The computation-representation divide:
The case of Bayesian approach to cognitive development

A general understanding in research about the workings of the brain, mind, an intelligence in general, is that of a divide between three levels of explanation (or even stronger, three levels of phenomena); computational, algorithmic and implementational. Even though the specifics of the levels and their relationships were, since Marr's (1982) seminal work, reformulated on more than one occasion (e.g. Anderson, 1990; Newell, 1982; Pylyshyn, 1984), a common position is that top-down computational, 'function-first' analysis offers answers to deeper 'why' questions while analysis at the level of implementation or mechanistic workings provides 'how' explanations. Due to this perceived deep divide between the levels, the probabilistic Bayesian approach has recently come under fire (e.g Elqayam & Evans 2011; Jone & Love 2011; Bowers & Davis 2012) as offering only 'just-so' stories (Bowers & Davis 2012).

Griffiths et al. (2015) respond to the surge of criticisms concerning the theoretical underpinning and importance of rational Bayesian models by arguing for the close connection between the computational and algorithmic levels of explanation. The author's key proposal is to „push the notion of rationality, often used in defining computational-level models, deeper toward the algorithmic level“ (pp 217) by conducting 'resource-rational analysis' reminiscent of Anderson's (1990) 'rational process models'. Both of these models emphasize the constraints environmental characteristics and computational limitations in terms of cost and capacity put on the algorithmic level. As noted by the authors, a similar line of argumentation can be made about representations (e.g. Tennenbaum et al 2011). Even more interestingly, Lewis et al. (2015) put forward their 'computational rationality' account that tries to link top-down and bottom-up mechanism approaches.

In line with Griffiths et al. (2015), I will argue that the traditional divide between the computational and algorithmic, representational levels can be surpassed by including intermediate levels of analysis. More specifically, I will show how, in the field of cognitive development, the Bayesian approach informs research about which representational-level assumptions are justified. The same issue was tackled by Thelen & Smith (1996) in their research that questioned the representational repertoire traditionally assumed in infant development. The Bayesian framework can at least begin to provide an answer to the question of how meaningful representational systems emerge - importantly and ideally - by using minimal assumptions 'grounded' in the characteristics of the environment. As Clark (2015: 259) puts it, „The upshot is a kind of meta-Bayesian determination of what to represent, and of when, and how, to represent it.“ In summary, the goal of my talk is to show how the computational and representational levels are closely knit together in recent Bayesian developmental research, therefore offering more than mere 'just-so' stories.

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