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9 From representation via planning to action: An extension of Egon Brunswik's Theory of
10 Probabilistic Functionalism

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18 Abstract

19 Scholz (in press) proposes how Brunswik's lens model can be extended to account for planning
20 of sustainable transitions of complex system. In this commentary, an alternative extension is
21 proposed, according to which planning is seen as a process that unfolds in three steps. The first
22 step can be understood with a model construction lens: A planning team builds a
23 representation, that is, a model of a (distal) complex system. In a second step, modeled with a
24 planning lens, the team contrasts its representation of the system with possible alternative
25 states, and simulates how the is-state could be transformed into an ought-state. In a third step,
26 modeled with an implementation lens, the team selects and implements a set of actions,
27 thereby leaving the "imaginary space" (Konrad Lorenz) and entering the real world.

28 Keywords: lens model; probabilistic functionalism; planning; complex systems; group processes

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31 Cognition comprises perception and action, or more precisely, action control. When we grasp a
32 coffee mug, we continuously coordinate perception and action during this process.
33 Conceptualized in the Kantian dualistic heritage, some objective reality is mentally represented,
34 and this representation steers our behavior in an attempt to modify this reality to serve our
35 goals, needs, and desires. While the mug was initially on the table, it will ultimately be at our
36 mouth so that we can drink. The human species made a step of tremendous importance in its
37 history when our ancestors could decouple representation and action. This decoupling allowed
38 for nothing less than, as Konrad Lorenz (1943) put it, *handling in the imaginary space* (orig.:
39 "Hantieren im Vorstellungsraum"), that is, performing mental operations instead of physical
40 operations. Planning is, at bottom, mental simulation. An objective reality is mentally
41 represented, that is, a model of reality is constructed. Within this representation, mental
42 operations are performed, the outcomes of these "actions" are simulated in the "imaginary
43 space", and among the resulting outcomes the most desirable one is identified and selected.
44 Subsequently, a decision has to be made whether or not one wants to proceed from mind to
45 muscles, that is, from mental operations to real actions.

46 In the target paper of the present commentary, Scholz (in press) proposes how Brunswik's (e.g.,
47 1952) *theory of probabilistic functionalism* (TPF) can be used to conceptualize and to aid
48 planning in teams. After having laid out the basic principles of TPF (in his Section 2), and after
49 having linked it to current biophysical and neurological models of visual perception (Section 3),
50 Scholz discusses—based on his rich experience in urban, regional, and industrial planning,
51 gained through numerous case studies that he and his colleagues conducted—how TPF can be
52 used to understand and to support planning teams' endeavors to cope with the cognitive
53 challenges of rapid sustainable transitioning (Section 4). In Sections 5 and 6, Scholz evaluates
54 and discusses his approach. The target paper is laudable and deserves attention. It makes two
55 important novel contributions, specifically, it builds two bridges. First, it links TPF to
56 contemporary visual perception research, thereby not only filling a gap in Brunswik's own work
57 (who, as Scholz points out, largely ignored biological aspects), but also a gap in visual
58 perception research (that largely ignored the psychology of Egon Brunswik). Second, Scholz
59 expands TPF to planning, thereby focusing on an area, namely action, that Brunswik was well
60 aware of but did not pay as much attention to as he did to perception. Conversely, it seems fair
61 to say that theoretical and practical approaches to planning have, so far, not paid much
62 attention to Brunswik's framework of psychology.

63 In the present commentary, I present and discuss two extensions of the lens model. The first
64 extension has been proposed by Leary (1987) and will be introduced next. In a second step, I
65 propose how Leary's idea can be even further extended to better cover the issue of planning. I
66 do not claim that these two extensions are contradicting anything Scholz said. But even if these
67 extensions were perfectly in line with his ideas, they may still be useful to better understand
68 and appreciate his contributions. Third, after having presented those extensions, I will
69 encourage both conceptual and empirical work that pits the ideas presented in Scholz (in press)
70 and in the present commentary against each other.

