

Interacting Networks in Social Landscapes: A Devo-Evo Approach to Sociocultural Dynamics

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Abstract

Can the study of epigenetics, physiology, and cognitive science contribute to the investigation and understanding of social-cultural systems while respecting the autonomy of social research? I present a developmental system theory (DST) approach, which takes the unit of analysis to be the system of self-sustaining interactions among multiple biological, psychological, and social resources. On this view, the cybernetic architecture of the networks that constitute the system channels development so that different trajectories lead to convergent end states, accounting for the system's developmental stability as well as shedding light on the conditions that lead to departures from typical outcomes. Based on previous work, which is extended here, I suggest that Waddington's epigenetic landscape metaphor, which was built to illustrate the relationship between genetic networks and embryological development, is a useful tool for thinking about the temporal dynamics of social systems, capturing some important features of social stability and change at different scales and levels of social organization. I discuss five social systems using the landscape metaphor

and explore the implications of this DST approach for investigating the relations between sociocultural development and evolution.

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Introduction

Relating human biology, especially evolutionary biology, to human social and cultural life is fraught with problems. There is more than a century-long history of strained disciplinary relationships between human evolutionary biology and the social sciences (especially cultural anthropology and sociology), with imperialistic attempts to explain the latter in terms of the former on the one hand and vehement opposition calling for the autonomy of the social sciences and the irrelevance of evolutionary considerations on the other (see discussions in Ellis, 1996; Fraccia and Lewontin, 1999; Dersken, 2005).

The biological and social sciences grew together and shaped each other as they defined their boundaries in the 19th century. Evolutionary biology, both Darwinian and neo-Lamarckian, influenced the development of the social sciences, and ideas from the developing disciplines of psychology, anthropology and sociology had an important influence on biological theorizing (Gissis, in press). During the 20th century, ideas about the nature of

heredity and evolution shaped the discourse on both biological and social development, contributing to the horrors of eugenics in the Western world (Teicher, 2020) and to the terrors of Lysenkoism in the USSR (Soyfer, 1994). Following a transient distancing between the biological and social sciences, the attempts to bring the two disciplines together resumed, and since the 1970s, ideas about the genetic basis of human social behavior have been developed by sociobiologists (Wilson, 1975) and evolutionary psychologists (Sperber, 1996). For example, Sperber argued that humans' dispositions to acquire and transmit knowledge are based on innate domain-specific cognitive-affective modules, which, alongside social products, act as factors of attraction, shaping the acquisition and reconstruction of mental representations (Sperber, 1996, 2011). Other biological approaches to cultural evolution were inspired by population and quantitative genetics models. A dual inheritance theory of cultural evolution was developed by Cavalli-Sforza and Feldman (1981) and Boyd and Richerson (1985), who showed how different cultural practices that were influenced by both genetic variations and culturally learned biases could spread in human populations (for a review of different models, see Mesoudi, 2011). Other cultural evolutionists, the memeticists, focused on a function and meaning-blind copying process of "memes" (ideas or practices), their differential copying, and diffusion between populations, employing epidemiological models of viral-like spread (Blackmore, 2000). More complex, evolutionary-ecological models that stress the bidirectional interactions between humans and their ecological and social environments were also developed (Odling-Smee et al., 2003), emphasizing the ways in which humans construct the sociocultural niche in which they live and in which they are selected.

The evolutionary framework suggested by evolutionary psychologists and cultural evolutionists did not bridge the disciplinary gap between the biological and social sciences (Fraccia and Lewontin 1999). It failed to address the most important concerns of social scientists: the processes of active socio-developmental construction and meaning-making based on detailed descriptions of the interacting social factors and processes that construct the life trajectories of individuals, groups, and institutions. Niche construction approaches, especially as applied to human cultural evolution (Kendal et al., 2011; Odling-Smee et al., 2023), see humans as active agents that construct the sociocultural niche in which they live and in which they are somehow "selected," and offer a more sociologically acceptable approach. However, the ontogeny and intentional meaning-making of individuals as they are socialized within the

system, conform to it, or challenge it, which sociologists and anthropologists engaged in qualitative research regard as central to their discipline, are not processes that are central to the niche construction approach.

For the last decade, my colleagues and I suggested a qualitative, developmental system approach to social dynamics that is inspired by the biological insights and descriptive models constructed by CH Waddington, the founder of developmental systems biology, which, we believe, goes some way toward bridging this gap (Jablonka, 2016, 2022; Jablonka & Noble, 2019; Shilton & Jablonka, 2022; Tavory et al., 2012, 2014;). The landscape model achieves this in two senses. First, by using a biological (embryological) framework of discussion and applying it to the construction of social system, it provides a conceptual bridge that shows the generality of the developmental approach and its usefulness for the social sciences. At this conceptual level, the focus is on the shared framework and the descriptive model that enables *analogous* approaches to the analysis of social systems. Second, a landscape-based system analysis allows the incorporation of multiple types of factors into the developmental matrix, including biological factors (although the relevance of different types of factors to the analysis depends on the case study, so biological, genetic or epigenetic factors are not informative for all cases).

The proposal is thus based on the developmental system theory (DST) developed by Waddington (e.g., 1957, 1975; described in section 2) and the elaborations suggested by Susan Oyama and her colleagues (Oyama, 1985; Oyama et al., 2001), which emphasizes the dynamic, self-sustaining feedback interactions among multiple resources, schemas, and activities that lead to the persistence of a system-state over time. The network of interactions among the constitutive factors of the system that renders the system state self-stabilizing is the focus of investigation, and the system, which in the social case is constituted by interacting individuals, groups of individuals, institutions, cultural webs of meanings, ecological factors, and genetic and epigenetic factors, is the unit of analysis. The construction of meaning is central to this approach – acquisition and transmission processes are constructive processes that are context and meaning sensitive, and the developmental-social trajectories of agents within the system are regarded as central to the dynamics of persistence and change, with each stage in the process of social construction scaffolding the next. This paper offers an extension of this approach, which my colleagues and I started to analyze in previous publications, by bringing together examples from different types of social systems that show the general

validity of the approach. In section 3, I discuss, in terms of social landscapes, five different social dynamics: the reproduction of urban poverty in the USA; the persistence and thriving of an Orthodox Jewish community in the midst of a progressive context in the USA; the persistence of the Israeli-Palestinian conflict; the overall stability of the Kivung orthodox practices in Papua New Guinea which are punctuated by transient landscape changes; and the emergence of a new theoretical evolutionary thinking style that is emerging in spite of the neo-Darwinians' resistance to theoretical change.

The social developmental system model and the use of landscape-based systems analysis for social systems suggested here are different from the evolution-inspired models that are at present being employed to understand social-cultural developments in three interrelated ways. First, unlike current cultural evolution models, the SDST model is inspired by developmental (ontogenetic) dynamics rather than evolutionary population models, which have a quantitative stance and bracket meaning-making. Second, since a SDST approach is based on *qualitative* sociological research, it requires thorough familiarity with the case study under consideration at several temporal and spatial scales and at several levels of descriptions (for example, biological, psychological, sociological-historical), including an understanding of the socialization processes of individuals. Third, processes of system dynamic persistence are the point of departure of SDST analysis. In each of the examples discussed in section 3, the characterization of the dynamics of stability, which include processes of selective stabilization and require underlying and overlying network plasticity, is the point of departure. The contribution of the model for understanding the relation between development and evolution in the cultural domain is explored in the discussion section (4), where I also discuss the conceptual relevance of the model to broad evolutionary considerations, suggesting that this developmental approach needs to be part of the extended evolutionary synthesis (EES).

Developmental Network Dynamics: Waddington's Epigenetic Landscape Metaphor

Waddington, an embryologist and evolutionary biologist, coined the term *epigenetics* to describe "the branch of biology which studies the causal interactions between genes and their products which bring the phenotype into being" (Waddington, 1975; p. 218). He was interested in the flexible network of regulatory interactions (which he called epigenotype) that underlies the stable direction of the trajectories of embryonic development, which lead to

a typical end state. He used a visual metaphor which he called *the epigenetic landscape* to describe it. He depicted embryonic development as the progression of a ball (the developing entity, starting with the fertilized egg) through a sloping landscape of alternative valleys (representing developmental trajectories) (Waddington, 1957; Fig. 1 top). This epigenetic landscape is shaped by underlying networks of interacting genes and their products (Fig. 1 bottom). The dynamic regulatory architecture of the networks of interaction constructs a functional, species-typical end state at which the developing entity comes to (dynamically) "rest." The end state, also called the attractor state, is relatively stable or canalized – the regulatory interactions and backup processes embedded in the network flexibly reorganize its dynamics when the internal and external conditions fluctuate, ensuring that the developmental trajectories end up converging at the typical attractor state. In Waddington's terms, the attractor state is canalized. The landscape is dynamic and

