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Diagrams as Cognitive Technologies

Building on the Extended Mind hypothesis (Clark & Chalmers 1998), a theoretical approach has recently been proposed which considers formal languages (among which *diagrammatic* formal languages) as cognitive technologies (Clark 2006; Dutilh Novaes 2012; De Cruz & De Smedt 2013). This perspective offers interesting insights on diagrams as inference technologies combining both illustrative and operative roles. It is argued that certain purely perceptual and/or syntactical properties of diagrams play a fundamental role for the cognitive process, and that different properties may have significantly dissimilar cognitive impact. The question thus becomes interesting whether and how different systems of diagrams differently participate in cognitive processes. In what different ways and according to what principles notations and diagrams can be instruments of inference? What are formal languages good for? The common answer is that diagrams can be evaluated according to three basic parameters: *expressivity* (diagrams are isomorphic representations of their objects), *iconicity* (diagrams are iconic or natural representations of their objects), and *calculation* (diagrams allow calculation being performed concerning their objects).

According to Charles S. Peirce, none of these parameters is primary in itself. For Peirce, a diagram is first and foremost an instrument of logical *analysis*. If we are interested in formal languages "not only as (mathematical) *objects* as such, but rather in the broader picture of how formal languages are *used* and the impact they have on practices" (Dutilh Novaes 2012, p. 52), then we can no longer ignore Peirce's own basic parameter for the study of diagrammatic reasoning, as well as the *use* he made of specific kinds of diagrams of his invention. For Peirce, the best analysis of the actions of the cognitive mind is through a diagrammatic syntax (MSS 485, 669, L 376), and the system of *Existential Graphs* (EGs) was, according to him, the most perfect system of logical representation for analytic purposes: "the system of Existential Graphs is designed to afford a sort of geometrical παρασκευή,—or diagram,—for logical analysis, i.e. for illustrating and facilitating the same" (MS 300, p. 34, 1908). The cognitive impact of a system of diagrams is to be evaluated on the basis of their analytic power. Algebra is more analytic than natural language, but the Graphs are more analytic than algebra (and, for that matter, of any equivalently expressive system of logic representation hitherto known). The merits of EGs do no consist in their allowing *multiple readings* (Shin 2002), nor in their functioning as instruments of *calculus* (Shimojima 1996). EGs are neither a *lingua characteristica* nor a *calculus ratiocinator* (as Frege thought his *Begriffsschrift* would be). Their chief merit consists in their enabling us to analyze the movement of the mind in thought: "the system of existential graphs is a rough and generalized diagram of the Mind" (MS 498, 1906)

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