DISCUSSION

HOW MUCH CAN WE LEARN FROM DOUBLE DISSOCIATIONS?

Nick Chater

(University of Warwick)

It is sometimes assumed that double dissociations between performance in Tasks A and B indicate that different underlying cognitive mechanisms are implicated in each task. According to this viewpoint, double dissociations are a powerful tool for probing the modularity of the mind. The validity of the double dissociation inference, and related inferences has been widely discussed (e.g., Dunn and Kirsner, 1988; Shallice, 1988). Here we focus on a particularly simple type of example, which nonetheless challenges the general use of the inference from double dissociation to the modular structure of the mind.

Suppose that the mechanisms underlying A and B overlap almost completely, except for one infinitesimally small component, which is specific to A; and one infinitesimally small component, specific to B. Sometimes damage to the system will leave these two special components intact – and perhaps just cause general degradation in performance for both tasks. Sometimes, damage will knock out both components, causing both tasks to be poorly performed. But, equally, damage that knocks out just one of the special components, or impairs it, will lead to dissociations between performance in one of the tasks. The double dissociation may be as extreme as one wishes.

So it would seem wrong to conclude that Tasks A and B are subserved by different systems – instead they are subserved by the same system, except for the tiny specialized components.

This seems to be more than a theoretical possibility. Suppose we knew nothing of the physiology of the digestive system from anatomical investigation, and instead attempted to infer it from 'double dissociations' in the behaviour of that system. Suppose that person 1 is allergic to prawns but can eat peanuts; and person 2 is allergic to peanuts but can eat prawns. We might conclude that prawns and peanuts are digested by separate systems. But of course they are digested by the same system – although there are presumably subtle chemical processes, presumably quite late in the process of digestion, that differ between the two.

The point can be sharpened further. Even the two 'specialized' components need not be involved purely in one task but not the other. Instead, the two components may both be involved in each task, but to different degrees. Then an impairment to one component may leave it still able to function well enough to contribute to the performance of Task A, but not well enough to facilitate the successful completion of Task B; or vice versa.

For example, consider two athletes, one who gets blisters from overzealous practice in throwing the javelin; another who gets blisters from overzealous

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practice in putting the shot. Once the blisters are present, the first athlete's javelin throwing is severely impaired; but the athlete's shot putting is largely intact (presuming that the patterns of pressure on the skin resulting from the two activities are different); and the second athlete has the reverse pattern. Suppose that the body were invisible, and we attempted to infer its underlying modularity from its motor performance (e.g., javelins and shots flying through the air). Then this double dissociation might tempt us to infer that different parts of the motor system are involved in the two events. But this would be misleading. Essentially the whole motor system is involved in both tasks; and the hands and fingers of the dominant hand are especially involved. But, at a fine-grained level, different parts of the hand are differentially involved. In one event, the pressure on one part of the hand will be greater than in the other event; and hence blisters will have differential effects. One could, of course, imagine similar cases where the underlying 'damage' had a different form, e.g., muscle strains, impact of different viruses, and so on.

A further twist is that the same pattern of results can be obtained, even if there is no difference whatever in the degree to which each 'critical' component is involved in the two tasks. Instead, it may be that, for one task, there is a back-up system that can take over the job of the component in that task; but for the other task this is not possible. Suppose that the contrasting tasks are writing on the blackboard and fruitpicking; that bodies are, as before, invisible; and that we consider using double dissociations in performance to infer the structure of the motor system. Suppose further that the legs are generally involved in both tasks (the person stands, both to write on the board, and to pick fruit); and both tasks are conducted with the dominant hand (say, the right hand). Now consider the case in which there is damage to the right hand – handwriting performance collapses; but fruitpicking remains intact – this task can be readily switched to the left hand, whereas writing cannot. Conversely, suppose there is injury to the legs. Now writing on the board is preserved; the person sits on a chair, rather than standing up; but fruitpicking is hopelessly impaired, as there is no similar 'back-up' strategy that leaves performance intact. The key point in this example is that the double dissociation may arise purely from the differences between backup strategies, and therefore can arise even where, in *normal* function, all components of a system are involved in both tasks under consideration.

It is perhaps of interest to note that many of the same arguments may equally well be applied to data from other methods, such as fMRI. Finding different 'hot spots' of neural activity for two different tasks cannot directly be taken as evidence for separate underlying cognitive machinery. It may be that the machinery is common for the two tasks, except for certain special components; or that all components are shared, but some are utilized more in one task, and some utilized more in the other task.

At this high level of generality, it seems then that double dissociation cannot be used as an inference principle for uncovering the modularity of the cognitive system. This does not, however, imply that neuropsychological data cannot be an important source of constraint on theories of cognitive architecture. Indeed, even a single dissociation may be a powerful constraint – if whole classes of cognitive model cannot reproduce that single dissociation. For example, the *single* dissociation evident in phonological dyslexia (Funnell, 1983), where whole word reading is largely preserved, but non-word reading is damaged, are challenging for some types of connectionist model of reading (see, e.g., Bullinaria and Chater, 1995; Plaut 1997, for discussion). But each prospective evidential relation between neuropsychological deficits and cognitive architecture must be considered on its merits; and in the light of other experimental, neuropsychological, or computational evidence. Double dissociation can not, as an abstract principle, reliably serve to uncover cognitive structure.

References

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Nick Chater, Institute for Applied Cognitive Science, Department of Psychology, University of Warwick, Coventry CV4 7AL, UK. e-mail: nick.chater@warwick.ac.uk