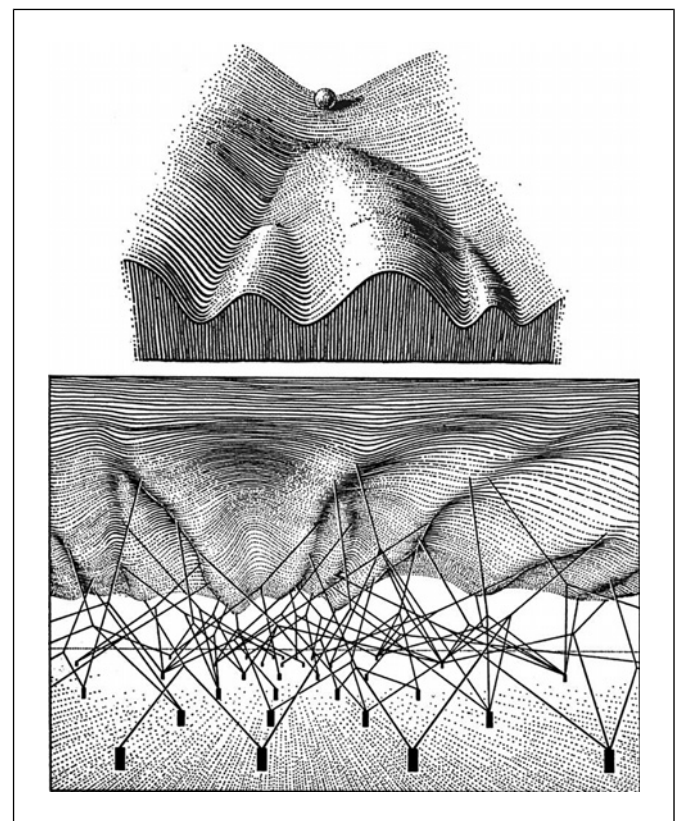


Fig. 1. The epigenetic landscape. Embryonic development is depicted as the progression of a ball through a sloping landscape of alternative valleys representing developmental trajectories (top figure). This epigenetic landscape is shaped by underlying networks of interacting genes (black pegs) and their products. (Waddington 1957, Fig. 4, 5).

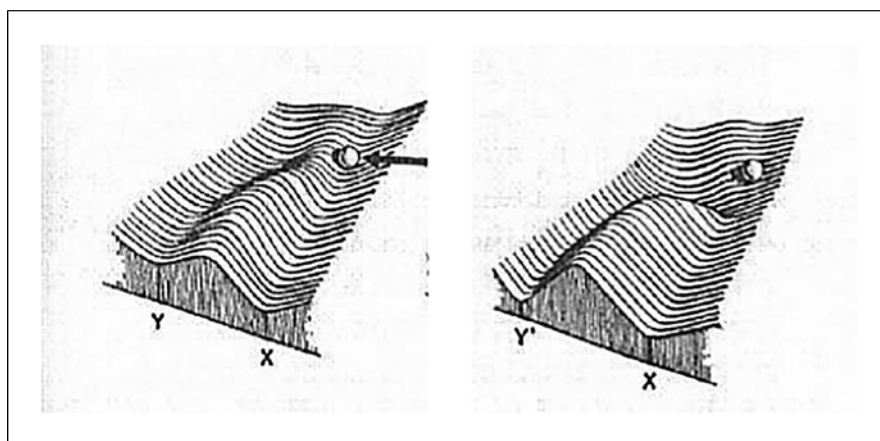


Fig. 2. Moving to a new attractor. A very strong external-environmental change (arrow) is needed to push the “ball” that normally follows the trajectory leading to X, onto the trajectory leading to the new alternative attractor, Y (left figure). When this trajectory change is advantageous and recurrent, genetic variations supporting development along this alternative trajectory are selected. This changes the genetic network underlying the landscape

(not shown) as well as the shape of the landscape (the elevation that prevented reaching X is lowered). Development now proceeds toward attractor Y' (slightly changed attractor; right figure). Waddington called the selection process that leads to development toward the alternative attractor “genetic assimilation” (The figure is based on Fig. 30, p. 167 in Waddington, 1957).

malleable, and this plasticity is what enables the canalized state to be maintained in spite of internal and external changes, although this plasticity also enables – under more drastic changes in circumstances – the decanalization of development, which may lead to reaching or constructing a new attractor through a change in the landscape architecture.

When focusing on the reconstruction and transmission of the dynamics over generations, the attractor can be seen as a Heritably Varying Trait (HVT), a characteristic of an organism or a group of organisms – a physiological, behavioral, or symbolic trait – resulting from the interactions between internal initial conditions and the external environment, which can take several variant forms, persist over time, and be transmitted between “parent” and “offspring” entities (Jablonka, 2004). An ontogenetic attractor state or a between-generation HVT can be described at different levels – the entire organism (e.g., a typical worker bee), an organ (e.g., a functioning heart), or a cell type (e.g., a muscle cell), and is typically stable even when the underlying (genetic) or the overlying (external-environmental) conditions change. Importantly, the trajectory of change *does not* preexist (although it can be predicted with high accuracy given the underlying scaffoldings; Fig. 1 is therefore somewhat misleading). It is constructed by the developmental processes, which are scaffolded on developmental biases.

As some scholars pointed out (e.g., West Eberhard, 2003), what is lacking in Waddington’s landscape model is an explicit depiction of the way environmental factors affect the landscape. However, although not apparent in Figure 1, Waddington did discuss the effects of environmental factors on the evolution of the landscape in his famous *The Strategy of the Genes* book (see for example, pages 166–168), starting with a change in the developmental trajectory that is the consequence of a drastic change in external or internal conditions (Fig. 2). However, he regarded heritable transgenerational changes as a result of changes in the genetic network. Non-genetic factors were acknowledged but were not assigned evolutionary importance in non-human organisms (Jablonka & Lamb, 2020).

In order to highlight the effects of both underlying and overlying factors on the structures and dynamics of the focal developmental network, which is itself a network of interactions, a modified model was suggested (Jablonka and Noble 2019; Fig. 3). This model shows a very small part of a developmental landscape, focusing on a single attractor state and not showing the multiple transient attractors that pave the way to its attainment.

Jablonka and Noble (2019) discussed the stability of heart function in terms of this three-tier model, starting with a typical heart in typical external (environmental) and internal (genetic) conditions (Fig. 4a). A change in the environment – a period of maternal malnutrition during pregnancy, for example – may not disturb persistent

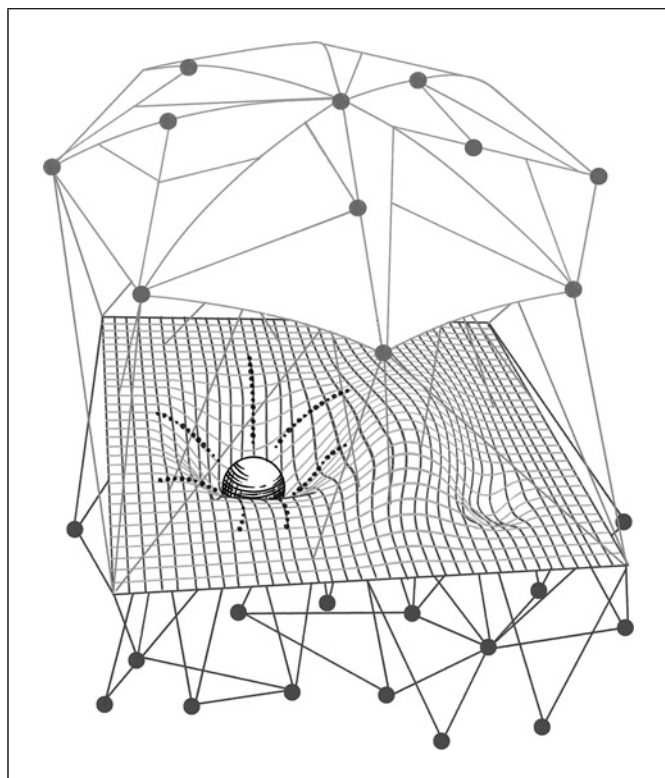


Fig. 3. The developmental landscape with the focal attractor (left) is constructed and stabilized by underlying and overlying networks, as well as interactions at its own level. A small part of the focal landscape (middle web) with a dominant single attractor state shows both the constructive effects of the underlying epigenetic networks and the effects of the overlying ecological/social network that construct the niche (the network emanating from the top umbrella). A shallow potential, but not readily attainable, attractor is shown on the right. The fabric of the focal landscape (middle web) is both made up of and influenced by the underlying and overlying networks. Different developmental routes lead individuals (little black dots) onto the attractor.

heart's function because alternative developmental and behavioral strategies are employed and alter gene-expression patterns, which compensate for the change (Fig. 4b). Similarly, a new mutation, even one that affects the pathways leading to the development of a heart, may have no apparent effects on heart function because the genetic network reorganizes and compensates for the effect (Fig. 4c). However, large and persistent fluctuations (e.g., a mutation in a regulatory region or prolonged starvation) or multiple small changes in genes and/or environmental conditions can change the landscape (Fig. 4d, e).

Waddington's landscape metaphor and his development evolutionary approach can be applied to other developmental-evolutionary systems. This was realized

by Piaget, who was familiar with and sympathetic to Waddington's developmental-evolutionary approach and arrived, through his studies of child development, at similar ideas about development (Piaget, 1971). Piaget's notion of assimilation – the incorporation of variation into the developing psychological system of the child without changing the system's organization and function – mirrors Waddington notion of canalization, while his concept of accommodation – the reorganization and change of the system as it responds to changes – is related to plasticity that leads to a new developmental stage, a new attractor.¹ A detailed discussion of Piaget's views of child development in terms of Waddington's epigenetic landscape and the landscape model can be illuminating, but here I focus on landscapes of social interactions, where the unit of analysis is the dynamics of the social landscape rather than the psychological-developmental landscape of an individual.

