

# Eigenbehavior

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Intuitively, objects are taken as instances – or sometimes even evidence – of an *external* reality, while subjects refer to an *internal*, a *subjective* world. Heinz von Foerster (1976) suggested an innovatively different approach that regards objects as “tokens for eigenbehavior”. This approach *internalizes* objects into subjects by conceiving both as expressions of structures emerging in the dynamics of complex systems that generate invariances while trying to maintain their operations. Observed, these invariances appear as a system’s *eigenforms*.

However, eigenforms cannot be unambiguously derived from a system’s inputs and hence do not comply with the superposition principle. Inputs do not add up linearly in a predictable way; instead, the systems’ components interact *non-linearly* such that their aggregation generates an apparently new phenomenon.

Von Foerster called such systems “non-trivial machines” and defined them as having two functions: (1) the “effect” function, implementing a state-dependent mapping of input  $x$  to output  $y$ :  $f_e(x, z) \rightarrow y$ ; and (2) the “state” function, performing the state transition depending on inputs:  $f_s(x, z) \rightarrow z'$

If the output of such non-trivial machines is recursively applied to the next step’s input, dynamics may run up to an *eigenvalue*, i.e., to a (temporarily) stable state that no longer depends on particular inputs. Mathematically, these eigenvalues correspond to the concept of attractors up to which systems of coupled differential equations tend to run.

Von Foerster’s proposal is a formalization of Jean Piaget’s description of cognitive activity. It is defined as the circular sensorimotor interaction of observation (*obs*), which induces a subsequent coordinative movement (*coord*), which in its turn changes the observational viewpoint, albeit slightly, and thereby again necessitates an observation that might induce movement, and so on. This yields an  $n$ -length sequence of *obs*- and *coord*-functions working on each other and thereby generating stable eigenforms, which internally are perceived as objects. Starting with an initial  $obs_0$ , this recursion can be depicted as follows:

$$\begin{aligned} obs_1 &= coord (obs_0) \\ obs_2 &= coord (obs_1) = coord (coord (obs_0)) \\ \dots & \\ obs_n &= coord (coord (coord (coord (\dots (obs_0)))) \dots) \end{aligned}$$

If iterated sufficiently often, the initial value becomes irrelevant. It is no longer important whether the recursion started with an observation or with a coordinative movement. Nor is the kind of observation or movement of any relevance.

For cognitive systems, the concept of eigenbehavior is pivotal as it accounts for how newborns learn to come to terms with their world and for brains forming their neural networks irrespective of their initial input. Similar to recursive functions such as  $f(x) = x/2 + 1$  (which has the eigenvalue of 2 regardless of its initial  $x$ ), or to systems of coupled differential equations such as common predator-prey systems (e.g., Yorke et al. 1973), cognitive systems also generate invariances *by themselves* and thus enable emerging stabilities to be observed as *objects*.

This leads to the *constructivist position of regarding reality as an ensemble of eigenvalues* in which “the perceiver and the perceived arise together in the condition of observation” (Kauffman 2005: 132). The goal of this special issue is to discuss the advantages and disadvantages of this position, the benefits and costs of regarding objects as tokens for eigenbehavior. The contributions could focus on the following questions:

(1) From the *philosophical* perspective, observers are tokens for eigenbehavior themselves and hence in need of observation in order to “be” (Füllsack 2014). This, however, implies an infinite regress of observing observers, which many will consider more troublesome than the conventional assumption of a firm base of an observer-free science. As this issue targets an interdisciplinary audience, it could be interesting to explore how different disciplines deal – or are able to deal – with this implication. Is it genuinely more difficult for natural sciences than for humanities to accept an observer-inclusive science? Is the modus of accepting the implication in theory but ignoring it in practice, as some “new ontological theories” pursue it, an expression of this difficulty?

