

LETTER TO THE EDITOR

Apraxia: a gestural or a cognitive disorder?

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Sir,

We read with great interest the article by Buxbaum *et al.* (2014) about the critical brain regions for tool-related and imitative actions. The authors performed voxel-based lesion–symptom mapping with data from 71 left brain-damaged patients. Three types of actions were examined: (i) pantomime to sight of tools (GestTool); (ii) pantomime on imitation (ImTool); and (iii) imitation of meaningless gestures (ImNov). Impairments in all three of the gesture tasks were associated with lesions in left middle and inferior temporal and inferior parietal regions. Moreover, tool-related actions (both GestTool and ImTool) were dependent on left middle and inferior temporal lobe, whereas imitation of meaningless gestures (ImNov) was dependent on left inferior parietal regions. From these findings, the authors drew two conclusions. First, the left inferior parietal lobe might be the basis for the kinematic component of the praxis system, useful for planning movement trajectories in terms of extent, direction and timing. Second, middle and inferior temporal regions might support representational components of the praxis system (e.g. the arm and hand posture associated with the use of a hammer). Note that these conclusions lead to a profound revision of Buxbaum's initial (2001) model. In this model, the left inferior parietal lobe was viewed as critical for storing sensorimotor knowledge about how to manipulate familiar tools, whereas the superior parietal lobes were thought to support imitation of meaningless gestures via a direct route from vision to action.

The results reported by Buxbaum *et al.* (2014) are of primary interest because, as emphasized, this study is the largest prospective study of apraxia-related lesions to date. Unfortunately, the authors overlook important data that can lead to another

interpretation of their findings. First, recent evidence indicates that left inferior parietal regions are critical to both the actual use of familiar tools with the corresponding object (i.e. real tool use) and the use of novel tools to solve mechanical problems (for reviews see Osiurak *et al.*, 2010; Goldenberg, 2013; Osiurak, 2014). These results are difficult to interpret with the kinematic component hypothesis formulated by Buxbaum *et al.* (2014) because the main difficulty of the patients with left brain damage who fail to solve mechanical problems is not to plan hand postures, but rather to select the appropriate tools to solve problems (Osiurak *et al.*, 2013). Perhaps, a better interpretation is that the left inferior parietal lobe is involved in all the tool-use situations by supporting the ability to reason about the physical object properties (i.e. the technical reasoning hypothesis; Osiurak *et al.*, 2010, 2013; Osiurak, 2014; for a similar interpretation see Goldenberg, 2013). This hypothesis has also been extended to imitation of meaningless postures. Indeed, mechanical problem-solving might also be applied to the multi-part mechanical object that is the human body (Goldenberg, 2013). In sum, the technical reasoning hypothesis can account for why Buxbaum *et al.* (2014) found that left inferior parietal regions were associated with all three of their tasks.

A second issue concerns the involvement of inferior and middle temporal regions in tool-related actions (GestTool and ImTool). Evidence has indicated that patients with a selective deficit of semantic knowledge and, as a result, temporal lobe lesions, are able to use familiar tools with the corresponding objects (i.e. real tool use) or to use novel tools to solve mechanical problems (Goldenberg and Spatt, 2009; for a review see Osiurak, 2014). In line with the aforementioned technical reasoning hypothesis,

this can be explained by the integrity of the left inferior parietal lobe in these patients. Interestingly, these patients have been shown to encounter difficulties in demonstrating how to use a tool presented in isolation (Hodges *et al.*, 2000). To account for this, Osiurak (2014) (see also Osiurak *et al.*, 2010) suggested that semantic knowledge stored in temporal regions is critical to determine the social usages associated with tools (e.g. knowing that a hammer is commonly used with nails and can be found in a workshop). In this frame, semantic knowledge is not the basis for understanding the potential mechanical actions, a function specific to technical reasoning. And, temporal regions would be particularly involved when subjects need to determine how to use a familiar tool presented in isolation, because information is lacking, particularly about the examiner's expectations. After all, asking someone to show how to use a knife presented in isolation (as in the GesTool task of Buxbaum *et al.*, 2014) is relatively ambiguous because the knife can be used for a great number of social usages (e.g. cutting bread, opening an envelope, peeling fruit). The additional presence of bread can help the subject to understand the examiner's expectations (as in real tool use). But, if the subject demonstrates how to peel fruit in a pantomime condition (e.g. GesTool), his performance might be viewed as impaired because this is not the action expected by the examiner. Nevertheless, most people can decide to show how to use the knife with 'an imaginary piece of bread' because they know that this is the most frequent usage of this tool, and as a result, what is certainly expected by the examiner. Said differently, the ability to perform tool-related gestures when information is lacking (as in GesTool and ImTool) might require social knowledge stored in temporal regions. This is another way of interpreting the data of Buxbaum *et al.* (2014).

In sum, Buxbaum *et al.* (2014) perpetuate the traditional perspective of apraxia, consisting in considering apraxia, first and foremost, as a gestural disorder (e.g. the kinematic versus the representational component of tool gestures). The interpretation

offered here provides an alternative by suggesting that apraxia must be rather viewed as 'the cognitive side of motor control' (Goldenberg, 2013).

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References

- Buxbaum LJ. Ideomotor apraxia: a call to action. *Neurocase* 2001; 7: 445–58.
- Buxbaum LJ, Shapiro A, Coslett HB. Critical brain regions for tool related and imitative actions: a componential analysis. *Brain* 2014; 137: 1971–85.
- Goldenberg G. *Apraxia: the cognitive side of motor control*. Oxford; New York: Oxford University Press; 2013.
- Goldenberg G, Spatt J. The neural basis of tool use. *Brain* 2009; 132: 1645–55.
- Hodges JR, Bozeat S, Lambon Ralph MA, Patterson K, Spatt J. The role of knowledge in object use: Evidence from semantic dementia. *Brain* 2000; 123: 1913–25.
- Osiurak F. What neuropsychology tells us about human tool use? The four constraints theory (4CT): mechanics, space, time, and effort. *Neuropsychol Rev* 2014; 24: 88–115.
- Osiurak F, Jarry C, Le Gall D. Grasping the affordances, understanding the reasoning: toward a dialectical theory of human tool use. *Psychol Rev* 2010; 117: 517–40.
- Osiurak F, Jarry C, Lesourd M, Baumard J, Le Gall D. Mechanical problem-solving strategies in left-brain damaged patients and apraxia of tool use. *Neuropsychologia* 2013; 51: 1964–72.