Stability and Change in Social Landscape: Five Examples

Tavory et al. (2012, 2014) adapted Waddington's embryological model to the far more open-ended and flexible case of social systems. Our "social landscape" is a descriptive model of a dynamically stable, reproducible pattern of life in a particular social world. While in Waddington's original scheme, attractors represent the dynamic morphogenetic stability of different organs or the determined states of different cell types, our focus has been on a reproducible social state, which is the explanatory target of sociological and anthropological inquiry – a social attractor. In other words, a social attractor is a region in the social landscape that is identified by the researcher as a typical, socially reproduced pattern of activity, and the dynamics of its persistence and/or change are the focus of investigation. This reproducible social pattern is the outcome of developmental, ecological, social, and epistemological niche construction.

The regulatory networks of interactions among the practices of individuals and groups, the effects of factors such as medical and nutritional conditions, institutional structures, ecological affordances, and so on, can lead to the continuous reconstruction of the focal cultural-social landscape as well as explain departures from it. Which factors are relevant to the analysis of the

¹Piaget's interpretations of genetic assimilation was flawed (and it is important not to identify his notion of assimilation and accommodation with the use of genetic assimilation and genetic accommodation (Jablonka 2017).

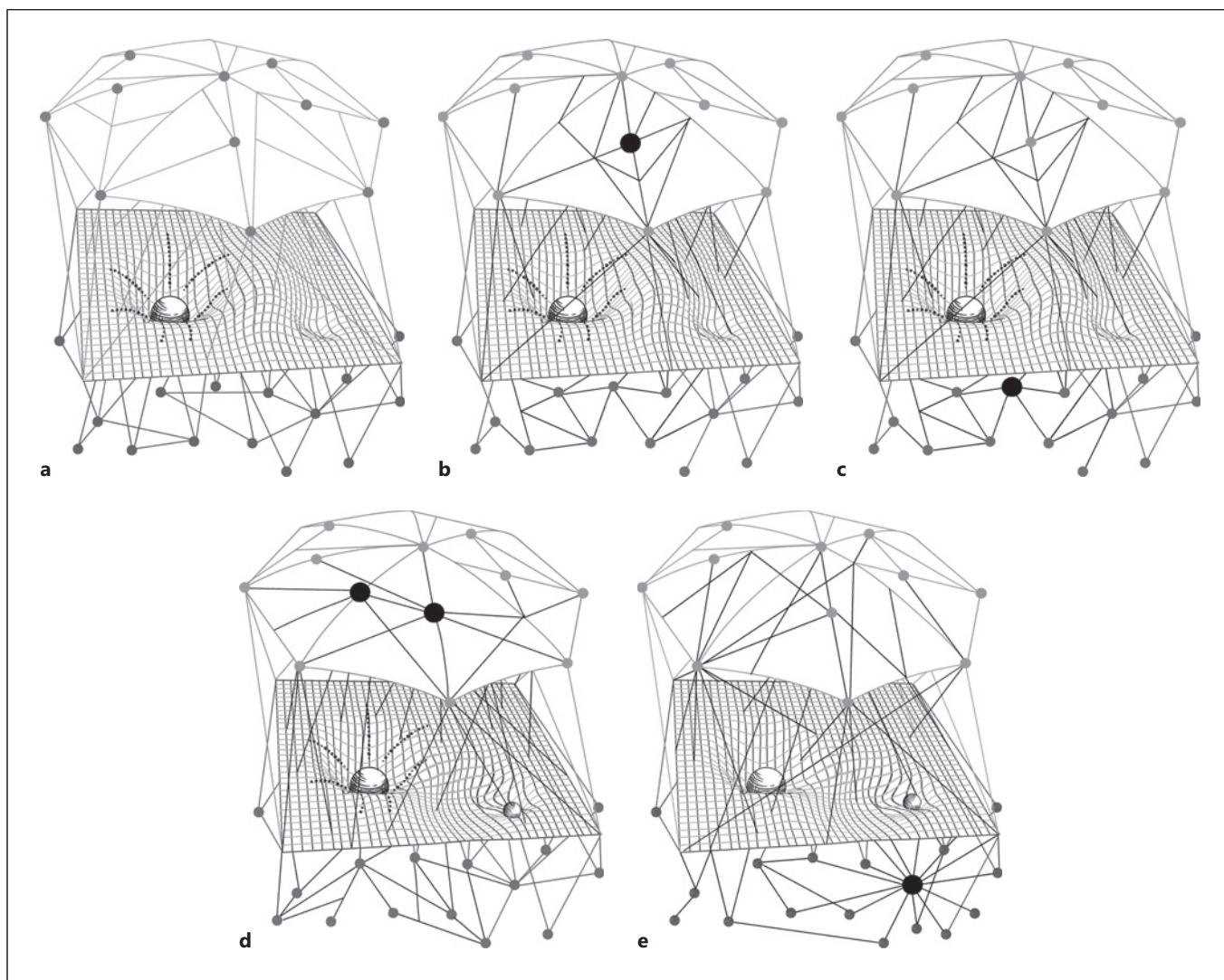


Fig. 4. **a** Stabilized and altered epigenetic landscapes: part of an epigenetic landscape (middle gray net), which is constructed and constituted by an underlying genetic network and overlying network of typical external conditions. The circles at the bottom represent genes, and the strings represent the biochemical effects and products of the genes; the upper umbrella network represents an overlying web of environmental conditions external to the focal developmental system. The depression in the middle of the gray web is the set point or attractor state representing the canalized, developmentally constructed functional state of the focal system (e.g., a functional beating heart). **b** shows that the attractor in the focal landscape can persist even when there is a change in external

condition, such as a short period of malnutrition during pregnancy (upper umbrella), through the reorganization of the genetic and environmental-behavioral network, which compensates and buffers the effects of the external change. **c** shows that a genetic mutation (red circle) may also leave the attractor in the landscape unchanged since the genetic and environmental networks reorganize to compensate for its effects. **d** and **e** show that a new attractor has been reached following a large genetic or environmental change that led to multiple changes in interaction and changed the landscape. Note that a change in underlying or overlying factors alters network interactions at all levels, even when landscape does not change (as in **b** and **c**).

landscape and its attractor/s cannot be decided a priori but depends on the social system one chooses to study. Importantly, and generally, the social landscape is typically *canalized* – there are multiple interacting factors that form feedback relations that overdetermine

the end result, leading to the attractor's dynamic persistence; so although the landscape is plastic and amenable to many changes in individual and group trajectories, these may not change the depth and width of the attractor. However, some changes in dynamics can

and do lead to a new landscape with an altered or new attractor. The attractor and the landscape in which it is embedded are part of a larger social terrain made up of several landscapes, but at a given level of analysis, the interactions within a specific landscape are more numerous and more self-sustaining than interactions between landscapes.

The characterization of the factors that construct the attractor of interest is, of course, critical. Although our focus is on the central role of attraction in cultural evolution (rather than transmission fidelity and selection) is similar to the approach developed by the evolutionary psychologist Dan Sperber, we have a different notion about the nature of what he calls “factors of attraction.” Sperber suggested that innate, domain-specific cognitive biases and cultural products are factors of attraction that channel the evolution of cultural representations even in the face of low transmission fidelity (Sperber, 1996, 2005, 2011; Claidière et al., 2014). Our view of the nature of factors of attraction is different from Sperber’s. First, as the examples below will illustrate, the factors of attraction that constitute the landscape and its attractor may belong to multiple domains. Second, we disagree with Sperber’s assumption that human cognitive biases are innate and domain-specific (Jablonka & Lamb, 2014) and agree with Heyes (2018) that such biases are culturally learned and culturally evolved. They are, on the view we take, parts of the culturally constructed networks of interactions that form the self-sustaining dynamics of the sociocultural attractor state and can themselves be amenable to landscape-guided analysis.

From the point of view of an individual – or any processual unit of analysis that we are aiming to explain – the landscape is the context of its development. An individual develops within a given social landscape and contributes to the collective and cumulative interactions that construct it, so the trajectories in the social landscape are the developmental paths of individuals as they become socialized. Usually, individuals go through partially preexisting trajectories which they stabilize and deepen, but occasionally, the landscape changes in a way that allows a group of individuals to carve out an alternative trajectory and reach a new HVT.

