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Cognitive Development



Commentary

(P) (re) presentations: What are they and how do they develop? Commentary on “Stepping off the pendulum: Why only an action-based approach can transcend the nativist–empiricist debate” by J. Allen & M. Bickhard

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1. Message 1

Allen and Bickhard's first message is that in developmental psychology, the nature of the fundamental theoretical debates and of the empirical steps taken to solve these debates crucially depends on the way in which fundamental concepts of the discipline are understood by its practitioners. This understanding is often highly implicit, subject to almost axiomatic belief, and often more based on habitual research practices (*praxis*) than on explicit reflection. The fundamental concept of the Allen and Bickhard article is *representation*. According to Allen and Bickhard, there is a widespread understanding that representations are internally stored structures of meaning. If triggered by particular sense experiences these internal structures endow these experiences with a specific meaning. This kind of understanding of *representation* forms an almost irreducible foundation for theoretical discourse and empirical research. In fact, the first message of the authors is that empirical research is theory dependent and should not be conceived of as a final and independent arbitrator of theoretical quarrels, e.g. whether or not this view on representation is true. The theoretical dependency of empirical observations and empirical methods is far from a recent discovery (e.g. Kuhn, 1962). Nevertheless, in an age where the belief of many scientists in the intrinsic and objective value of empirical data is fueled by the pressure of publishing as much as possible it is good to repeat that old message every now and then. For developmental psychology to mature, there should be much more interaction between empirical research and serious and intensive theory building addressing the conceptual foundations of development as well as the fundamental developmental mechanisms.

2. Message 2

A second message of Allen and Bickhard is that representations, and knowledge for that matter, are emergent phenomena, and they emerge in a person's real-time constructive activity, that is the

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person's interaction with the material and social environment. According to Allen and Bickhard, what emerges on the long-term time scale is a person's ability to competently interact with a particular environment (an environment that is adapted to the abilities of the person, and the person who is adapted to the affordances of this particular environment). The question arises whether it is possible or adequate to use the word *representation* in this context (e.g. Barsalou, Breazeal, & Smith, 2007). Can we say that cognitive development entails, among others, that children develop representations? Does not this contradict a definition of representations as a particular kind of process constructively emerging in real-time action? Although we use the same word, *representation*, we should make a distinction between *representation_{short-term}* that refers to the process of constructing a representation in the context of real-time action (e.g. when a child makes a drawing of the earth in a mental model research context; e.g. Hannust & Kikas, 2010), and *representation_{long-term}* that refers to the total of skills, knowledge of facts, memories, etc. that change on the long-term time scale and that enables a child to construct a particular representation, e.g. a particular drawing or a verbal description, when asked to do so. We probably commit a mistake if we think that some sort of (however complicated) copy or "representation" of the emergent process that takes place in the form of real-time activity is internally stored, and that this internally, durably stored "representation" is what gives the short-term representational activities their content (which is the foundationalism that Allen and Bickhard refer to).

3. Intermezzo: how to make sense of "representation"?

In order to obtain a better understanding of representation we would like to go back to its original meaning, i.e. its etymology. The Online Etymological Dictionary (<http://www.etymonline.com>), describes representation as follows:

"to bring to mind by description," also "to symbolize, to be the embodiment of;" . . . from Latin *repraesentare*, from *re-*, intensive prefix, +*praesentare* "to present," literally "to place before".

The semantic core of the word *represent* is contained in the word *present*, which means to place something before a person, to show, exhibit or give something. To this kernel of *presentation*, the prefix *re-* is added, which means "again". A re-presentation is thus a repeated presentation. The basic question for cognitive psychology, and developmental cognitive psychology, is to understand *what* is presented, *how* this is done, *by whom* and *to whom* it is presented. It is interesting to note that for the phenomenologists the concept of *presentation* was of crucial importance and formed a fundamental aspect of the notion of the person's-being-in-the-world (Thompson, 2007). This phenomenological approach is conceptually related to dynamic systems approaches focusing on embodied cognition in general, which the current authors endorse.