71 To reiterate, cognition comprises perception and action. Brunswik had a clear focus on
72 perception, which also explains why almost all the literature (including Brunswik's own
73 writings) that discusses the lens model depicts a double lens whose left side refers to some
74 distal stimulus (or variable) and whose right side refers to the organism's perception of that
75 stimulus. The area between distal stimulus and proximal cues is located in the environment,
76 and the area between the proximal cues and the perception of the object is conceived to be
77 within the organism. Organism and environment meet each other in the lens, that is, in the
78 sensory organs. Put differently, the sensory organs (e.g., the eye) are like gulfs through which
79 the environment enters the organism. On the one side, the retina consists of cells built and
80 maintained by the organism; and hence belongs to the organism. On the other side, light from
81 the environment enters the eye and creates an image on the retina; and hence the pattern of
82 arousal on the retina can be seen as a part of the environment.[1]

83 Consistent with Tolman and Brunswik (1935), Leary (1987) proposed that this *perceptual lens*
84 can be complemented by a *behavioral lens* (Figure 1). The joint functioning of perception and
85 behavior (or action) can then be portrayed as follows: The distal object, for instance, a coffee
86 mug, is depicted on the very left. It is perceived through some senses whose input can be
87 conceived of as proximal cues. The integration of these cues ultimately leads to a
88 representation of that object (referred to as central response in Figure 1). Now the organism
89 can do something with the mug, for instance, put it in the dish washer to have a clean room, or
90 use it to get and drink some more coffee. Such actions, which can be seen as means to reach
91 goals, are represented by the behavioral lens. Figure 1 can also be read from the right to the
92 left side: The inner perception of being thirsty may lead to the goal of drinking something. A
93 mean to reach this goal is to get some container, and so we screen the environment until we
94 have, eventually, perceived the mug on the cupboard. Just as there are several cues the
95 organism can use when perceiving objects, it can typically also choose among several means
96 (e.g., drinking water from the tube) to reach a certain goal, and so the vicarious functioning of
97 cues finds its correspondence in a vicarious functioning of means (Figure 1).

98 Leary's two lenses are adequate to describe daily activities such as drinking coffee. However,
99 for more complex activities such as transforming a complex system (e.g., a city or a company) I
100 propose to change the terminology a bit, and, more importantly, to add one more lens into the
101 picture. The center of Leary's figure is what he called the central response of the organism. I
102 propose to refer to it as the organism's representation (or, synonymously, the model) of some
103 distal object. Given that the present extension is proposed to account for the planning of
104 transitions of complex systems, I will henceforth replace the term *objects* by *systems*.
105 Moreover, I propose to split up this representation of a system, the midpoint in Leary's figure,

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[1] A provocative question may be allowed here: Where is the border? The surface of the eye, the retina, or
eventually even the brain? Can the physical brain, including its activities at a given point in time, be conceived as
part of the environment? And is the perception of an object located in the brain or must this perception be sharply
distinguished from electric activities of the brain? (Note that the philosophy of the mind literature uses the term
"qualia" to refer to a reality that cannot be reduced to physical patterns.)

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106 into an *is* and an *ought*, and to connect these two states via a third lens which I will, henceforth,
107 refer to as the *planning lens* (Figure 2). The *is*-state is the model that an individual or a group
108 creates to understand a distal complex system. Typically, this model construction happens in a
109 social context. For instance, some stakeholders may experience some dissatisfaction and
110 initiate a process with the ultimately goal of changing the status quo. This is the context in
111 which a planning team is assembled that typically starts by creating a model of the status quo.
112 With the help of this model, the team may be able to convince the stakeholders that they have
113 no reason to be dissatisfied, but this seems unrealistic. The more likely outcome is that the
114 team, based on the problems they have identified in the model themselves, and based on its
115 understanding of the stakeholders' goals, enters a phase in which they draft an *ought*-state.