We need, however, to do more than translate the terms of Waddington’s embryological landscape metaphor into the terms of social science. As we emphasized (Tavory et al., 2012, 2014; Shilton & Jablonka, 2022), when translating and applying the metaphor to the social-cultural domain, we assume the following:

- The social landscape is far more plastic than the original embryological one; the social attractor is more malleable, and the landscape can change dynamically over both short and long historical times (social changes due to the usage of the internet and AI in the last 2 decades are obvious examples).
- The social landscape describes group-level processes and meaning-making systems (rather than the development of a single individual, as does the embryological original application by Waddington). However, individual development is an important and explicit part of the model: individuals follow and reconstruct trajectories outlined by the past and present social processes that lead them to the attractor. The analysis of individual reconstruction is a central part of methodology of scholars engaged in qualitative sociological and anthropological research (Tavory and Timmermans 2014). This qualitative aspect is also an essential component of the social landscape approach.
- The resources and “factors of attraction” that overlie and underlie the focal landscape typically belong to different categories or “fabrics” (although only some of these resources may be relevant for a given case): genetic, epigenetic, ecological, institutional, and symbolic resources. It is the attractor state or the HVT chosen for analysis that determines the relative functional significance of these different “fabrics.” For example, genetic variations are relevant for the analysis of embryological development, while epigenetic-developmental factors, but not genetic variations, can be relevant for the analysis of cycles of poverty. Neither genetic nor ontogenetic physiological factors are relevant for the analysis of the persistence of the scientific paradigm described below, which needs to be analyzed at a different level of description.
- The underlying resources and the overlying constraints are not just externally affecting the focal network – they are the threads in the fabric from which it is made. Hence, although it is possible to point to different types and levels of networks of interactions, they are inseparable at the focal level of description – the focal landscape level in which the attractor is embedded, where they are often woven together. The effects of networks at all three levels are often tri-directional: changes in the underlying levels can alter interactions at the landscape level and sometimes even at the overlying level. Changes in the overlying level may affect both underlying and landscape levels, and changes at the (middle) landscape level may alter factors and relations at the underlying and overlying levels.

The characterization of the three network levels, their cybernetic organization and hierarchical structure, as well as the specification of the relevant networks' interactions which construct the focal social landscape, is far from obvious and is a major part of the research project. In the original embryological landscape suggested by Waddington, the characterization of the three levels is straightforward: the epigenetic landscape represents the development of the embryo, the underlying network described the molecular interactions between genes and their products, and the overlying network described the external conditions (e.g., the physiological state of the maternal womb and the conditions impinging on it). With social networks on the other hand, the decision of what is underlying and overlying depends on the specific case studied. The developmentally constructed niche involves interactions among the behaviors of individuals and groups within their specific social background; the underlying network consists of interactions among more bottom-up factors that influence physiology or behavior of the social agents and the overlying network describes top-down interacting constraints and affordances (e.g., ecological, historical, global-political factors).

Although the landscape model focuses on the dynamics of robustness and persistence, and although individuals go through partially preexisting trajectories which they typically tend to stabilize and “deepen,” their activities may also alter the local features of the landscape with which they interact. A gradual accumulation of changes can reach a tipping point, leading to a change in the landscape’s architecture and to a new attractor, but landscape and attractor change can also occur as a result of drastic global changes (for example, wars, mass immigrations, revolutions). The analysis of both the self-sustaining interactions that underlie and overlie the persistence of a particular attractor as well as the analysis of a diversion to a new attractor is necessary for understanding the multifactorial and multilevel feedbacks that maintain or alter the landscape.

Urban Poverty: A Persistent Harmful Attractor

Our first example in our original papers (Tavory et al., 2012, 2014) was the persistence over time of urban poverty in the USA, which is detrimental at the personal and social levels but is nevertheless very robust. The question we asked was as follows: what maintains this cycle? The rich literature on urban poverty in the USA suggests that factors and processes that lead to the reconstruction of poverty include the following (references illustrating and discussing these factors can be found in Tavory et al. 2012, 2014):

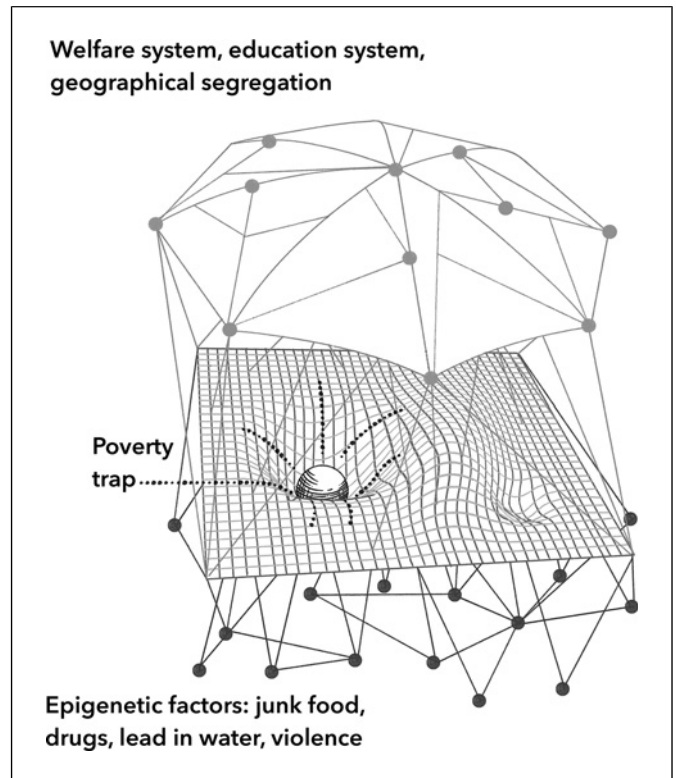


Fig. 5. The urban poverty attractor. Both the underlying network of the epigenetic, persistent physiological effects of poverty and the overlying institutional and ecological-geographic networks contribute to the construction of the cycle of poverty. The probability of escaping the poverty trap (shallow attractor on the right) is low.

- Limited job opportunities and outsiders’ prejudice
- Residential segregation
- Social policies at different levels of government
- The distancing of those who escape the poverty cycle from the poverty-stricken neighborhoods
- Sub-par schools, the low cultural capital of students’ families, low expectations from teachers
- The developmental effects of malnutrition, the consumption of unhealthy food, alcohol, or other toxins
- Meaning-making coping strategies such as sticking to insecure low-paid jobs as niches of respectability

These factors (which are of course only some of the factors which participate in the networks) interact and reinforce each other, sustaining and re-forming the individual and group trajectories that lead to poverty and explaining why it is difficult to escape it. Interventions at several levels (educational, nutritional, economic, psychological) are necessary to move to a new attractor Figure 5.

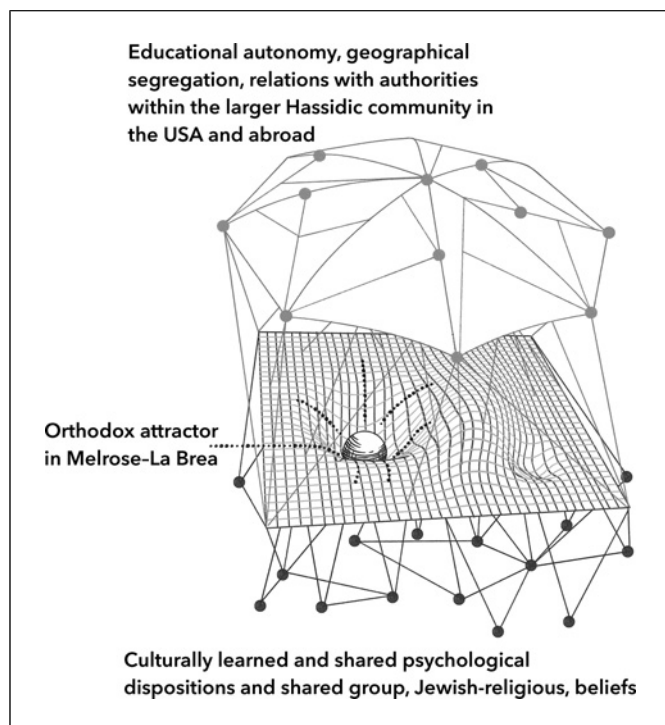


Fig. 6. The social attractor of the Jewish orthodox lifestyle in LA. Individuals follow and deepen developmental paths that lead to the developmental reconstruction of the attractor. The networks and representations that underlie the landscape are based on culturally learned and shared dispositions and beliefs. Overlying constraint and affordances include the autonomy of the educational system, geographical segregation, relations with authorities within the larger Jewish Orthodox community in the USA and abroad.

The Persistence and Thriving of an Orthodox Jewish Community in a Modern Secular City

Tavory (2016) analyzed the persistence and thriving of the largest and most successful Jewish Orthodox community on the West Coast of the USA today—both residentially and institutionally. This orthodox Hassidic community is situated in Los Angeles’s Melrose-La Brea neighborhood, an area known for its “transgressive” youth culture rather than for strict adherence to religious edicts. The question Tavory asked was how this community sustained shared ways of life that the modern city in which it is embedded was supposed to erode and extinguish. I highlight here four of the many processes that Tavory (2016) identified as crucial for these self-sustaining social dynamics:

- The neighborhood community affords members with the institutional framework they need and generates participation, creating multiple obligations that members are constantly pulled toward. Examples are

the private education system, which is very expensive and requires parental participation, and demanding Sabbath edicts.

- Because they are so similar to “others” in the neighborhood, the community members create boundaries differentiating between themselves and the “others,” transforming their seeming marginality and difference into a seductive experience of community.
- The community forms geographic boundaries, with members living close together and within walking distance for their synagogue.
- Public worship situations create interactions which sustain religious communal life and generate communal meanings (see Figure 6).