The question of presentation logically precedes that of re – presentation, that is we should attempt to understand how things are presented before trying to understand how they are re-presented. Since human beings are dynamic systems, a particular presentation of something to a particular person (a current "state" of the system) has an effect on some later "state" of the system, for instance in the form of the person re-presenting the presentation by recognizing it, remembering it, or describing it at a later time, etc. (e.g. Van Geert & Steenbeek, 2005). A major developmental effect of presentations (we would call them experiences in more colloquial language) is that they lead to *pre – presentations*, in the form of anticipations of expected presentations, in the form of increased ability to pick up important aspects of later presentations, etc. This is in line with Allen and Bickhard's view that the nature of representation is anticipation rather than correspondence (see also Bickhard, 2009). However, anticipation can take many forms, for instance, actions such as visually focusing the place where a particular thing is expected to occur, physiological anticipations, long-term effects of learning and development and so on.

From a dynamic systems point of view, a child's experiences, i.e. his active experiences of how particular things are presented to him or her (among others by adults or by peers) form an iterative process, with each new presentation being a function of the preceding presentations, i.e. the pre – presentation (for a discussion of iterativeness see Van Geert & Steenbeek, 2005). Pre-presentation is

only possible in a system with memory, i.e. in a system in which any presentation brings about some sort of change in the system, such that any new presentation (of a particular object or content or whatever) is a function of the preceding presentations. Developmentally, the iterative nature of pre-presentations and presentations will lead to a bootstrapping process that enriches the structure of future presentations. They will show more detail and differentiation, more relationships and internal structure etc. than preceding presentations. If this iterative process is a process occurring in a complex dynamic system, it is likely to lead to self-organization and emergence, which in the case of cognitive development involves the emergence of novelty and new structural possibilities of the kind described by all theories of cognitive development.

4. Combining Message 1 and Message 2

If representations_{short-term} are constructive processes in real-time, emerging in the concrete interaction between an agent and some actively participating material and social environment, their study requires the observation of (sufficiently naturalistic) real-time processes in individual children, dyads or interacting groups such as classrooms, where these interactive construction processes actually take place. Such observations should be continued long enough and often enough to also capture the long-term time scale of changes in these real-time processes.¹ The nativist and the empiricist approach share an implicit understanding of human experience as something that is always composed of two clearly separable aspects, which is reminiscent of the Cartesian mind-body distinction. For instance, if we observe a young child in some sort of science-related problem, such Cartesian interpretation implies that there is a distinction between the bodily processes of sensory information intake (e.g. visual focusing) and object manipulation on the one hand, and the mental processes of assigning meaning to the sensory data and meaningfully planning the movements that the arms and hands will have to make on the other hand. These – very important – internal mental processes are not directly observable. However, other theoretical and empirical traditions have opted for a different view, in which there is no distinction between the impoverished aspect, namely the “incoming” experience, and the meaning-giving part of the experience. For instance, the Gibsonian view on perception has defined experience as an intrinsically meaning-laden relationship with the world, which is to say that perception implies that an organism picks up the affordances, relevant to the particular organism that the environment provides. Likewise, the phenomenologists have analyzed human experience as the coming together of the person and the world in a process that constitutes a continuous “I-being here”, in which the visual focusing and the object manipulation are inseparable parts of the ongoing stream of meaningful consciousness (e.g. Thompson, 2007). Hence, the basic problem for (developmental) psychology is to understand the emergence of *presentation* in the dynamic intertwining of the agent and the world, how the presentation of the world changes during the short-term timescale of real action and the long-term time scale of development, and how these two time scales are related.