116 How to find the *ought*-state and how to find the way from *is* to *ought*? There are two ways,
117 bottom-up and top-down, which will be described next and in this order. Obviously, the
118 planning lens can be located within the organism, here, the planning team. When the team
119 develops various potential *ought*-states, it is "handling in the imaginary space." Based on the
120 model of the system, which includes an understanding of how the (distal) system is functioning,
121 the team can simulate the outcomes of various manipulations. The anticipated effects of these
122 manipulations can be obtained via mental simulations, but if the model of the system is precise
123 enough to be cast in program code, these simulations may also be run on a computer. There is
124 one important difference between the means in the planning lens (Figure 2) and those in the
125 behavioral lens (Figure 1). Whereas the former are mental operators, the latter are real actions.
126 A manipulation in the real world will have an effect in a real world, and there may be
127 uncertainty when it comes to identifying this effect (in complex systems, one manipulation has
128 most likely multiple effects, and one observation is most likely an effect of multiple causes—
129 which Brunswik in his TFP called stray effects and stray causes). In contrast, when introducing a
130 manipulation in the planning lens, the effects are under the teams' control, but the team
131 members may be uncertain about which effects they should assume, and whether the effects in
132 their simulated world will match those in the real world. Hence, not only the team's
133 representation of the present state of the system may be flawed, but also its expectations
134 about which manipulations will lead to which outcomes. But these uncertainties involved in the
135 planning of complex system transitions are exactly those features that invite the use of
136 Brunswik's TPF as a framework to model these processes (with a model construction lens and a
137 planning lens, respectively). To wrap up, all these operations are performed by the planning
138 team in an "imaginary space". Different operations lead to different outcomes and the team,
139 together with the stakeholders, can select which should be aimed for, that is, chosen as the
140 *ought*-state.

141 A top-down approach, in contrast, would be less constrained by the model of the *is*-state and
142 by the repertoire of means. Such an approach starts in some future and may be inspired by the
143 writings of Jules Verne. Let's dream! Let's create visions, let's walk on the thin line between
144 fantastic ideas and wild fantasies! The *ought*-states generated by such an approach will most
145 likely appear to be more desirable compared to those generated by the bottom-up approach.

146   The problem may be to find operators and means that lead from *is* to *ought*, but chances are
147   that *ought*-states generated by the top-down approach may inspire and motivate one to find
148   means that were not in the initial behavioral repertoire. Obviously, the bottom-up approach
149   and the top-down approach are not exclusive but may complement each other. The former
150   focusses on the *is*-state and the means, the latter on the *ought*-state and the goals, but at the
151   end both needs to be brought together. It may be useful, in order to make full use of the
152   potential of a team, to follow both approaches, be it in temporal sequence or by splitting the
153   team into subgroups, at least for a limited time during the planning process.

154   Independent of whether the *ought*-state has been identified via the bottom-up approach, the
155   top-down approach, or a mixture thereof, the planning team—or someone else, based on the
156   planning team's work—can now move forward, from the imaginary space to the real world. It is
157   the *ought*-state and the experience made with the (mental or computer) simulations that
158   informs the decision how to proceed, that is, which actions to implement in the real world in
159   order to transform its present state and into a future state. Achievement could then be
160   measured either by comparing the present state with a future state, or by comparing the
161   ought-state with a future state. A result of such an evaluation that reflects these two different
162   benchmarks could be: "Better than before, but not as good as envisioned and anticipated".