A Sociopolitical Landscape: The Israeli-Palestinian Conflict and the Persistence of the Occupation Culture in Israeli Society

The Israeli-Palestinian conflict and the sociopolitical and psychological factors involved in its consolidation and persistence have been thoroughly analyzed by Daniel Bar-Tal (Bar-Tal, 2013, 2023). This more than century-old violent conflict is driven by differences in political, economic, territorial, religious, and cultural aspirations of Israeli Jews and Palestinians. Collective traumas engender hate and distrust of the out-group, leading to disregard of the needs of the other, negation of the identity and narrative of the opponent, systematic demonizing of the other, and the perceiving of every concession as a loss for the conceding side. The conflict, which impinges on all aspects of life of the two people, is maintained and amplified by supporting narratives that are anchored in multiple political, social, and psychological feedback loops. Focusing on the Israeli side of the conflict and the dominant narrative that sustains it, Bar-Tal argues that the life within the conflict zone has become routinized. It has become what he calls a “comfort zone” for the Israelis because the society members prefer the status quo, over any change whose effects would be unknown (as long as the violence of the conflict and the cost in Israeli life are kept low enough).

Bar-Tal summarizes and highlights some of the factors that construct the conflict-supporting narratives in the Jewish-Israeli society in the last 2 decades (since the early 2000s):

“Under the circumstances [disbelief in the possibility of peaceful resolution], maintaining the conflict supporting narratives has therefore become a pressing need in order to justify the fragile situation as it exists, in which “we will forever live by the sword.” Again, these narratives supply the

basic needs of society members—just as they did at the peak of the conflict, during the 1950s and 1960s, without awareness that they fuel the conflict and create cycles of violence and that there are other narratives that can satisfy the human needs. However, the radicalization of Jewish society that has occurred during the last 2 decades is not only expressed in opinions or abstract perceptions—but has penetrated the institutional system of the country and has become an inseparable part of political and national culture. It has changed the essence and character of the state of Israel and its institutions, its values, and even its identity. I would like to use the detailed analysis of Israel as a case study of a society that, under conditions of bloody and lasting conflict, has moved to conflict supporting views because of the flow of misinformation and indoctrination that has become systematic, continuous, and widespread. The government, necessary for maintaining the conflict, needs the support and readiness to participate in conflict activity in different capacities, including the use of security forces that not only kill, but whose members are also killed or injured. In some respects, it is a miracle that in this context, a peace camp, anti-racist, moral and involved in the defense of human rights, still exists in Israel, considering the difficult conditions it faces, of being mistreated and delegitimized, with active attempts to silence its voice.” (Bar-Tal, 2023, pp. 199–200. His emphasis)

The occupation of Palestinian lands in 1967 and their military, economic, and political control include taking over land, Palestinians’ expulsion, huge investments in settlements and their defense, bureaucratic harassment, deprivation of Palestinians’ political and property rights, collective punishments and other violation of human rights and geographic and social fragmentation of the Palestinian society. All these are justified by the Israeli group’s beliefs and the narratives that express them, which supply the reasons and logical and emotional bases for continuing the conflict, reflected and reinforced by the attitudes, practices, and political and economic interests that both feed and result from these narratives, forming self-sustaining loops. Based on his extensive analysis of the conflict (Bar-Tal 2013, 2023), he suggested that these processes include the following:

- Israeli solidarity, especially following wars and terror attacks, is combined with self-perception as innocent victim. This is actively reinforced through holocaust-related memorials and other memorization practices and through the demonization of Palestinians who are often compared to the Nazis.
- Positive moral self-image and the spreading liberal-democratic images of Israel, claiming that Israel is the only democracy in the Middle East, Israel is very moral, the Israeli army is morally superior institution, etc. All Palestinian aggressive actions are regarded as unprovoked actions.

- Delegitimization of critical views, such as those voiced by “Breaking the Silence”, soldiers who blow the whistle on military crimes. Such acts are seen as acts of treason, undermining the army, which defends and protects the Israeli nation. There is perception of non-Jewish critics of the Israeli government occupation policies as antisemites and perception of Jewish critics as self-hating Jews.
- Moral silencing of criticism according to which other nations have no right to rebuke Israel since Jews have been victims and the criticizing nations did not take steps to save them during the Holocaust or participated in their annihilation.
- Development of formal and informal institutions that maintain the narrative and the occupation (e.g., educational system, legal system, use of mass media, and social media). For example, financial government investments that maintain, reinforce, and direct the system.
- The rise and increasing impact of social, cultural, and political influence of religious right-wing Zionism, which adds a religious-racist flavor to the glorification of the occupation and justifies double moral standards. In addition to encouraging settlements and occupying Palestinian land, this group enacts legislation, appoints judges, determines social behavioral norms, prepares educational curricula, determines budget distribution to schools, controls extra-curricular activity, and develops ideological and financial relations with right-wing diaspora Jews.
- Changes in language usage such as calling torture “moderate physical pressure,” calling blockade, “closure,” and targeted assassination “targeted strike.”
- Concealment, distortion, and falsification of information that does not tally with the dominant narrative. Information supporting the narrative is amplified. There is censorship, limiting access to archives.
- Sectors that economically profit from the conflict situation, such as the settlers, companies, and individuals who earn money from settlement-supporting industries as well as industries of hi-tech weapons and surveillance, actively maintain the conflict.

These are only some of the factors, each of which comes with multiple variations and ramifications, that form strong self-maintaining and ever-growing networks that support the conflict attractor. The effects of these factors on the social situation in Israel and Palestine can be described by a landscape diagram (Fig. 7), although

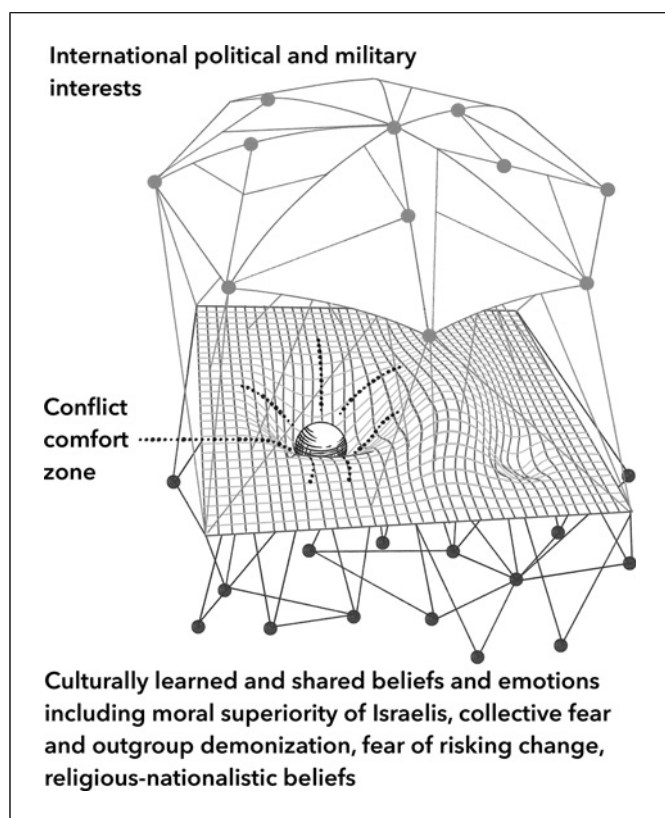


Fig. 7. The Israeli conflict comfort zone. The underlying network consists of culturally learned and shared beliefs and emotions such as the moral superiority of Israelis, collective fear and out-group demonization, risk aversion, as well as nationalistic and religious beliefs. The overlying network is made up of international interests and their political and economic actions and inactions. All these contribute to the construction of the attractor zone in the focal landscape.

Bar-Tal did not use this model to discuss the dynamics of the conflict. A more complete picture must include not only more detailed specifications of the factors and their relations that construct the Israeli conflict narrative but also the Palestinian conflict narrative landscape within the broader regional landscape and the way in which it interacts with and reinforces the dominant Israeli narrative (Fig. 7).

A shift to a new attractor (the implementation of a peaceful resolution) is at present unlikely, as none of the conditions able to affect such change are in place. A change may occur if Israeli leaders alter their attitudes to the conflict because of internal pressure of civilian groups, if global or regional events such as wars, revolutions, and other drastic changes in the political system destabilize the system, and if the Palestinian opposition to occupation or external

pressure by other countries (e.g., economic and cultural boycott) will exact a very heavy price on Israeli society.

The Stability of Mainstream Kivung Religious Practices Punctuated by Transient Transitions to Variant Practices

The Kivung religious movement in Papua New Guinea was studied and analyzed by the anthropologist Harvey Whitehouse, who described the networks of interactions among different belief systems, practices, narratives, and institutions (Whitehouse, 2021). The Kivung movement, established in the early 1960s, was influenced by Christian missionaries and loosely adopted the ten commandments and modified stories from the Old Testament. A central idea dominating this system of belief is that the ancestors of the Kivung followers may be persuaded to return as white people, bringing with them all the wonders of Western civilizations, so the Kivung will enjoy a period of plenty. Those who will use this period of plenty well will be forever in paradise, while abusers will go to hell. In order to persuade the ancestors, the people must follow the Kivung doctrine and its many practices. A centralized leadership controls the teachings and practices of the movement, which include various rituals and some taboos. One such taboo is prohibiting betel nut chewing, a practice that is widespread in neighboring populations around Papua New Guinea. The Kivung associate the red substance produced by chewing the betel nut with menstrual blood, which is regarded as impure, thus increasing the odds of people adhering to the taboo. Since the red substance reddens the teeth, detecting transgressors and policing them is very easy.