In order to make the preceding points – the importance of taking action as the focus of study, of naturalistic studies and of the primacy of presentation – more concrete, we present an example from an ongoing study on young children’s construction of explanations, predictions and activities in the context of scientific and technological problems (Meindertsma, van Dijk, & van Geert, 2012; Van der Steen, Steenbeek, & van Geert, in 2012). We try to understand how this explaining, predicting, manipulating unfolds in action and how this unfolding develops by meticulously studying the observable processes that take place when a child, usually in a process of “Socratic” guidance by a well-informed adult, tries to solve a particular problem posed by the adult. In one of those situations, a child was confronted with the air squirt apparatus, consisting of two plastic syringes, connected by a translucent plastic tube, and which is filled with air.² The adult wants to know if the child understands the structure of relationships between the movements of the pistons in the air squirt apparatus. He pushes the

¹ It is highly likely that such processes are so-called non-ergodic processes, which means that they are processes the structure of which cannot be understood by pooling across individuals, which is the standard approach in most of the behavioral sciences. In order to understand them, we will have to study them on the level of particular time-serial cases, and collect many of such cases in order to understand how they might differ between individuals; Molenaar and Campbell (2009).

² The subtitled video clip of the situation can be watched at <http://www.talentenkracht.nl/?pid=67>.

piston down in his syringe and then asks the child to predict what will happen with the child's syringe, what will happen if the child pushes his piston down, whether the child can explain what happens, and so on.

The underlying scientific idea is that there exists a system of symmetrical or reversible relationships describing the cognitively or educationally important pattern of possibilities of the air squirt apparatus, for instance the connected movements of the pistons. This structure of relationships describes the (trained) adult interviewer's pre – presentation of the activity. The truth value of the description depends on whether the description allows us to predict the range or type of the adult's actions, such as questions to the child, reactions to what the child is doing, etc. We can also say that the adult anticipates to *enact* this structure of relationships with the child. Based on our observation of the child's verbal and emotional reactions, we can infer that the child pre-presents the activity as playing with syringes and squirting with water. The actual *presentation* of the object relationships to the child that unfolds in the interaction between child and adult is strongly guided by the adult, i.e. by the adult's pre-presentation or anticipation. The question, "where is the child's understanding" can be answered by saying that the understanding is in the child's activity itself, dynamically unfolding in the relationships with the adult and the air squirt. The adult interviewer intends to present this structure of relationships in the form of a Socratic process, that is by means of a series of questions and rebuttals, triggering the child's reactions and reacting to these reactions. This Socratic process is an excellent example of a classic dynamic system, in the sense that it is clearly iterative, with the next "state" of the process being explained by the preceding "state" (Van Geert & Steenbeek, 2005).

A valid description of what is presented to the child in this unfolding situation should consist of a detailed and rich description of the actual ongoing process, such that the description has maximal anticipatory value. That is, the description should be such that it gives us the best possible predictions of what the child is likely to do in a specific future situation (that is to say, not a situation "in general").

A time serial description of what occurs in a particular problem solving situation, such as that of the child, the adult interviewer and the air squirt, captures *representation*_{short-term}, that is the real-time process of the presentation of a particular aspect of the world, in this particular case the ensemble of tightly related, symmetrical events that characterize the air squirt. We see that this particular *representation*_{short-term} changes during this real-time, interactive process: the child discovers new properties of the air squirt. What is the effect of this and comparable events on *representation*_{long-term}, namely on the long-term changes in the complex network of skills, tools and knowledge that forms the child's "understanding" of the air squirt? Any lasting effects on the child of this particular experience, any memory traces left, create a developing possibility of literal re – presentation of the air squirt as an object with increasingly complex and structured affordances (the symmetries between the pushing and pulling up the pistons, the relations between the movements of the pistons, etc.). In this sense, any new experience will be some sort of re – presentation (in the sense of being presented again) of the preceding experiences. The child's experiences also lead to an increasing ability to pre – present this particular structure of relationships of the air squirt apparatus, which means that he will be able to anticipate the possibilities of the apparatus much more readily (Allen and Bickhard's view of representation as anticipation).

