Try to articulate and defend certain basic and important constraints on, or enablers for, a big-picture of cognitive development, or, alternatively some meta-theoretical principle you think should shape cognitive ***development*** *theorizing.*

We are cognitive developmental psychologists. Also on the banner in our quest for the truth on cognitive phenomena, is the title *scientist*. On one hand, I am happy to share in the scientific rigor, with clearly defined operationalized variables, systematic methods, replicable/ falsifiable results. On the other hand, it seems that a core principle of science— parsimony— tends to be defied when interpreting most things considered developmental. In fact, as emerging developmentalists, we are being challenged to *embrace* complexity. Likewise, the reductionist approach to scientific problems also seems incompatible with the developmental and contextual emphases in our enterprise. Hence, one could question whether the scientific framework remains worthwhile, given that some of its core principles seem inapplicable to developmental phenomena. With this in mind, I will go about describing three things that contribute to the complexity of our quest and afford extra attention in our theorizing, and in places, to propose meta-theoretical principles that might help.

Complexity #1: Dynamic constraints

Development is constrained: it does not go in all possible directions, but rather manifest a degree of regularity amongst our species. One fundamental constraint on cognitive development is the relationship between our bodies and the world. It has been argued in Gibsonian thinking that the world is contextually rich and full of structured information, but this is only half the story: the rich and structured information cannot exist independent of our agentive self doing the perceiving and interpreting. If humans were six inches tall with compound eyes, then our whole environment would become a very different perceptual and conceptual experience. Back to reality, despite all the individual differences, we do share a basic anatomical and physiological makeup. This constrains the repertoire of possible actions between man and world, thus also constraining cognitive development.

Such themes exist in hypotheses like Less is More (Newport, 1990). The *immaturity* of an infant, for instance in the form of a restrictive input filter or other capacity limitation, reduces the repertoire of feasible interactions with the world. In this case, functioning becomes constrained but it is to the learner's benefit, e.g. focusing on simpler linguistic constructions helps make incidental language learning possible. In other words, biological changes (assuming that the input filter is grounded in perceptual + neural systems) modify the infant's relationship with the world and thus the experience and learning possibilities in it. Somewhat ironic is how a comparable 'immaturity' at old age also constrains functioning, but this time to the learner's inconvenience. The situation is only exacerbated by the increased need and decreased efficiency of culture with age (Baltes, 1996).

Considering person-environment fit on the cognitive level leads us one step further. If there were changes on part of either the human makeup or the structure of the world, it is reasonable for the cognitive experience to differ to some extent. To take an extreme example, in prehistoric natural environment, a community of cavemen probably perceived fewer right angles than we do in our modern world. This could shape perceptual expectation, interpretation and action, and subsequently, the population profile of cognitive development. Thus, the nature of our interactions with the world may be changing throughout history, so it is conceivable for even fundamentals of cognition and its ontogeny to have changed, subtly or radically, across the centuries. This may be something important to consider when proposing evolutionary accounts for cognitive capacities such as language (Jackendoff, 1999). Finally, integrating this to our opening issues: unlike the relatively timeless scientific laws, human cognitive development may be dynamic on all levels.

Complexity #2: Is an explanatory level really out there?

When theorizing about cognitive development, we are encouraged to complement description with explanation. For the infant moving through the sensorimotor stages, Piaget suggested a process of assimilation, accommodation, and equilibration. For the toddler realizing a

zone of proximal development, Vygotsky proposed a mechanism of cultural scaffolding, internalizing of the intermental. For the 4-year-old coming with strategies to solve mathematical problems, Siegler put forward a model of overlapping waves. However, there still seems to be an imbalance so that, although we can test our theoretically driven predictions, we are only able to directly observe and describe static snapshots (even with the high-resolution ones taken with the microgenetic method), leaving our explanations to be an intuitive best guess at the most.

Recent years have promising approaches such as information processing, by which we can simulate predicted mechanisms, and brain imaging, by which we can gain insight into the neural areas subserving a given cognitive performance at a given developmental stage. Therefore, in theorizing, it is really important to consider what we are looking for in an explanation for the cognitive capacity being looked at. Is it an elaborate pattern of activation in neural circuitry? Is it an expression or suppression of a set of implicated genes? It almost seems like we are pursuing explanations that are really descriptions on another lower level, which then begs the next in the explanatory question cascade. This is challenging, for one has the greater tendency to ask why when dealing with cognitive phenomena (e.g. theory of mind) than with overtly physical ones (e.g. a volcanic eruption). In any case, one positive conclusion is that, through the process, we *are* converging on a picture of cognitive development that is rich, multilevel, and illuminating.

Complexity #3: Making sense of the active, constructive meaning-maker

In multiple domains of cognitive development, theories tend to lack detail in terms of their metacognitive nature. For example, we wonder what children are aware of when they implicitly choose amongst strategies, when they digest new knowledge or overturn a presupposition, when they test and update a theory to achieve a more coherent mental model (Siegler & Alibali, 2004; Vosniadou & Brewer, 1992; Wellman & Gelman, 1998), These are tough questions to tackle empirically especially when children's introspective answers are so often elusive and inconsistent; but it is also hard for theorizing. Furthermore, until the interdisciplinary effort of cognitive science makes clearer sense of what consciousness means,

there will still be vagueness surrounding what the notion of *making meaning* and *actively constructing (or co-constructing) one's own development* entails.

In overview, amid the daunting quest of embracing the complexities of cognitive development, it is easy for important points to become implicit, assumed, or avoided. Of these are the tight and dynamic constraints emergent from our bodily relationship with the world, the need to clarify goals on the explanatory level for each cognitive domain, and the metacognitive nature of the growing child's experience of cognitive change. Only in this way can theories of cognitive development make the complex phenomena amenable to good science.

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