton stresses that this case does not represent a de novo independent invention, but one based on the same Oldowan substrate as the Acheulean. We can say that the western Acheulean and the East Asian bifacial group shared a common ZLS incorporating core and flake knapping technology as a basic element. The question is then, how did this ZLS develop? Was there an inherent capacity originating from a genetic development, as a narrow original ZLS concept suggests? Applying instead an extended, cumulative ZLS concept as we proposed, the capacity would have unfolded in interaction with the three developmental dimensions – evolutionary-biological, historical-social, and ontogenetic-individual – within the specific environment. Thus, according to the socially extended ZLS concept, re-innovations can be independent of copying, in humans as well.

Development of ZLS Beyond Non-copying Social Learning

In their third and last section Bandini et al. object that we neglect "the important role of non-copying social learning mechanisms" as "a fundamental aspect of the ZLS hypothesis" and therefore even accuse us of "unintentional plagiarism." It is true that the ZLS approach also in its original individualist reading involves non-copying social learning mechanisms and that we didn't discuss this aspect in our article. But does this make our interpretation in terms of habitus obsolete? Remember that the idea of our approach is to account for cumulative mechanisms of cultural evolution below the level of high-fidelity form copying. Bandini and Tennie (2017, p. 4) integrate non-copying social learning into the individualist ZLS approach, but they explicitly restrict its scope to explaining the *frequency* of behavioral patterns across individuals. The *form* of these "socially mediated serial reinnovations" is still completely determined by genetically fixed latent solutions, thus ruling out the possibility of cumulative effects. In our view, socially mediated serial re-innovations as described by Bandini and Tennie (2017) do point to a cumulative aspect, as the ZLS of the individuals in a group is altered with each performance practiced in social context. The socially mediated basis is habitus, the (re)inventions start from this basic culture, and via an aggregation of similar inventions the specific material and social environment including the habitus—and with it the ZLS—shifts or expands. The inventions become distributed innovations, which slowly become traditions and form a new basis for further (re)inventions, innovations, and traditions. This is, in our opinion, how the ZLS is part of a cumulative process, well before high-fidelity copying comes into play.

According to the social conception we proposed, ZLS is not genetically fixed, but must rather be seen as an entity that has a trajectory of cultural evolution. An individual living today in the digital era draws on a different ZLS than

[1] Just as convergent behavior in independent groups requires explanation within a social reading of ZLS, it should be noted that, conversely, divergent behavior (in ecologically and genetically similar groups) is a challenge for the individualistic reading. Bandini and Tennie (2016, p. 4) risk underestimating this point when they postulate further latent solutions in order to account for the diversity of behavioral patterns. Multiplying the number of latent solutions ad libitum serves only to weaken their explanatory power.

one living in the 1970s. With new technical tools, the specific environment as well as the habitus of those growing up and living in this environment has changed. Even for those who are not very skilled users, preferences, rhythms, and strategies of problem solving altered fundamentally (Löffler 2019). In a recent publication that already reacts to some of our criticisms, Tennie et al. (2020, p. 23) explicitly allow that ZLS evolves over time. But this development seems to be a mere consequence of the species' biological evolution. It has no irreducible dynamics of its own. In our social reading, the ZLS itself is a cultural phenomenon. It is cumulative from the beginning and has its own irreducible dynamics.

In contrast to what Bandini et al. assume, we do not want to overcome the ZLS-only approach applying to non-copying species. We propose instead an enhancement of the concept of ZLS to which in the course of hominin evolution cognitive gadgets sensu Heyes (2018) were added. Besides form-copying, several capacities arising during hominin evolution could represent such gadgets, which are not self-supporting across generations in apes: for example, modularity (Haidle 2009; Haidle et al. 2015; Charbonneau 2016; Lombard et al. 2019), composite capacities (Ambrose 2010; Barham 2013; Haidle et al. 2015), complementary capacities (Lombard and Haidle 2012; Haidle et al. 2015), and symbolic or notional capacities (d'Errico et al. 2003; Haidle et al. 2015). We definitely see cognitive skills under the control of social learning corresponding to the cultural evolutionary psychology approach of Heyes (2018): according to the EECC model, they are culturally affected by developing in three interdependent dimensions in interaction with their specific (and developing) environment.