5. Message 3

The third message of Allen and Bickhard is that developmental psychology should take an action-based approach, in order to avoid the foundationalism that leads to the unsolvable pendulum swing between nativism and empiricism. We agree with this message and make some additional comments.

The first regards the following question: if the alternative approach described by Allen and Bickhard is action-based, then what is the basis of the approach that leads to foundationalism? We think that the latter is an approach that does not focus on actions as the unit of analysis, but on *psychological states* as the unit of analysis. That is, if one's focus of psychological research is on the properties of psychological states such as to know (something), to believe (something), to see (something), and so forth, one tends to isolate these psychological states from the context of activity in which they emerge and from which they borrow their changing and context-specific meaning. By doing so, one is likely to search for intrinsic, mental (or brain-based) properties of those states. In that case, one is also likely

to focus on the intrinsic and mental properties of the “objects” to which these states refer, namely the content of one’s knowledge, the thing one sees etc. In this particular interpretive framework, this content or object is part of the mental state at issue, and the researcher will be inclined to see this content as a concurrent *mental re – presentation* or “mental shadow” of what is *materially presented* in the situation at issue. It is also likely that the researcher will try to understand these mental states, such as children’s understanding of the causal relationship between the movement of the air squirt syringes by averaging over many such mental states in many different subjects in order to discover some essential properties of these mental states across the mess of variation between individual cases.

In an action-based approach, one is obliged to focus on the action as something that unfolds in real-time as an interaction between persons and a material world. Explaining means to describe the steps of the process, i.e. the iterative nature of the actions of the short-term time scale of real activity and the long-term time scale of iterative activities (Steenbeek, Janssen, & van Geert, 2012).

The second remark is that an action-based approach has consequences on several levels. Allen and Bickhard emphasize the theoretical and empirical consequences, namely what does it imply for the underlying theory on the one hand and what does it imply for the way we do research on the other hand. There is a third level on which the action-based approach might have consequences for the way we do developmental research, and this is the level of formal explanatory models. In our own work, we have taken the position that in order to explain why children are doing certain things we must build an agent/action model that generates predictions of the action patterns we are interested in. Such action-based models have been built and tested with regard to dyadic play in children (Steenbeek & Van Geert, 2007, 2008) and to student–teacher interaction during individual math instruction (Steenbeek & Van Geert, 2013). Dyadic play or asking math questions can also be explained by means of a statistical regression model, which is likely to be considerably simpler than the conceptually quite complex agent model that we are using. However, if explanation means to reduce an observed phenomenon to a more general causal theory, and that more general causal³ theory is a theory of action, then it is the simplest possible action model that should be preferred and not the simplest possible model per se.

6. What does this all mean for nativism?

Allen and Bickhard focus on a form of nativism according to which human beings possess specific content aspects of knowledge that did not find their origin in experiences. If such aspects of knowledge don’t have an origin in experience, they must by necessity be present before any act of experience can take place, that is they must be innate. It’s either experience-based or innate. . . However, there is a third possibility, namely the viewpoint of emergence, and this viewpoint is one of the great contributions of complex dynamic systems theory (van Geert, 2009) and it is also the view held by Allen and Bickhard. The nativism–empiricist debate contains another either-or position, which is that a particular representation or particular representational category is either present or not. However, in a dynamic systems oriented, emergentist approach, “having” a particular representation is a gradualist thing (McGeer & Schwitzgebel, 2006; van Dijk & van Geert, 2005). Finally, the major developmental question must focus on presentation, more precisely on how an active human relates to his or her world, on the short-term time scale of action and on the long-term time scale of development, on which developmental changes in presentation, pre-presentation (anticipation) and re – presentation (recognition and recall) are taking place.

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³ We shall treat causality in a very broad fashion, also implying processes of enablement, given that enablement rather than direct cause is characteristic of the “causal” pattern in biological processes (Longo, Montévil, & Kauffman, 2012).

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