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Structuralism, Constructivism, and Information Processing: Ontological Compatibilities and Incompatibilities

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At the conceptual heart of their monograph, *The Development of Size Sequencing Skills: An Empirical and Computational Analysis*, McGonigle-Chalmers and Kusel (2019) confront the question of compatibility between Piagetian structuralism and constructivism. On the one hand, McGonigle-Chalmers and Kusel embrace the characterization of psychological development provided by Piagetian constructivism (or, as they term it, "transactionalism"), whereby "in order to know objects, the subject must act upon them, and therefore transform them: he must displace, connect, combine, take apart, and reassemble them" (Piaget, 1983, p. 104). On the other hand, they regard Piagetian structuralism as psychologically implausible and critically question the epistemological utility of logical structures of thought (such as reversibility) for explaining transformations in development. In this, they proceed from a long line of neo-Piagetian theorizing that stresses both structuralism's fundamental incompatibility with constructivism and the need to replace structuralism with actual accounts of process (Campbell & Bickhard, 1986; Fischer & Bidell, 1998). For McGonigle-Chalmers and Kusel, a decidedly "information processing" conceptualization of process—albeit one that eschews appeals to "fixed maturational factors and formal measures of task complexity" (p. 167)—proves far more explanatorily viable than the "logicism" of Piagetian structuralism.

McGonigle-Chalmers and Kusel adopt a *functionalist* reading of Piagetian structuralism in their monograph, one that is consistent with most neo-Piagetian approaches. Within such a reading, psychological structures constitute internal processes that control actual problem-solving efforts, effectively causing individuals to act as they do in particular contexts. When considered from the standpoint of this reading, their monograph advances an important, information processing alternative to Piaget's structuralist account of the cognitive mechanisms that generate transformations in serial and ordinal size understanding between early and middle childhood—an alternative that is computationally grounded in a "bottom up," perceptual learning model of continuous feedback between perception, action, and memory processes.

But, as the authors themselves acknowledge, Piaget's structuralism admits of more than just one reading. In fact, for increasing numbers of Piagetian and Piagetian-inspired scholars, the kind of functionalist reading to which McGonigle-Chalmers and Kusel appeal constitutes a gross misrepresentation of the *formal* explanatory framework that Piagetian structuralism was meant to provide (Chapman, 1988; Liben, 1987; Lourenço & Machado, 1996; Müller, Carpendale, &

Smith, 2009; Overton, 1991, 2006; Witherington, 2007). And critically, if Piagetian structuralism is read in terms of formal, not functional, explanation, then it is, as Liben (1987) has succinctly argued, "rationally, not empirically derived, and as such…not subject to the same kind of empirical falsification that is appropriate for propositions formulated within [information processing] approaches" (p. 114). Thus, the very question of whether Piagetian reversibility and coordinate logic explanations can even be adjudicated on the basis of empirical and modeling demonstrations is itself a matter of debate within the Piagetian literature, depending on which conceptual reading of his structuralism is adopted.

Historically, functionalist readings of Piagetian structuralism arose from both the pragmatist interpretations and faulty translations of Piaget's work that accompanied its introduction to the United States in the middle of the last century. Piagetian structures came to be conceptualized as "competencies," residing in the individual, which, alongside contextual performance factors, causally determined the individual's behavior in an antecedent-consequent fashion. As Chapman (1988) noted:

> Inevitably, perhaps, developmental psychologists assimilated Piaget's structural-stage theory to their own functionalist approach. Thus, Piaget's observation of rough developmental synchrony at the population level was interpreted as implying synchrony at the individual level, and his "structures" were understood as functional constructs intended to explain this synchrony. Instead of being seen as morphological criteria for classifying forms of knowing and reasoning, structures were viewed as the *functional antecedents* of age-related behaviors. (p. 363)

Viewed through the historical lens that Chapman (1988) and others have articulated, many (if not most) of the classic, prominent attacks on Piagetian theory from the 1970s and 1980s (including attacks from neo-Piagetians) reveal themselves to be driven not by empirical considerations but by conceptual mischaracterization (e.g., Brainerd, 1978; Cohen, 1983). Admittedly, inconsistencies in how Piaget himself characterized psychological structure provide ample grist for a "functional antecedent" or "intervening variable" interpretation of structuralism (Campbell & Bickhard, 1986). Nonetheless, growing consensus among Piagetian scholars suggests that, within Piaget's epistemological framework, psychological structure is most coherently conceptualized in terms of formal explanation— as "systematic structural description(s) of *possible* actions" (Campbell & Bickhard, 1986, p. 68, italics added), not as "some internal mediating device triggered by incoming information" (Müller et al., 2009, p. 5).

As formal levels of explanation, what exactly do the structures of Piagetian structuralism entail? Structures speak neither to the activity of the individual in context—that is, the individual's overt "performance" in the world—nor to the internal activities or processes of the individual that temporally precede that performance. Structures instead speak to the potential of the individual to act and to refrain from acting. Structures speak, in other words, to an individual's powers (abilities, capacities, etc.), which, as potentials, are not in themselves actualities (Hacker, 2007). Powers are not "tangible, space-occupying entities but *attributes* of space-occupying entities" (Bennett & Hacker, 2003, p. 118). They are what an individual *can* do; they constitute that individual's potential for functioning, which is organizationally maintained for

periods of time and across contexts (i.e., during periods of organizational stability in development).

