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Source

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Biological Agency Without Levels

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Abstract

We discuss two challenges facing any attempt to integrate the concepts of levels of organization with biological agency. These are: (i) the mapping of agency on levels of organization is not straightforward. Agency can only be mapped on levels if they contain mediating units which are more proximate to entities that possess agency, like well-defined biological individuals; (ii) we run into conceptual problems when distributing agency across levels of organization that are not only understood as evolving over evolutionary time (from unicellular life to humans), but that arise and are lost various times during development and across life-cycles. Based on these two challenges, we hold that while the levels concept can confer powerful heuristics, the heuristic reach of the levels concept does not avail to the conceptual challenges facing biological agency. Thus, it is not sufficient to make the two notions compatible in a way resembling “levels of agency.”

Key Words

Levels of organization; biological agency; individuality; development; life cycle

In recent years, philosophy of biology has seen a resurgence of interest in reviving the concepts of biological agency and teleology. Scholars in this current debate adopt an understanding of internal teleology that often rejects Kant’s (1790/93) epistemic views of organisms’ agency. Rather than treating organisms as if they are agents we need to understand that they are agents (e.g., Weber & Varela, 2008; Walsh, 2015; 2018; Mossio & Bich, 2017; Gambarotto & Mossio, 2022). But their agential properties are not, as Ernst Mayr claims (Mayr, 1974, p. 99), stored in a “program [that] is the result of natural selection, constantly adjusted by the selective value of the achieved endpoint.” Instead, organisms have certain degrees of freedom in the way they set and realize goals suitable for their own existence. What is more, organisms may actively shape their internal organization and their environment in ways that allow them to modify the selection pressures acting on them and thus to co-shape evolutionary trajectories through processes like developmental plasticity and niche construction (see Laland et al., 2015; Walsh, 2015; Sultan et al.,

2022; Baedke & Fábregas-Tejeda, 2023; Fábregas-Tejeda & Baedke, 2023). In short: organisms are agents of their development and evolution.

Within this framework of agency, levels of organization are increasingly considered to play a role in understanding different degrees of agency, both in ecological and organizational accounts of agency. According to the ecological camp, biological agency is understood as the capacity of an environmentally embedded organism to shape and bias its repertoire in response to what its conditions afford for pursuing a goal (Walsh, 2015). For example, Fulda (2017, p. 70) highlights: “Since the repertoire of a system can vary in its richness, there can be degrees of agency along a continuum, from the simplest adaptive agents at one extreme, such as bacteria, to the most sophisticated cognitive agents on the other, such as human beings.” A similar understanding of *levels* or *degrees* of agency evolving over long periods of evolutionary time is shared by the second theoretical camp: organizational and autonomy-based accounts of agency. They understand a biological agent as a far-from-equilibrium natural system that actively

modulates its environmental interaction to canalize the flow of energy and matter for its maintenance (i.e., organizational closure, Montévil & Mossio, 2015) and thus constrains and determines the conditions of its own existence (Mossio & Bich, 2017). Again, degrees of agency are mapped across the tree of life. For example, Barandiaran et al. (2009) hold that in the course of evolution, more sophisticated ways of spatio-temporally interacting with the environment occurred, from bacteria to plants, to multicellular animals, to humans, which led to more complex ways of maintaining the systems' organization (for another evolutionary view of agents as autonomous systems, see Ruiz-Mirazo & Moreno, 2012). Both of these theoretical accounts describe evolving degrees or levels of agency, and both are currently utilized in debates about minimal or basal cognition and evolution of cognition (Levin, 2019; Sims, 2021; see Fulda, 2017) which try to map degrees of cognitive processes or intentionality in living systems on the evolution of biological agents.

In these present-day discussions, level-talk is steadily increasing. However, one might wonder whether degrees or grades of agency, which are used rather loosely in the literature, can be usefully mapped onto a more concrete notion of levels, particularly levels of organization, like single cells, multicellular organisms, ecosystems, etc. We are skeptical of this move. In this paper, we discuss two challenges to any attempt to integrate the concepts of levels of organization with that of biological agency. One of these challenges concerns the prospects of deriving meaningful application from levels when discussing degrees of agency, while the second concerns the apparent disappearance and reappearance of agency in developmental time.