(2) In general, what can considering eigenbehaviors or eigenforms contribute to a discipline’s insights? What does its analysis gain? What is the specific added value of grasping interacting species in terms of fixed points and limit cycles, national domains as expressions of stable conflicts, leadership and monopolies as the result of Mathew effects, or the I as an observed relation between myself and observing myself? What are the implications of this? And, do different disciplines benefit in different ways? Or to a different extent? What is it in particular that makes thinking in eigenforms enlightening? And when should it be rather avoided due to obfuscating effects?

(3) Specifically, in *systems theory*, the eigenbehavior of a system could be seen as a distinguishing criterion for defining non-linear systems. A precondition would be to dispose of systematic transdisciplinary roadmaps for analyzing processes in respect of their unexpected, since internally determined, results. Going beyond chaos and catastrophe theory, this could draw on conceptions such as alternative stable states and their critical transitions (Scheffer 2009), or of autopoiesis, self-organization, or second-order cybernetics, to cover a wide range of phenomena from different spheres. Case studies, for instance, of emerging or shifting, and in particular, *surprising* eigenbehaviors in this respect would contribute to further enlightening the significance of thinking in eigenforms.

(4) The eigenbehavior of systems generates distinct patterns, as for example on the coat of animals, the shell of snails or mussels, or in the output of cellular automata. These patterns make systems distinguishable, they provide them with identity and thereby make them observable. They also define a system's boundaries at which abrupt transitions occur. A cat is a cat as a dog is a dog, while dogcats are hard to observe. To stumble into basins of attraction thus could make a difference that makes a difference after all and thus should have fundamental attention in science. Case studies of getting entangled in eigenbehaviors and thus ending up with unwanted consequences – from the Russian Revolution to the persistence of hospital bugs – could further the understanding of systemic aggregations.

(5) Last but not least, a conception that relinquishes reality might be viable for the goals of science but could be met with skepticism in other domains. This in itself may be a consequence of particular eigenbehaviors in social systems. As Luhmann (1990) pointed out, science, with its particular “guiding distinction” (“Leitunterscheidung”) of true and false propositions, could be more responsive to counter-intuitive assumptions than the everyday domains of social beliefs. So the question arises of how and under what particular social conditions the constructivist position could become applicable for non-scientific domains.

## Article submissions

The special issue will be organized around a number of target articles accompanied by Open Peer Commentaries (OPCs). Expressions of interest to submit a target article should include a short abstract and should reach us by 15 September 2016. If your proposal is accepted, submission of the full paper (in English) is due 6 December 2016, followed by a double-blind review. In the case of conditional acceptance, sufficient time will be allocated for the revisions requested. **Target articles should not exceed 9,000 words.** The special issue will be published in July 2017 in *Constructivist Foundations*, an open-access journal indexed in Web of Science, Scopus, and other citation indices. Submission of papers is free of charge.

Please use the Word template with the author guidelines. It can be found at

**<http://tinyurl.com/cf-template>**

Declarations of interests, paper submissions, and all further inquiries should be sent by e-mail to the editors at:

**[eigen@constructivist.info](mailto:eigen@constructivist.info)**

For further information about this special issue, see:

**<http://constructivist.info/special/eigen>**

## Timetable

15 September 2016: Expressions of interest (including abstract)

**6 December 2016: Submission deadline for full papers**

15 January 2017: Peer-review feedback returned to authors

15 February 2017: Revised paper submission

15 March 2017: Final paper submission, papers sent to commentators

**21 April 2017: Submission deadline for OPCs**

11 May 2017: OPCs sent to authors for response

15 June 2017: Author's response to OPCs due

**15 July 2017: Publication date**

## About the journal

*Constructivist Foundations* is a scholarly peer-reviewed e-journal concerned with the critical interdisciplinary study of constructivist and related approaches to science and philosophy. It is indexed in the *ISI Arts & Humanities Citation Index (AHCI)* and *Current Contents/Arts & Humanities*. The journal has published over 700 articles by more than 450 authors and has more than 10,000 subscribers. <http://constructivist.info>

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