Comparison of Approaches: Taking the Social Dimension Seriously

None of the readings proposed by Bandini et al. captures the main intention of our work. There is a misconception of the foci regarding (a) the concepts of culture and cumulative culture, and (b) the importance of social learning on a basic level for cumulative culture. Culture can be cumulative even if no forms are copied. Form-copying can boost cumulative effects, as can other cognitive gadgets such as modularity, and so forth, but none of these cognitive gadgets is a prerequisite for cumulative culture.

The root of the dissent can probably be found in two basic assumptions. The original approach of ZLS entails a sharp distinction between human and nonhuman culture (including the early hominin technocomplexes up to the Acheulean; see Reindl et al. 2018) based on the presence or absence of form-copying. The first assumption is the link of form-copying to the ratchet effect as a mechanism enabling cumulative culture. The second premise is the model of cultural evolution as composed of discrete steps. If our analysis is right, it is these two assumptions on which future discussion should focus.

Cumulative culture is often tacitly identified with the ratchet effect. Its simplistic focus on progress through greater efficiency and increasing complexity (a concept borrowed again from neoclassical economics) makes it problematic, as it neglects multiple diverging effects, individual or group specific preferences, and irrational choices (Haidle 2019; Haidle and Schlaudt, forthcoming). Lombard (2012, 2016) has suggested a different, much smoother and more flexible mechanism called "mountaineering." Like actual mountaineering, Lombard suggests that cultural evolution takes place on a terrain rather than a single dimension. It incorporates many alternative paths, detours that eventually lead to the same goal, or alternative paths leading to different goals. In some cases, moving backwards can also prove helpful (think of the simplification of tools!). Linking form-copying to the ratchet effect and taking the ratchet effect as characteristic of cumulative culture rules out a cumulative force by simpler forms of social learning. Replacing ratcheting by mountaineering allows cumulative culture without form-copying.

The pyramid model of cultural evolution, as described by Whiten and van Schaik (2007) and Whiten (2016), presents additive layers characterized by mechanisms of social transmission of increasing strength: social information transfer, traditions, culture, and finally, cumulative culture. The authors of the original ZLS hypothesis align the ZLS-only species with the layers up to culture, followed by a layer of cumulative culture with high-fidelity form-copying as a mechanism of social transmission forming the summit of the pyramid, or the cherry on the cake, reserved only for humans. If we take the social dimension as presented in the EECC model seriously, the pyramid model has to be modified. While cultural phenomena of different complexity can surely be distinguished, at least on a purely conceptual level, the implicit assumption of "stratification" has to be replaced by a relation of "containing" or "recursion" (cf. Löffler 2019, pp. 195–204). The succeeding layer is not just added on top of the former, which remains unchanged. Rather, the new layer embraces the former, impregnates and transforms it. Once sociality has emerged, the individuals remain social throughout. Consequently, there are no "naive" individuals and all culture is cumulative; cumulativeness is not the cherry on the cultural cake but rather the substance. Instead of becoming narrower with each step, the cultural spheres expand with increasing complexity resulting in an increasing variety of possibilities (cf. the expansion of cultural capacities as part of the EECC model; Fig. 3 from Haidle et al. 2015).

The conclusion from these remarks is straightforward. If we resign from the model of the ratchet and the model

of the pyramid, the rigid distinction between noncumulative culture in nonhuman primates and cumulative culture in humans becomes obsolete. Bandini et al. fail to recognize that even low-fidelity social learning changes the picture completely and can lead to a culture that is inherently cumulative.

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