Mapping Levels of Agency

Labels of level come rather cheaply. Although phrases following the basic formulation of “levels of X” pervade the philosophical and scientific literature, what is at stake when invoking the term “levels” in these cases is often unclear (Brooks, under review). For instance, phrases such as *levels of analysis* and *levels of explanation* profess to order their domains of application (here analysis and explanation) into serial representations that purport to mimic or build upon the relations observed between entities and

processes occurring at different scales within nature. However, this ordering is frequently parenthetical to the core ideas of the leveled view of nature captured by the concept of *levels of organization* widely referenced in the life sciences. Specifically, such orderings seem to trade in expectations that the serial depiction of a given category into two or more points of reference comprises a kind of extrapolation from the core idea of the layered view of the natural world at work in scientific thinking, and designated by levels of organization.

Against this, it is first worth noting that at least two distinct means of relying on the term levels accrue in cases such as this.¹ On the one hand, there are significant epistemic, methodological, and ontological consequences of postulating a leveled view of nature as expressed by levels of organization (Wimsatt, 1994; Brooks, DiFrisco, & Wimsatt, 2021). Some of these consequences include, for example, that a vast division of labor across the sciences is necessary to investigate all the constituents of nature, that explanatory significance is couched differently depending on which level one turns their interests toward, or that the ontology of the world resembles a rainforest rather than a desert (Wimsatt, 1994). Under this framing, phrases such as levels of analysis or levels of explanation can be rephrased into something like ‘the level of organization at which analysis (or explanation) can or should proceed or is desirable.’

On the other hand, most ‘levels of X’ phrases seem to follow a wholly different understanding of the term ‘levels’ to mean that the domain of application mentioned by the ‘of’ qualifier itself iterates serially into two or more points of reference. These points of reference, then, are depicted as complementary or in tension with one another (as in the case of integrative and reductionist explanations or analyses, respectively), or may serve to provide a classification scheme for the domain in question. In such cases, recovering what is substantively contributed to the discussion at hand by the term “levels” often requires significant exegetical reconstruction, and may ultimately be questionable. Instead, what is typically expressed by a levels phrase reflects a quality or criterium by which the domain of application becomes ordered into different efforts or products. For instance, levels of explanation in

general philosophy of science are conventionally taken to reflect *degrees of abstraction* rather than iterated explanatory efforts that shift between levels of explanation. This errors, however, in forgetting that any level may be more or less abstractive in its presentation. In such instances, relying on levels does not appear warranted despite the widespread reliance on the notion.

Putative levels of agency appear to follow the second option, while simultaneously drawing justification from the first. That is, expressions of levels of agency (1) express a kind of continuum according to which different kinds, or grades, of agency appear as we traverse different kinds of entities that in turn reflect increasing complexity, but also, and independently, (2) seek to establish patterns concerning the occurrence of agency across different levels of organization. Failing to distinguish between these two endeavors introduces several conceptual knots to the discourse on agency we believe are best avoided by keeping agency and levels separate, at least initially. For one thing, we believe it is highly problematic to attribute agency to levels per se. Rather some, but not all things that occupy levels comprise possessors of agency. However, and at the same time, level occupancy is not sufficient (and possibly not necessary) for possessing agency. For example, putative agency within cells will almost certainly track different behavioral repertoires and environmental interactions in the case of bacteria than in the case of eukaryotic cells. Still more different would be the case between prokaryotic and eukaryotic cells, respectively, within the context of a multicellular organism. In both cases, where such differences would rank these types of cells as possessing different degrees of agency, they nonetheless co-occur in all cases at the same level of organization (see also the next section).

Instead, in order to invoke levels in a substantive manner, agency (a) needs to be mapped onto levels in a way that also (b) clearly indicates how considerations of levels contribute to understanding agency. We deal with these desiderata in turn.

When considering how agency could map onto levels of organization, it is important to (re) emphasize the distance between the two notions. Entities possessing agency, i.e., agents, may indeed comprise organized entities (or processes), but org-

anized entities and processes need not themselves possess agency. This means, minimally, that without further qualification, levels per se will not directly recover important or significant generalizations concerning what kinds of entities or processes should be considered agential, nor what agential behavior could entail. Instead, we believe that entities or processes identified as agents require mediating units more proximate to the levels concept for agency-level mappings. Two such units, we submit, include *biological individuals* or organisms.²

Now, reconstructing how individuals or organisms map onto levels is itself a subtle and complicated set of issues, which we can only gesture towards in this short commentary. Our initial thoughts are the following: if agents are minimally conceived as individuals (or organisms, for that matter), then these may hold more promise to mapping onto levels of organization. However, the same critical upshot of conflating uses of levels described above holds in that the criteria directing attributions of agency will only sometimes pick out a full-blown level of organization. Instead, these attributions will hold only insofar as they also coincide criteria that pick out agents conceived of as individuals (or organisms), which only then may or may not iterate across different putative levels.

