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TOOL USE AND MANUAL ACTIONS: THE HUMAN BODY AS A MEANS VERSUS AN END

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RUNNING HEAD: TOOL USE AND MANUAL ACTIONS

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TOOL USE AND MANUAL ACTIONS: THE HUMAN BODY AS A MEANS VERSUS AN END

In his book (“Apraxia: The cognitive side of motor control”), Georg Goldenberg (2013) offers a very exhaustive overview of the issues raised in the field of apraxia. He also presents his viewpoint on most of these issues. In this commentary, I will focus only on the way he hypothesizes the cognitive basis of manual actions involved in tool use.

There is an intense debate in the field of apraxia to define the nature of knowledge supporting tool use. Three kinds of knowledge are commonly proposed: Functional knowledge, manipulation knowledge and mechanical reasoning (Buxbaum & Kalénine, 2010; Goldenberg & Spatt, 2009; Osiurak et al., 2009, 2013). The stance held by Goldenberg (2013) is that mechanical reasoning is central to actual tool use, by allowing the segmentation and combination of the different parts and properties of tools and objects for construction of mechanical chains (e.g., the slit on the head of the screws enables the transfer of rotation from the screwdriver to the screw; see also Goldenberg & Hagmann, 1998; Jarry et al., in press; Osiurak et al., 2010). Besides, he assumes that functional knowledge may play a role, by specifying the purpose, recipient and context wherein a tool can be used. Yet, this knowledge would not be directly involved in the actual use of tools. More importantly, he denies the existence of manipulation knowledge. This knowledge is supposed to contain information about the hand movements associated with the manipulation of a specific tool (e.g., for a hammer, a broad oscillation of the elbow joint; Buxbaum, 2001). Goldenberg (2013) questions the viability of this hypothesis on the grounds that it is almost impossible to define “invariant features of muscular and joint actions” for a specific tool (see also Osiurak et al., 2011). Rather, he suggests that mechanical reasoning can also be applied to the multi-part mechanical object that is the human body. Said differently, manual actions

would also be determined by mechanical reasoning, leading Goldenberg (2013) to support a strong version of the mechanical reasoning hypothesis.

This strong stance raises a certain number of issues about the underlying cognitive mechanisms of object manipulation. Object manipulation can be performed not only to use tools with objects, but also to transport objects from one location to another. In both cases, there is object motion. Rosenbaum et al. (1990) demonstrated that when people have to move a bar from a horizontal to a vertical position, they tend to grasp the bar in a way that affords a comfortable final rather than initial posture (“End-state comfort effect”). This phenomenon indicates that postural end states are known before movements begin and it is the visual representation of the action (object’s motion) that constrains the final, and subsequently, the initial posture (Rosenbaum et al., 2012). According to the strong version of Goldenberg’s mechanical reasoning hypothesis, the ability to perform correct comfortable grips to transport objects should also require the analysis of the multi-part object that is the human body. The corollary is that a strong link should be found between appropriate tool use and the ability to perform comfortable grips in transport tasks. In fact, this link should also be obtained between the ability to perform comfortable grips to actually use tools and appropriate tool use. Evidence, however, invalidates these predictions (e.g., Osiurak et al., 2008; Randerath et al., 2009).

An alternative stance is to posit that, when people have to either transport objects or use tools, they form a visual representation of the tool/object’s motion, which then constrains the nature of the grip and the course of the movements. In this weaker version of the mechanical reasoning hypothesis, manual actions are not determined by mechanical reasoning (Osiurak et al., 2010, 2011). Rather, manual actions are supported by the production system, on the basis of laws such as the end-state comfort. Of course,

this is not to deny that mechanical reasoning can induce modifications about the way of grasping a tool to use it. For instance, a hammer can be used to perform either power or precise actions, leading to grasp it either at the basis of its handle or close to its head, respectively. Contrary to what Goldenberg (2013) suggests, the grip selection can be viewed as guided by the understanding of the lever principle, which assumes that the more the rotation point of the hammer is far from the point of percussion, the more the hammer's impact strength is amplified. So if someone understands this principle, he will be able to form a visual representation of the correct motion of the hammer relatively to the nail. And, once this representation formed, constraints about the movements to be executed can be processed by the production system. In this weaker version of the mechanical reasoning hypothesis, mechanical reasoning does not intervene to select appropriate manual actions.

Importantly, the weaker version I propose here is not inconsistent with the parallel drawn by Goldenberg between tool use and imitation of gestures (see Goldenberg, 1995, 1999, 2009). Indeed, it can be argued, as Goldenberg (2013) does, that in some tasks such as the imitation of hand postures relatively to the body, that the human body has to be "analyzed" as a multi-part mechanical object. In this way, mechanical reasoning can be useful for segment and combine the different body parts to reproduce a posture. This parallel is clearly supporting by evidence indicating that the left inferior parietal lobe is involved in both actual tool use and imitation of hand postures (see Goldenberg, 2013), even if additional data might be useful for specifying this link at a behavioral level. Nevertheless, in the case of imitation, the human body is processed as an end, and not as a means as this might be in tool use, and more generally object manipulation. So there is perhaps here a fundamental difference, which challenges the strong version of Goldenberg's mechanical reasoning hypothesis.

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