163   How are the three lenses—model construction, planning, and implementation—related to each
164   other and how can the work of Scholz (in press) be extended in even other ways? The first lens
165   captures how a system is represented. Different team members may find different aspects
166   important. They may still be able to construct a model to which all can agree. Alternatively,
167   they may not be able to find such an agreement, be it because they have unshared information
168   that will not be communicated and revealed as such (Stasser & Titus, 1985; see also Reimer &
169   Hoffrage, 2006), or because they cannot agree on assumptions that need to be made, on causal
170   relationships, on extrapolations and predictions of future states, and so on. Conversely, note
171   that the absence of any conflicts during the model construction phase does not necessarily
172   imply that the team's representation of the system is an accurate one (Janis, 1972). As these
173   examples show, research on group processes offers multiple insights that could be used to
174   complement Scholz's cognitive perspective (see, e.g., Kerr & Tindale, 2004). Independently of
175   whether groups amplify or attenuate biases of individuals, any flaws in the representation will
176   jeopardize the planning and the ultimate success of the transition process. What is captured by
177   the planning lens hinges on what happened during the model construction phase. Wrong
178   assumptions and misrepresentations may lead to distorted results obtained in the imaginary
179   space. Garbage in, garbage out. If the representation of the system is flawed, it may be hard to
180   identify the resulting biases in the planning phase (see again, Janis, 1972). Chances are that the
181   selection of means in the behavioral lens may be suboptimal as well and lead, in turn, to
182   suboptimal outcomes. Note that the planning phase in Figure 2 is wider than the planning lens.
183   Planning in the narrow sense, as captured by the middle lens, tackles the question of how to
184   find an *ought*-state and how to get from *is* to *ought*. But planning in a wider sense is a process

185 that also includes model construction and implementation, that is, stretches into the two
186 adjacent lenses.

187 How does the present framework of the three lenses relate to the ideas presented in Scholz (in
188 press)? Even though the sequence of three lens models is not visually displayed in the target
189 article, one may argue that integrating his ideas into the framework presented in this
190 commentary (and vice versa) would be easy. Space constraints did not allow for a more detailed
191 conceptual analysis to verify or refute this suspicion. But apart from such a conceptual analysis,
192 this question might also be treated as an empirical one. Scholz looks back at 21 large scale case
193 studies, involving 97 planning teams, about 1300 master students and 2000 practitioners. These
194 numbers are impressive and indicate how much effort and how many man-years went into all
195 those activities. Scholz (in press) also points out that "As the above studies focused on
196 sustainable transitioning of cases and not on how planning groups function, unfortunately no
197 detailed data are available that provide in-depth information about the presence, functioning,
198 and impacts of the proposed principles of TPF" (p. xx). While the requirements of planning
199 groups working on real cases may not allow for experimental work, it may not be too hard to
200 start in the lab and on a small scale. I would like to encourage Scholz and other scholars to
201 conduct empirical research along the lines of what Scholz (in press) proposes in his section 5.3.
202 One could, for instance, let several groups of Master students, who function as planning teams,
203 work on the same case, but in isolation of each other. Prior to their planning activities, the
204 groups could receive a different training, that is, they could be equipped with different
205 theoretical frameworks and different tools. Another group of Master students could observe
206 and document the processes that unfold in the different experimental conditions and, if such
207 data can be obtained, eventually also evaluate their achievements. In one experimental
208 conditions, groups could be familiarized with TFP only, in another condition with standard
209 planning techniques only, in a third condition with the link between TFP and planning as
210 proposed by Scholz (in press). Finally, if Scholz comes to the conclusion that the framework
211 presented in this commentary is sufficiently different from his own framework, and if he finds it
212 worth further investigations, he could implement a condition that allows one to determine
213 which is more useful for (the training of) planning teams. The same can of course be said for
214 other proposals of how to extend this work (e.g., made by other commentators).
215
216 The goal to create and to have a sustainable future is something we can all agree on. But the
217 devil is in the details, and people may disagree what sustainability entails and how to reach
218 such a desired state. I close this commentary with a double-question. The first part is inspired
219 by the warnings of the Club of Rome and various environmentalist movements: "Can we afford
220 to continue with our way?" When considering the depletion of the planet's resources, the
221 answer should be a resounding "No." But what is the alternative? "Can we afford to stop that
222 way?" It seems many people are not willing to reduce their living standards substantially. In
223 view of this dilemma, planning the necessary transitions into a sustainable future is
224 indispensable and hard at the same time, in particular during a political climate of "alternative
225 facts" in which even climate change is occasionally denied. I wish Scholz and his colleagues all
226 the best with their attempts to help planning teams to navigate through these mine fields.
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253   Figure 1: Extension of the lens model to behavior (Figure and caption taken from Leary, 1987, p.
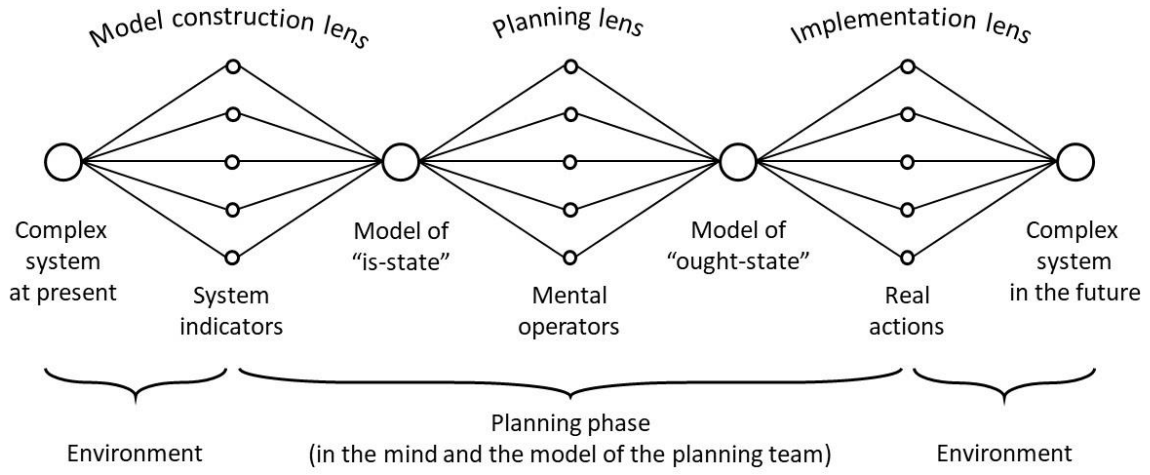254   123).