Given this, and turning to our second desideratum (indicating how levels could contribute to understanding agency), we may repose the exploratory question ‘What are levels of agency?’ into the critical question ‘Why should we expect levels to provide insight into agency?’. That is, given that we could map agency onto levels with the help of more proximate intermediary notions like individuality, what substantive insight would follow from the idea of levels back into agency? Here we are more pessimistic about the stakes in invoking the levels concept. Most importantly, we see nothing lost to the discourse on agency in switching the levels concept out for *scale*, a deflationary move developed in detail by Markus I. Eronen in the context of mechanistic levels (Eronen, 2013; 2015; see also Potochnik & McGill, 2012). Specifically, insofar as characterizations of agential abilities focus on things like behavioral repertoire (dispositions, capacities, and the like) in a given environment, scale-based interactions will probably

be more useful for researchers on agency to recover salient generalizations.

Agency, Levels, and Development

Even if we assume that levels of organization are homogeneously populated by biological individuals that can not only be clearly individuated and, in some way, exhibit agential properties (and this is not at all clear) we still face another challenge. This challenge results from the fact that levels of organization do not only evolve over evolutionary time – from bacteria to humans – but also emerge and change during developmental time. Let us explore in detail what this means for the concept of biological agency.

Current endorsement of the idea that we find in nature different levels (or degrees) of agency typically argue that these levels change over evolutionary time (Ruiz-Mirazo & Moreno, 2012; Arnellos & Moreno, 2015; Walsh, 2018; Sims, 2021; Newman, 2022). This evolution creates, when mapped on the tree of life, a rather linear story, from less to more complex forms of organization and agency, from non-neural to neural systems, and from minimally-cognitive to intentional agency. An increase in complexity, say by moving from the single cell level to that of multicellularity, is accompanied by the evolutionary acquisition of a new, usually more advanced form of organismal agency. Unfortunately, when it comes to developments things are a bit more complex.

We often forget that within life-cycles levels of organization are not pre-existing or static structures, but rather also emerge and disappear over developmental time (see Baedke, 2021). In multicellular organisms with a single-celled stage during their life cycle (bottleneck), moving from the single cell to organismal level through cellular differentiation means constructing a number of levels along the way like tissue and organ levels (Woodger, 1930-31). This vertical buildup of levels of organization is a highly plastic process and sensitive to environmental influences. If we conceive of these levels as levels of agency, this would mean that many life cycles carry within them shifts in agency, from single cell agents to multicellular agency. For example, human development would have to exhibit the full ‘evolutionary spectrum’ of agential forms from non-cognitive agency with a limited repertoire

and rather simple organization in a single cell to intentional agency with a highly diverse spatio-temporally flexible repertoire and complex whole organization that integrates and maintains internal processes happening at various levels and scales. In short, we see the whole evolution of agency mirrored in organisms’ development of agency – call this the *agentogenetic law*, if you’d like.

Thus, any theory of levels or agency does not only have to capture how evolutionary shifts, like those between major evolutionary transitions for example, lead to (or are driven by) the emergence of new agential forms, but also how and why radically different forms of agency transition and develop across life cycles. However, these agential transitions are governed by quite different mechanisms compared to evolution. From the often contingent, spontaneous, and stochastic processes in which properties of cells emerge and inter-cellular networks are formed, to developmental biases that affect formations of higher organizational structures during embryogenesis, to the (goal-directed or even intentionally-guided) plastic ways in which organisms including humans interact with their environments and thus direct their own development through a steady build-up of internal levels, there are a plethora of general processes to navigate.