Whitehouse (2021) pointed to the many factors and their relations that construct the Kivung attractor and presented them as a network of interactions (Fig. 2.2, 2.3, and 2.4 in Whitehouse, 2021). Some of the key factors (Fig. 8) that Whitehouse discusses in his 2021 book are as follows:

- Panhuman cognitive-affective beliefs and tendencies that anchor individual and social behavior, such as beliefs in mind-body duality, beliefs in intelligent design, hazard-precaution routines, immanent justice intuitions, and a tendency to over-imitate, especially when behaviors are causally opaque
- Religious influences of missionaries promising a better life mixed with capitalist ideals of prosperous Western lifestyle and traditional beliefs in ancestors' powers to implement the ideals

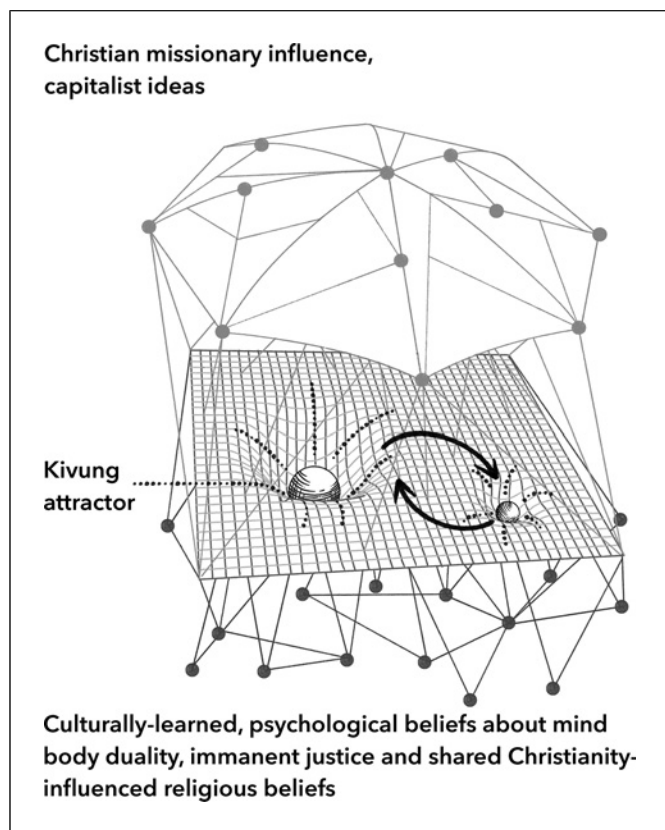


Fig. 8. The Kivung attractor. Panhuman, culturally learned psychological beliefs about mind-body duality, immanent justice, etc., as well as shared Christianity-influenced religious beliefs, form the underlying network that anchors the focal landscape, which is also held by the overlying historical network that includes authority of Christian missionaries and the appeal of capitalist ideas of well-being. Individuals sharing the group's beliefs reaffirm the religious narrative and follow the daily and weekly practices and rituals that maintain and reconstruct the attractor state. The shallow transient attractor of splinter groups is shown on the right. The transient movement of this attractor is due to slight changes in the focal landscape, which "lower" the threshold between the two attractors.

- A set of shared group beliefs, rituals, and taboos that require frequent involvement and are registered by community members and external authority figures
- Central religious leadership that includes teaching and policing of ritual practices

The orthodox Kivung doctrine is stable, but occasionally, short-lived splinter groups are formed in some Kivung villages (the shallow attractor on the right-hand side of Fig. 8). These transitions are based on disillusion with the efficacy of orthodox practices that never bring about the utopia and an unusual event that is viewed as a sign of

imminent ancestors' coming. The splinter groups add to and modify the orthodox rituals and are characterized by high arousal and extravagant rituals but are extinguished after a few months. Following such transient bursts, orthodoxy is re-established and reaffirmed. Whitehouse suggested that employing the landscape metaphor suggested by Tavory et al. (2012, 2014) and applying a multilevel landscape analysis that includes epigenetic, cognitive-developmental, and social-historical landscapes may elucidate the dynamics of social systems (for a discussion of this suggestion, see Shilton & Jablonka, 2022).

The Persistence of the Neo-Darwinian Theory of Evolution and the Emergence of a New Thought Style

The fifth example is different from the previous four in that it focuses on the sociology of science and specifically on the dynamics of persistence and change of a scientific theory. However, since like other social-cultural systems, scientific research traditions are complex dynamic entities constructed by the activities of scientists and shaped by intra- and extra-disciplinary theoretical assumptions, experimental practices, and educational and institutional norms, theoretical persistence and change are processes amenable to analysis in terms of developmental systems theory (Jablonka, 2022). I follow Ludwick Fleck's analysis of the sociology of science, which focused on the construction of the conditions and methods that lead to the reproducible correlations that we call "facts." He identified four major characteristics of the dominant scientific approach, which he called a "thought style" (later called "paradigm" and "disciplinary matrix" by Kuhn, 1970), which characterizes a specific scientific community (which he called the "thought collective"):

"It (a thought Style) is characterized by common features in the *problems of interest* to a thought collective, by the *judgment* which the thought collective considers evident, and by the *methods* which it applies as a means of cognition. The thought style may also be accompanied by a *technical and literary style* characteristic of the given system of knowledge" (Fleck, 1979, p. 99, my emphases).

The case of the neo-Darwinian version of Darwinian evolutionary theory, which is now challenged by a developmentally oriented version called the Extended Evolutionary Synthesis (EES), exemplifies the resistance of the dominant theory to theoretical change. The dominant neo-Darwinian version of Darwinism (also known as the Modern Synthesis, the MS) centers on genes, decouples development and heredity, assumes that heritable variations are all function-blind and marginalizes individual and group niche-constructing

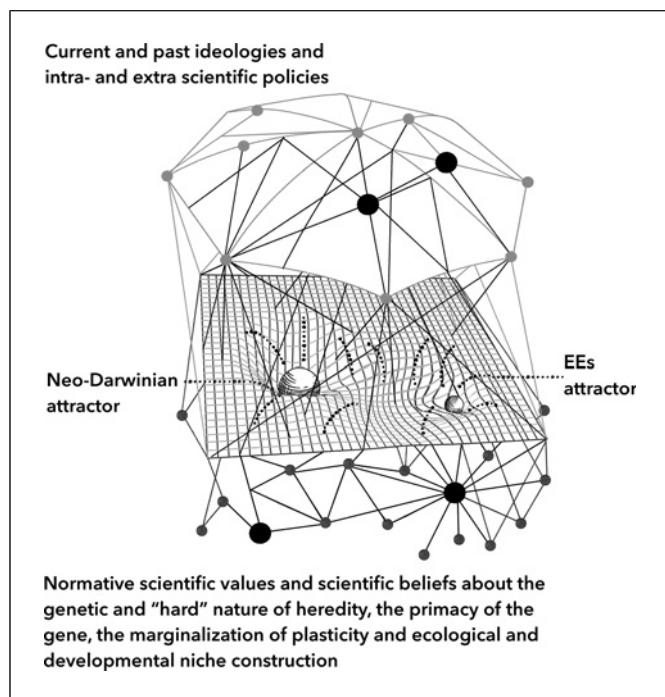


Fig. 9. The MS (neo-Darwinism) dominant attractor and the emergence of the EES. The deep MS attractor is based (underlying network) on beliefs about the genetic and “hard” nature of heredity, on the primacy of the gene as a unit of selection and evolution on the marginalization of plasticity and ecological and developmental niche construction, and normative scientific values. Sociopolitical factors, both internal to the biological disciplines and external, contribute to the stability of the landscape. The landscape is constructed by self-maintaining interactions among social-scientific institutions, scientific socialization, ways of modeling and choice of model organisms, etc., and is further affected by overlying lingering ideologies and intra- and extra-scientific policies that have social/political historical roots and are reflected in funding and job opportunities. Changes in theoretical assumptions, generational changes, and changes in practices and methodologies make the EES attractor much more accessible.

activities (Fig. 9). The EES, which challenges this view, centers on the developing individual rather than the gene, on the agency of individual organisms and groups of organisms that construct the environment in which they and their descendants are selected, and on a broad notion of inheritance that includes not just the inheritance of DNA sequence variations but also variations in gene expression, in behavior and in symbolically encoded information (Jablonka & Lamb, 2020; Laland et al., 2014, 2015). The EES is gaining adherents but is facing strong resistance.

A partial list of factors (discussed in more detail by Jablonka 2022) that generate the theoretical attractor of the dominant neo-Darwinian thought style includes:

- Theoretical assumptions including the exclusion of “soft” inheritance, a view of biological inheritance that focuses on DNA variations, the marginalization of niche construction, developmental plasticity, the effects of symbiosis, and saltational process in biological evolution.
- Focus on sexually reproducing animals with early and rigid germline soma segregation. General theoretical conclusions are based on experimental studies in such animals (for details, see Jablonka & Lamb, 2011).
- Influential textbooks and popular science based on the neo-Darwinian theory, belittling, ridiculing, and distorting alternative approaches. Metaphors and jargon tailored and reinforcing the dominant view are widely used.
- Ignoring or marginalizing findings that contradict the neo-Darwinian paradigm while amplifying the significance of corroborating findings.
- Funding policies of grant-giving bodies and job opportunities favor adherents of the dominant thought style.
- Political effects: The cold war between the USSR and the West that spilled into biology led to the disregard in the West of any challenging findings in the USSR (Lindgren, 1966), while the silencing of developmentally oriented research findings and ideas in Austria, which challenged Nazi ideas, was perpetuated long after the end of the second world war, ensuring the careers of ex-Nazi scientists (Muller, 2017).