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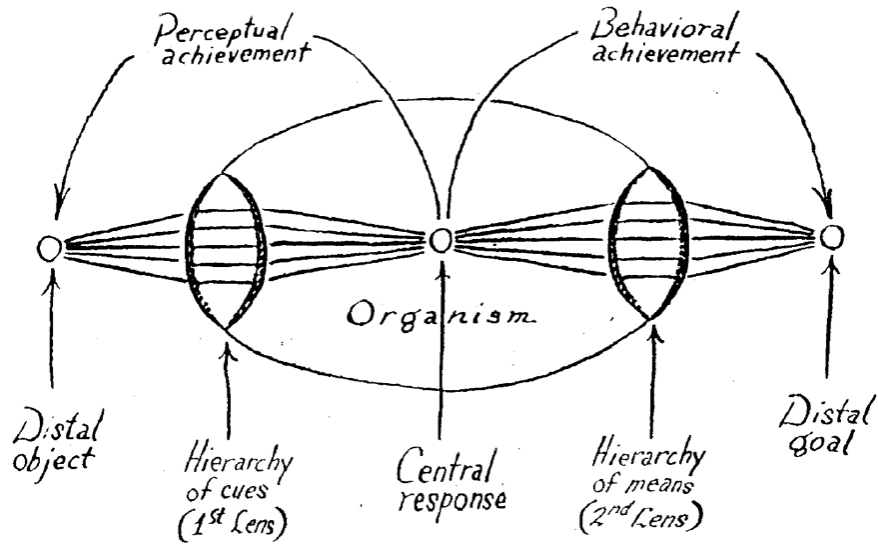
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258   Figure 2: Extension of the lens model to planning.

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