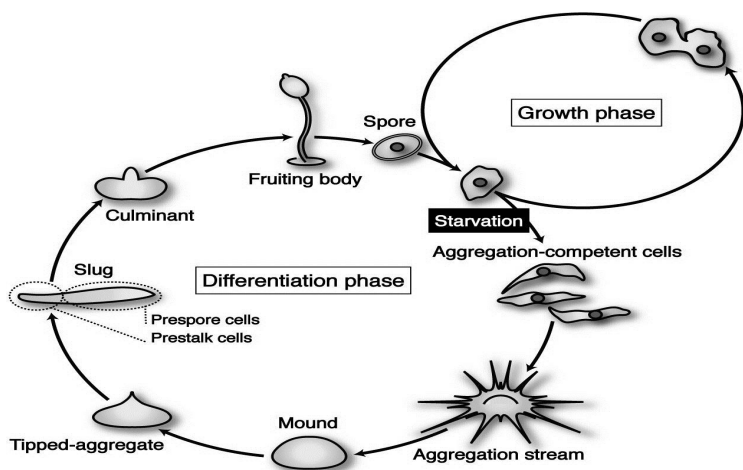
What is even more challenging for a level-based theory of agency is that in many organisms the linear story of the agentogenetic law does not apply. This means we need to explain why we often see not only the acquisition, but also the loss of agency occurring at various times during life cycles. For example, what does it mean for single cells to lose their agency (or rather assign it to a larger whole) via cell differentiation in multicellular systems?

More importantly, why do some biological individuals seem to be able to not only transition between different levels of organization but between vastly different kinds of agency without these two kinds of changes being necessarily linked to one another? For example, in the slime mold *Dictyostelium discoideum*, we see, depending on environmental conditions, single- and multi-cellular phases of life (see Fig. 1). Single cells could be described as biological agents that search and phagocytose bacteria. Under starvation conditions, however, single cells reject this agential existence.

Instead, they then form multicellular structures of thousands of cells: aggregates, mounds, and finally slugs – a new level of collective organization in which some cells (those in the front of the slug, the *prestalk* cells) more than others (those in the back, i.e., *prespore* cells) determine the migratory agential behavior of the collective. Finally, this multicellular system constructs fruiting bodies, each consisting of a mass of spores and a supporting cellular stalk. In this process the anterior prestalk cells that were previously actively guiding the slug along a certain terrain, now completely give up their agency (by basically sacrificing themselves) as they become the cells that form the stalk. In contrast, the rather passive cells in the back of the slug now form spores, again single cells. In other words: in this life cycle we move from a single-cell form of agency to a multicellular form of agency, in which the agency of some cells in a collective is lost, only for these very cells to later again gain agency when transitioning back to the single-cell level, while other cells maintain their migratory agency in the multicellular stage but later lose it when switching back to single cells. It's a complex developmental web of transitions between two different levels in which not every shift in level necessarily includes a gain or loss of agential properties compared to earlier life phases. Levels of organization and kinds of agency seem to be rather loosely coupled here. When and why a change in levels of organization during development is linked to a shift in agency, and when it is not, is an open puzzle that a theory of levels of agency should be able to answer. This is quite a difficult task.

Conclusion

In this paper we proposed two challenges to the emerging idea of levels of agency. One challenge concerned the intelligibility of basing agency on levels. This follows from our proposal that agency can only be mapped on levels if are mediated by units that are more proximate to entities that possess agency, like well-defined biological individuals. The second challenge focused on the predicament that the emergence and disappearance of agency during development and complex life cycles is often decoupled from the production of different organizational levels during these processes. Based on these two challenges, while we are surely willing to grant that the levels concept can confer powerful heuristics to a research program by contributing a descriptive scaffold to an emerging system of interest or otherwise guiding scientific efforts (Brooks & Eronen, 2018; Brooks, 2021), the heuristic reach of the levels concept does not avail to the conceptual challenges facing biological agency. Instead, we maintain that adding levels to the mix of agency introduces more conceptual noise than precision, more puzzles to figure out than real insight.³ Given further that a general, and substantive, theory of biological agency is itself a challenging endeavor to produce, the rhetorical and inferential strengths of the levels concept are of little help in getting clear on agency. As it stands, evaluating putative levels of agency seems to simply test linguistic intuitions against what could count as agents, or levels for that matter. How these make empirical differences, however, remains yet to be seen. We thus advise against bringing the two concepts together into so-called levels of agency.



Left: The life cycle of the slime mold *Dictyostelium discoideum* (Reproduced from Maeda & Chida, 2014).

Notes

1. Switching between these means of relying on the term “levels” leads in many instances to a kind of “shell game” where the importance of the term is lost in the shuffling of labels (Brooks, under review; Brooks, DiFrisco, & Wimsatt, 2021).
2. For more on the distinction between the two concepts, see Prieto (2023).
3. This point does not block the prospects of a worked-out “grades of agency” framework (cf. “grades of individuality” in Huxley, 1912; see also Gawne & Boomsma, 2022 for commentary). Rather, we are merely pointing to the deep challenges and questionable returns in engaging the search for any systematic relations between a substantive notion of levels and biological agency.

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