In this case, an alternative EES attractor seems to be materializing. A growing number of (mostly young) evolutionary biologists adopt many of the EES ideas, the “politics” of evolution are changing, the hold of old powerful figures weakens, new methodologies that can test the assumptions of the EES are being developed, novel model organisms are used, and handbooks and popular books related to EES topics that explore the implications of the EES thinking style for the biological, social sciences, and humanities are being written. The status of the ESS within biology is interpreted in different ways by different parts of the biological community, and the topic is hotly debated (Jablonka & Lamb, 2020).

Before discussing the way in which landscape-based system analysis illuminates the relation between development and evolution in a way that fits the EES, I would like to highlight three general points that the different cases I discussed illustrate. First, a landscape-guided analysis requires that one looks beyond a single practice as THE key for explaining the dynamics of a social structure. Rather, the focus should be on the relations that

constitute the canalized system. Even a focus on “hubs” – junctions where many factors come together – is not sufficient; it is those junctions where different factors create autocatalytic, self-sustaining interactions leading to the canalized state, which should be at the center of investigation. Similarly, when a change in landscape does occur, it leads to a new social attractor requiring multiple changes at all three levels. Even when a landscape change is initiated by a dramatic single event, such as a global war, it is effective in changing the landscape because it leads to cascading effects, changing many interactions. The nature and direction of this effect depends, among other things, on previously formed trajectories, which were highly canalized and therefore ineffective within the framework of the previous landscape. For example, in the case of the Israeli-Palestinian conflict, if a transition to a new political attractor (acceptance of a peace agreement) will ever occur it will be based on previous challenges to the conflict-supporting narratives and practices that were previously ineffective in bringing about the change but did, nevertheless, outline possible “escape” trajectories. Explicit, ideological, religious, or theoretical shared group beliefs and narratives (Bar-Tal, 1990) are often, as in cases of political and theoretical conflict and religious group persistence, an integral part of the maintenance dynamics of the system but are not necessary in all cases (ideological group beliefs are not necessary for the maintenance of cycles of poverty or cycles of sexual abuse). The analysis of individual reconstruction is a central part of methodology of scholars engaged in qualitative sociological and anthropological research. This qualitative aspect is also an essential component of the social landscape approach.

Second, once the factors and interactions are described, simulations that alter the relations among the networks’ factors can be made and this may allow new insights regarding the landscape dynamics and the exploration of possibilities of intervention. However, the identification of the relevant factors and the feedback interactions among them is the most difficult and the most challengeable task of the researcher. Different analyses of the same focal social landscape may suggest different sets of factors and relations. For example, the landscape-guided analysis of the Israeli-Palestinian conflict and the emergence of the alternative EES attractor that I presented in this paper will be challenged and construed very differently by Israelis with right-wing convictions and by traditional neo-Darwinians, respectively. A landscape-guided analysis cannot reconcile these different views, but a comparison of alternative network dynamics and the predictions and

postdictions that they suggest may contribute to the reflective critique of the choices and interpretations made by different scholars.

Third, traditional cultural evolution models, which are based on the assumption that selection of agents and products is driving the persistence and thriving of the system over time, are not sufficient to describe the behavior of self-constructing social systems. This is particularly clear for cases like the cycle of poverty or cases such as female genital mutilations (not analyzed here) that are detrimental to most of the participating agents, but is relevant to all systems, whether adaptive, neutral, or detrimental. Of course, there are always some individuals and groups who richly benefit from social conflicts and social misery, and the interests of these agents are among the factors that contribute to the cycle’s robustness, but a sole focus on the “who benefits?” question is of limited explanatory value. It is the cybernetic structure of the networks that determines the level of stability, persistence, and patterns of transformations of the landscape, including the depth, shape, and width of the attractor and the occasional escape to an alternative one or the carving-out of a new attractor.

Discussion

Waddington’s epigenetic landscape illustrates the role of the interacting molecular networks in shaping the canalized and plastic morphology, physiology, and behavior of the developing organism. The agency of the organism, which is not passive vis á vis environmental changes and actively constructs its own biology and its niche, is a key part of Waddington’s approach to both development and evolution. Following Waddington, the EES takes the developmentally constructed phenotype as the point of departure in the explanation of evolutionary change, with genetic variations following rather than leading evolutionary processes (Waddington, 1957, figure 30; part of this figure is shown in Fig. 2 here; see also West Eberhard, 2003).

Because it emphasizes agency and multilevel developmental construction, the landscape metaphor is a tool facilitating the analysis of complex systems such as the social-cultural systems discussed here. It starts with the identification of the factors and processes that create autocatalytic, self-sustaining feedback interactions leading to the reproduction of the system and may, therefore, unravel stabilizing or destabilizing interactions that were previously unappreciated. For example, the realization that developmentally induced

epigenetic variations in gene expression can be transmitted between generations has led to the reinterpretation of observed behavioral dispositions (e.g., in the offspring of victims of starvation or trauma) which contribute to the feedback interactions among factors influencing physiological and psychological well-being and are suggesting more informed ways of intervention (Jablonka, 2016).

The landscape approach calls for comparative analysis between landscapes sharing common contours. For example, landscape-guided comparative analysis can be applied to the Israeli-Palestinian conflict and other past and present persistent conflicts (e.g., the Irish-English conflict; the South-African conflict; the on-going Kurdish-Turkish conflict; see Bar-Tal, 2013). Such comparisons may enable the identification of the positive and negative feedbacks that drive the system's persistence, shed light on the role of charismatic leaders and the policies and practices that alter attractor depth, and suggest new ways of intervening. Another interesting case, which is unfolding today, is the social changes resulting from the COVID-19 pandemic, which are impacting most aspects of life including patterns of communication, work, education, community and family interactions, medical organization, and the public image of medical research (including the formation of antivaccination groups and the proliferation of related fake news). Landscape-guided analysis may enable one to identify the most powerful feedbacks in this currently labile social situation, and a comparison to landscapes of historically important pandemics may help identify important communalities and differences, shedding light on the long-term effects of this type of global disaster. Generally, comparisons based on the degree of attractor canalization and cybernetic structures, ranging from highly canalized attractors to more precariously canalized phenomena that can be more readily changed, would allow sociologists to create a new comparative tool.

The landscape model, and especially its application to historical sociocultural changes, has, I believe, important theoretical implications. It problematizes the distinction between development and evolution and leads us to questions such as: Is a sociocultural historical process best described in terms of historical development or in terms of sociocultural evolution? What is the distinction between development and evolution in this case? How should we think about selection processes, and what is the relation between selection and the generation of heritable variation?

As emphasized throughout this paper, the processes of acquiring and transmitting cultural information are not context and meaning blind. They are context- and meaning-sensitive construction processes where the acquisition and

transmission of cultural information is an active learning (developmental) process depending on the nature of the information, the context in which it is acquired, and the internal state of the receiver. The transmission of cultural information is often intentional (teaching), but even when intentional teaching is not involved, the transmission processes consolidate the transmitted information in the sender (consolidation is, of course, a developmental process), changing the stored and transmitted information to a small or large degree. Since both acquisition and transmission are developmental processes, the consequent developmental-evolutionary processes can be broadly defined as the processes leading to the *persistence or change of reproducible variations in developmental traits over time*. It is a system approach that needs to be applied to all complex systems, ecological, biological, and social, stressing the self-perpetuating feedback cycles that involve different types (biotic, abiotic, social-cultural) that are critical to determining persistence. (Lenton et al. 2021). Marion Lamb and I recognized the need to establish this system view and argued that a new term needs to be coined to capture the hybrid nature of systems' developmental-evolutionary transformations (we suggested the term "evelopment," but it did not catch). I believe that this developmental view, which focuses on selection in both non-reproducing and reproducing systems, is crucial for the development of the extended evolutionary synthesis (see Laland et al. 2015; Jablonka and Lamb 2020 for discussion of the extended synthesis).

The proposed definition of developmental-evolutionary ("evelopmental") processes suggests a broad view of evolution based on processes of exploration and selective stabilization. Exploration involves active, constructive detection of preexisting variation and interactions, or the generation of new ones, and stabilization processes lead to the differential persistence over time of a subset of variations. Examples include the generation and selection of mutations and epimutations, the exploratory behavior of unicellular organisms seeking nutrients and following gradients, the selective stabilization of synaptic connections during development and learning, trial-and-error learning in animals, habitat and mate selection, and cultural-learning processes in humans. Hence, selective stabilization processes include both the differential multiplication and survival of entities (Darwinian selection) and selective stabilization processes that do not require replication and multiplication. Price was aware of non-replicative selection processes which he called "sample selection," the selection of a subset from a preexisting set of variable items according to some value criterion (stability, functional value, attractiveness). Examples of sample selection include choosing a particular seat in the theater from a set of

available seats or choosing to follow one political party rather than another (see Price, 1971). However, Price's sample selection is a simple instance of system selection, which does not explicitly recognize the affordances of the dynamic, cybernetic architecture of the system under study. On a broad view of system selection, the natural selection of multiplying genes, heritable epigenetic patterns, memes, organisms, or traits can be seen as a special case of exploration and selective stabilization, which also includes stabilization of non-multiplying and non-replicating interactions at different levels of organization, cases that are best understood in terms of differential attraction. The devo-evo view advocated here accommodates both "replicator" and "attractor" dynamics and can be used to analyze sociocultural and ecological histories, the evolutionary histories of the biological species that compose them, and the evolutionary processes that go on within organisms (e.g., during brain embryonic development and during learning). As Steven Rose said in a 2009 lecture commemorating (Rose., 2009) Darwin's 200th anniversary, nothing in evolution makes sense except in the light of development, and for humans, neither makes sense except in the light of culture, technology, and human history.