As such, powers do not constitute antecedent forces, processes, or activities; they do not cause individuals to actually do what they have the power to do. Nonetheless, individuals' powers carry critical explanatory weight. The meaning of any given action on the part of an individual necessarily depends on what that individual is currently capable of doing. Entailing the bounded range of possibilities available to individuals for various kinds of activities, powers constitute a crucial explanatory context within which to understand the actual activities of individuals. Powers are thus different from and irreducible to their exercise. An individual can exercise the same power in varied ways, and any given activity of an individual in a particular context may be indicative of radically different kinds of powers. Furthermore, that individuals happen to engage in a particular activity once does not necessarily mean that they have the power for such activity, because that activity could have emerged in a particular context by chance rather than being related to what they, in general, can do (Hacker, 2007; Witherington, 2019).

If powers do not cause action, in the sense of serving as antecedent "forces," and if powers are not activities in their own right, how do powers relate to their exercise, to activities themselves? Powers are *constraints,* defined not in modulatory or regulatory process terms (i.e., as another kind of antecedent, constructive "force") but in organizational terms. Powers delineate *limitations* for what kinds of activities are available to an individual; they represent the degrees of freedom within which an individual can operate (Deacon, 2012). The real-time activity of an individual in particular context is necessarily constrained by what that individual is capable of doing—this reflects the "top-down" influence of power on actual activities. But what that individual is capable of doing necessarily emerges from the individual's history of activities-in-context—this reflects the "bottom-up" influence of real-time activities on powers, which are dynamically constructed via an individual's engagement with the world. Thus, developmentally speaking, an individual's real-time activities-in-context—themselves constrained by that individual's current powers—give rise to new powers, which themselves constrain future real-time activities-in-context.

Within a formal reading of Piagetian structuralism, *schemes*, whether sensorimotor (e.g., schemes of reaching and grasping) or operational (e.g., schemes of uniting and dividing), are psychological powers. They are potentials for action. Schemes express the "structure or organization of actions" (Piaget & Inhelder, 1969). Every exercise of a scheme constitutes a unique action, but the scheme itself refers to "that which is generalizable in a given action" (Furth, 1969, p. 124). The exercise of schemes—the actual activities in particular context of an individual—engenders the process of development, generating new possibilities for action, i.e., new schemes. This constitutes Piagetian constructivism. But to fully understand what an individual is doing requires understanding what that individual can do—the bounded possibilities for engagement with the world at any given point in development. A delineation of the schemes themselves and of the increasingly abstract forms they assume in development provides this understanding and constitutes Piagetian structuralism.

Within a functionalist reading of Piagetian structuralism, however, schemes become activities in their own right, that is, they are internal activities or processes that temporally precede and causally initiate the external activity of an individual. Functionalist readings reify schemes and

render the relation between a scheme and its exercise in antecedent-consequent terms, on the assumption that schemes, to be explanatorily meaningful, must bear a causal relation to their exercise. For McGonigle-Chalmers and Kusel, the operational schemes to which Piaget appealed exist as internal causal processes and, as such, are both inefficient and implausible, so the authors recommend replacing the logicism of Piagetian operations with learned sequencing heuristics and reliable algorithms—internal processes of computation that drive external "performance." But from the standpoint of a formal reading of Piagetian structuralism, the relation between a scheme and its exercise, just like that between a power and its exercise, is a *logical* one, not a causal one (Hacker, 2007). Consequently, within a formal reading of Piagetian structuralism, the very idea of reifying schemes constitutes a conceptual confusion and paves the road for pernicious dualist frameworks that divide inner, antecedent causes ("psychological" mechanisms) from outer, consequent behavior (the byproducts of such mechanisms).

Dynamic systems theorists like Paul van Geert (1998, in press) and Enactivist theorists like Ezequiel Di Paolo (in press; Di Paolo, Buhrmann, & Barandiaran, 2017) have embraced both the process dynamics of Piagetian constructivism and the explanatory importance of schemes—as formally defined in terms of powers or capabilities—in their developmental modeling efforts. Enactivist theorists have also mounted a strong campaign against information processing explanations of cognition and their ubiquitous "appeal to information-bearing states inside the system," grounded in representationalist, encoded information views of mind (Thompson, 2007, p. 52; see also Di Paolo et al., 2017). The extent to which it even makes sense to align information processing approaches (given their commitment "to the unviable assumption of foundationally encoded information") with Piagetian constructivism has long been of concern within Piagetian circles, and many Piagetian scholars have seriously questioned the ontological compatibility of constructivist and information processing treatments of development (e.g., Campbell & Bickard, 1986, p. 3; Liben 1987; Overton, 2006).

All of this is simply to suggest that continuing debate over the explanatory utility of Piagetian structuralism is fundamentally conceptual in nature and, in the absence of shared presuppositions, cannot be resolved empirically. By a functionalist reading of Piagetian structuralism, McGonigle-Chalmers and Kusel (2019) have produced an admirably systematic, detailed process account that seriously challenges the viability of Piagetian structural concepts like reversibility for explaining transformations in serial and ordinal size understanding between early and middle childhood. But by a formal reading, the entire premise of McGonigle-Chalmers and Kusel's monograph is predicated on a fundamental misrepresentation of Piagetian structuralism, coupled with misguided allegiance to an information processing framing of Piagetian constructivism. Consequently, the debate over Piagetian structuralism rages on.

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