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Beyond Functional Architecture in Cognitive Neuropsychology: A Reply to Coltheart (2010)

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Abstract

We (Patterson & Plaut, 2009) argued that cognitive neuropsychology has had a limited impact on cognitive science due to a nearly exclusive reliance on (a) single-case studies, (b) dissociations in cognitive performance, and (c) shallow, box-and-arrow theorizing, and we advocated adopting a case-series methodology, considering associations as well as dissociations, and employing explicit computational modeling in studying ''how the brain does its cognitive business.'' In reply, Coltheart (2010) claims that our concern is misplaced because cognitive neuropsychology is concerned only with studying the mind, in terms of its ''functional architecture,'' without regard to how this is implemented in the brain. In this response, we do not dispute his characterization of cognitive neuropsychology as it has typically been practiced over the last 40 years, but we suggest that our understanding of brain structure and function has advanced to the point where studying the mind without regard to the brain is unwise and perpetuates the field's isolation.

Keywords: Cognitive neuropsychology; Functional architecture; Computational modeling

In a recent article in this journal (Patterson & Plaut, 2009), we lamented the apparent lack of impact that cognitive neuropsychology (CN) has had on cognitive science, and suggested that this might stem from three fundamental aspects of how CN has been practiced to date: (a) near-total reliance on single-case studies; (b) near-total reliance on dissociations in cognitive performance; and (c) shallow, descriptive theorizing based on box-and-arrow diagrams. We argued that richer and more fruitful interactions between CN and other approaches to studying ''how the brain does its cognitive business'' might be possible if the field employed a case-series methodology, considered associations as well as dissociations in performance, and adopted an explicitly mechanistic, interactive perspective in theorizing about cognitive and neural processes.

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In a reply to our article, Coltheart (2010) contends that our concern about CN is misplaced, not because we have mischaracterized the approach, but because we have misunderstood its aims. According to Coltheart, despite the fact that the primary source of evidence in the field derives from brain damage, CN has nothing to do with the brain; rather,

> The primary aim of cognitive neuropsychology is to study the mind: to elucidate the functional architecture of cognition. Coltheart, 2010, (p. 4)

In support of this position, Coltheart includes numerous quotes from leading practitioners in the field and an analysis of the 2008 volume of the journal *Cognitive Neuropsychology*. He also points out that the standard approach to CN—more or less as we portrayed it—continues to make progress toward this aim.

The tone of Coltheart's reply suggests that he expects us to disagree with his summary that the great majority of CN research is solely about the ''functional architecture'' of cognition; but we do not disagree with this—not at all. The point made in our original article is not that this is untrue but that it is unwise. In fact, given the dramatic recent progress in the study of how neural processes give rise to cognitive processes, Coltheart's summary is a clear illustration of why, in our view, the field of CN has become increasingly isolated and detached from this much broader and exciting multidisciplinary effort to understand both mind and brain. Perhaps no further comment on our part is necessary.

And yet the reason we wrote our article in the first place was not to malign current practice in CN (although some criticism was needed to make our case) but to try to point the way forward to an integrated approach in which the study of cognitive impairments in brain-damaged patients can make a more profound contribution to understanding cognition. Indeed, our definition of CN was intentionally broad:

> Cognitive neuropsychology uses patterns of cognitive disorders as evidence to derive inferences about cognitive function in the normal brain. (Patterson & Plaut, 2009, p. 41)

Coltheart rejected this definition as indicating that we ''have misunderstood the nature of cognitive neuropsychology'' (p. 8), presumably not because he disputes that cognitive function is a function *of the brain*, but because he contends that the mind is properly studied—at least within CN—without regard to the brain. Note that, for Coltheart, what it means to study the mind is something rather more specific than ''deriving inferences about cognitive function''; it is to study its ''functional architecture.'' But what exactly does this mean? As Coltheart puts it, it amounts to the claim that

> … there is a functional level at which cognition can successfully be studied: a level that specifies what the information-processing procedures are that people use when carrying out cognitive processing in any particular cognitive domain, without making any statements about the neural structures involved. (p. 10)

Unfortunately, as we pointed out in our original paper, CN almost never does specify these information-processing procedures in any detail—it merely labels boxes that are assumed to carry out these procedures. As Seidenberg (1988) emphasized, it is nearly impossible to evaluate claims regarding a functional architecture without a full specification of the representations and processes used by each of its components. That is precisely why we suggested that computational modeling, which requires explicit specification of component procedures, might have something vital to offer CN.

Furthermore, the relevant question is not whether it is possible to study cognition ''without making any statements about the neural structures involved'' but whether this is the best strategy for making progress. In this regard, Coltheart adopts what he takes to be ''a rather standard position in cognitive science'' (p. 9) that there is an algorithmic (i.e., cognitive) level of description that is distinct from, and largely independent of, the implementational (i.e., neural) level (Marr, 1982). But on what basis should we evaluate the likely degree of independence between cognitive and neural processes? Marr himself pointed out that hardware choices for a given algorithm can have a huge impact on performance, and cognition is under severe performance constraints (e.g., vision is of little help if it takes 2 min to recognize the oncoming man-eating tiger). Moreover, Marr's intuitions were driven by the clear hardware/software distinction of general-purpose computers at the time, but the last 25 years of progress in computer science has led to such tight integration of hardware and software in the service of increased efficiency that sometimes the distinction blurs. Given the tremendous recent advances in cognitive neuroscience, we are not convinced that it still makes sense, in understanding cognition, to talk about a ''functional architecture'' that is independent of the actual neural architecture. This may have been a convenient approximation when our knowledge of brain structure and function was still quite limited, but it is now too coarse to be useful. As Shallice (1988, p. 214) puts it, in one of the quotes used by Coltheart to question our view of CN,

> The rather negative assessment made of group studies and localisation information is not one of principle, but a pragmatic one specific to the methods available at present. With, say, advances in neurological measurement techniques, the situation might very well change. The situation has changed.

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