References

- Bar-Tal, D. (1990). *Group Beliefs: A Conception for Analyzing Group Structure, Processes, and Behavior*. Springer-Verlag.
- Bar-Tal, D. (2013). *Intractable Conflicts: Socio-psychological Foundations and Dynamics*. Cambridge University Press.
- Bar-Tal, D. (2023). *Sinking into the Honey Trap of the Intractable Conflict: The Case of the Israeli-Palestinian Conflict*. Westphalia.
- Blackmore, S. (2000). *The Meme Machine*. Oxford University Press.
- Boyd, R., & Richerson, P. J. (1985). *Culture and the Evolutionary Process*. University of Chicago Press.
- Cavalli-Sforza, L. C., & Feldman, M. W. (1981). *Cultural Transmission and Evolution: A Quantitative Approach*. Princeton University Press.
- Claidière, N., Scott-Phillips, T. C., & Sperber, D. (2014). How Darwinian is cultural evolution?. *Philosophical Transactions of the Royal Society B*, 369(1642), 20130368.
- Derksen, M. (2005). Against integration: Why evolution cannot unify the social sciences. *Theory & Psychology*, 15(2), 139–162.
- Ellis, L. A. (1996). discipline in peril: Sociology's future hinges on curing its biophobia. *American Sociologist*, 27, pp. 21–41.
- Fleck, L. (1935/1979). Genesis and Development of a Scientific Fact, trans. In F. Bradley & T.J. Trenn. Chicago University Press.
- Fracchia, J., & Lewontin, R. C. (1999). Does culture evolve? *History and Theory*, 38(4), 52–78.
- Gissis, S. (In press). *Knots: Lamarckism and the Emergence of "Scientific" Social Sciences in Nineteenth-century Britain and France*. Springer.
- Heyes, C. (2018). *Cognitive Gadgets: The Cultural Evolution of Thinking*. Harvard University Press.
- Jablonka, E. (2004). From replicators to heritably varying traits: the extended phenotype revisited. *Biology and Philosophy*, 19(3), 353–375.
- Jablonka, E. (2016). Cultural epigenetics. In M. Meloni, S. J. Williams & Martin P. (Eds.), *Biosocial Matters: Rethinking the Sociology-Biology Relations in the Twenty-First Century*. (64:1, pp. 42–60). Wiley-Blackwell. The Sociological Review Monographs.
- Jablonka, E. (2017). The Evolution of Linguistic Communication: Piagetian Insights. In N. Budwig, E. Turiel, & P. Zelazo (Eds.), *New Perspectives on Human Development* (pp. 353–370). Cambridge University Press.
- Jablonka, E. (2022). Progress in modern biology: A developmental system approach. In S. Yafeng (Ed.), *New Philosophical Perspectives on Scientific Progress. Series: Routledge Studies in the Philosophy of Science* (pp. 149–167).
- Jablonka, E., & Lamb, M. J. (2011). Changing thought styles: the concept of soft inheritance in the 20th century. In R. Egloff, & J. Fehr (Eds.), *Vérité, Widerstand, Development: At Work with/Arbeiten mit/Travailler avec Ludwik Fleck* (pp. 119–156). Collegium Helveticum.
- Jablonka, E., & Lamb, M. J. (2014). *Evolution in Four Dimensions: Genetic, Epigenetic, Behavioral and Symbolic variations in the History of Life* (2nd edn.). MIT Press.
- Jablonka, E., & Lamb, M. J. (2020). *Inheritance Systems and the Extended Evolutionary Synthesis*. Cambridge University Press.
- Jablonka, E., & Noble, D. (2019). Systemic integration of different inheritance systems. *Current Opinions in Systems Biology*, 13, 52–58.
- J. Kendal, J. J. Tehrani, & J. John Odling-Smee (Eds.), (2011). Human niche construction in interdisciplinary focus. *Phi Trans Roy Soc.* (366, pp. 784–934).

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- Kuhn, T. S. (1970). *The Structure of Scientific Revolutions* (2nd edn.). University of Chicago Press.
- Laland, K., Uller, T., Feldman, M., Sterelny, K., Müller, G. B., Moczek, A., Jablonka, E., Odling-Smee, J., Wray, G. A., Hoekstra, H. E., Futuyma, D. J., Lenski, R. E., Mackay, T. F. C., Schluter, D., & Strassmann, J. E. (2014). Does evolutionary theory need a rethink? Yes, urgently. *Nature*, 514(7521), 161–164.
- Laland, K. N., Uller, T., Feldman, M. W., Sterelny, K., Müller, G. B., Moczek, A., Jablonka, E., & Odling-Smee, J. (2015). The extended evolutionary synthesis: its structure, assumptions and predictions. *Proceedings of the Royal Society B*, 282(1813), 20151019.
- Lenton, T. M., Kohler, T. A., Marquet, P. A., Boyle, R. A., Crucifix, M., Wilkinson, D.M., & Scheffer, M. (2021). Survival of the systems. *Trends Ecol Evol*, 36(4), 333–344.
- Lindgren, C. C. (1966). *The Cold War in Biology*. Planarian Press.
- Mesoudi, A. (2011). *Cultural Evolution: How Darwinian Theory Can Explain Human Culture and Synthesize the Social Sciences*. Chicago University Press.
- G. B. Müller (Eds.), (2017). *Vivarium. Experimental, Quantitative, and Theoretical Biology at Vienna's Biologische Versuchsanstalt*. MIT Press.
- Odling-Smee, F. J., Lala, K. N., & Feldman, M. W. (2003). *Niche Construction: The Neglected Process in Evolution*. Princeton University Press.
- Oyama, S. (1985). *The Ontogeny of Information. Developmental Systems and Evolution*. Duke University Press.
- Oyama, S., Griffiths, P. E., & Gray, R. D. (2001). *Cycles of Contingency*. MIT Press.
- Piaget, J. (1971). *Biology and Knowledge. An essay on the Relations between Organic Regulations and Cognitive Processes*. Edinburgh University Press.
- Price, G. R. (1971/1995). The nature of selection. *Journal of Theoretical Biology*, 175(3), 389–396.
- Rose, S. (2009). A lecture given in a seminar Commemorating Darwin: human nature revisited. Séminaire du 27 avril au 2 mai 2009 organisé par Halldor Stefansson et Denis Duboule. <https://lestreilles.hypotheses.org/3420>
- Shilton, D., & Jablonka, E. (2022). Rituals, Music, and the Landscape Metaphor. *Journal for the Cognitive Science of Religion*, 8(2).
- Soyfer, V. N. (1994). *Lysenko and the Tragedy of Soviet Science*. Rutgers University Press. Translated by Leo Gruliow and Rebecca Gruliow.
- Sperber, D. (1996). *Explaining Culture: a Naturalistic Approach*. Blackwell.
- Sperber, D. (2005). Modularity and relevance: How can a massively modular mind be flexible and context-sensitive? In P. Carruthers, S. Laurence, & S. Stich (Eds.), *The Innate Mind: Structure and Content* (pp. 53–68). Oxford University Press.
- Sperber, D. (2011). A naturalistic ontology for mechanistic explanations in the social sciences. In P. Demeulenaere (Ed), *Analytical Sociology and Social Mechanisms* (pp. 64–77). Cambridge University Press.
- Tavory, I., Ginsburg, S., & Jablonka, E. (2012). Chapter 30 Culture and epigenesis: A Waddingtonian view. In Jaan Valsiner (Ed), *The Oxford Handbook of Culture and Psychology* (pp. 662–676).
- Tavory, I., Ginsburg, S., & Jablonka, E. (2014). The reproduction of the social: a developmental system approach. In L. R. Caporael, J. R. Griesemer, & W. C. Wimsatt (Eds.), *Developing Scaffolds in Evolution, Culture, and Cognition* (pp. 307–325). MIT Press.
- Tavory, I., & Timmermans, S. (2014). *Abductive Analysis. Theorizing Qualitative Research*. Chicago University Press.
- Tavory, I. (2016). *Summoned. Identification and Religious Life in a Jewish Neighborhood*. Chicago University Press.
- Teicher, A. (2020). *Social Mendelism: Genetics and the Politics of Race in Germany, 1900–1948*. Cambridge: Cambridge University Press.
- Waddington, C. H. (1957). *The Strategy of the Genes*. Allen & Unwin.
- Waddington, C. H. (1975). *The Evolution of an Evolutionist*. Edinburgh University Press.
- West-Eberhard, M. J. (2003). *Developmental Plasticity and Evolution*. Oxford University Press.
- Whitehouse, H. (2021). *The Ritual Animal. Imitation and Cohesion in the Evolution of Social Complexity*. Oxford University Press.
- Wilson, E. O. (1975). *Sociobiology: The New Synthesis*. Belknap Press.