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Searching for Memory Systems

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In his comment on Nyberg and Tulving's (1996) article, Shanks (this issue) argues that the dissociation evidence we presented for the multiple memory systems approach is weak. In this reply, we consider his comments, discuss some inconsistencies in his arguments, and note that he seems to have overlooked some of our points. We maintain our position that dissociation evidence constitutes one important source of support for separate memory systems, and we argue that converging evidence from dissociation studies and functional neuroimaging studies strongly indicates the existence of multiple human memory systems.

INTRODUCTION

A current focus of interest in memory research is the hypothesis that human memory is composed of several separate but interacting systems (for recent reviews, see Schacter & Tulving, 1994a; Squire & Knowlton, 1995). Schacter and Tulving (1994b) have suggested a set of three criteria that need to be satisfied when referring to a putative memory system. In a recent article (Nyberg & Tulving, 1996), we evaluated the evidence with respect to one of these criteria, "converging dissociations". According to this criterion, the separate existence of two putative systems would receive support if several different kinds of dissociations could be found in tasks that can be assumed to be differentially affected by the systems.

In our review (Nyberg & Tulving, 1996), we searched the published literature for four kinds of dissociations—functional, developmental,

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pharmacological and brain damage—with respect to all six possible pairwise comparisons of four long-term memory systems: episodic, semantic, perceptual representation system (PRS) and procedural (Schacter & Tulving, 1994b). We found relevant evidence of variable quality in 23 of the 24 possible comparisons, and concluded that the findings thus support the hypothesis of the separate existence of these four systems. Now Shanks has proposed that our literature analysis provides "almost no compelling evidence for the four-way division of long-term memory" (Shanks, this issue, p. 112). Because his objections to the study of the organisation of memory do little more than replicate previously voiced and by now well-known criticisms of the systems view (e.g. McKoon, Ratcliff, & Dell, 1986), and because he does not offer any constructive suggestions as to what kind of evidence for the systems view he would find acceptable, we find Shanks' comments unhelpful.

EPISODIC VERSUS PROCEDURAL MEMORY

Shanks examines in some detail the examples we gave for dissociations between episodic memory and procedural memory. With respect to functional dissociations, he raises concerns about our particular example (Willingham, Nissen, & Bullemer, 1989), and he argues that, at least in the serial reaction time task, episodic and procedural knowledge are strongly associated. As support for this argument, he makes reference to a study by Perruchet and Amorim (1992). However, he fails to mention that this study, too, has been heavily criticised (Cohen & Curran, 1993; Willingham, Greeley, & Bardone, 1993; for a reply, see Perruchet & Gallego, 1993), once again proving that finding the truth in our discipline is not easy.

A basic assumption underlying our analysis was that one cannot make a strong case for separate memory systems based on functional dissociations alone, and we presented dissociations between performance on episodic and procedural tests as a function of brain damage and chronological age. Specifically, we made reference to studies showing an effect of ageing and brain damage on episodic but not procedural test performance. Shanks objects to this evidence because some studies have shown that young people can outperform older people and amnesics on procedural tests. This criticism of Shanks provides an example of why the study of the organisation of memory is so difficult, and why one has to exercise double the amount of care when interpreting the data. It is widely accepted that there are no "pure" tasks that tap the resources of only a single system (e.g. Jacoby, Toth, & Yonelinas, 1993; Tulving, 1983, pp. 77–78). Shanks apparently accepts the idea of multiple determi-

nation of tasks, even if he seems to have overlooked our concurring sentiments at the outset of our review (Nyberg & Tulving, 1996, p. 164). Such multiple determination of tasks means that it is quite possible for performance on a procedural task to be facilitated by declarative (episodic or semantic) knowledge, although declarative knowledge is not necessary for task performance (cf. Squire, Knowlton, & Musen, 1993). The extent to which declarative information can facilitate procedural performance can even be tested (cf. Russo & Parkin, 1993). But the point we wish to make is that while Shanks is saying that more than one memory system can contribute to task performance, he also says that we cannot interpret the superior procedural test performance of normals over amnesics by making reference to the potential contributions of more than one system. Such a stance is not helpful.

Shanks also questions the validity of our example of a psychopharmacological dissociation between episodic and procedural memory—the finding by Nissen, Knopman and Schacter (1987) of a selective impairment of scopolamine on episodic test performance (free recall). The basis for this was the finding by Knopman (1991) of an effect of scopolamine on a verbal (but not a motor) version of the serial reaction time task. Whereas this finding indeed indicates that scopolamine can affect different kinds of procedural tasks differentially, we take it to suggest that further study and thought is required. We would like to stress that there is no reason for expecting all procedural memory tests to be affected in the same way by various manipulations (see Squire & Knowlton, 1995, for a taxonomy of non-declarative long-term memory and associated brain structures). A dissociation between episodic test performance and performance on a given type of procedural test (e.g. motor serial reaction time task), but not between performance on the same episodic test and another type of procedural test (e.g. verbal serial reaction time task), may provide important enlightenment rather than undermining the multiple memory systems view.

CRITIQUES OF MEMORY DISSOCIATIONS

A more general point raised by Shanks (this issue) is that a number of the distinctions we consider have been questioned previously. He argues that our claims "might be viewed as simplistic in the light of broader theoretical and methodological considerations" (p. 117). As one example, he points to the episodic/semantic distinction, and he suggests that by referring to a single study (an example of a functional dissociation) we "give the impression that the episodic/semantic distinction is a valid one" (p. 117). Shanks ought to know that there is much more to the evidence

regarding the episodic/semantic distinction than the single example. In our paper (Nyberg & Tulving, 1996), we refer to a review chapter which provides several other examples; we refer to two studies showing a developmental dissociation; we refer to three studies reporting a pharmacological dissociation; and we refer to three studies showing a dissociation as a function of brain damage. These numerous examples are quite consistent in showing an effect of advanced age, pharmacological agents and brain damage on episodic but not semantic test performance. In addition, evidence regarding the functional neuroanatomy of multiple memory systems, including episodic and semantic memory, has been presented (Fletcher, Dolan, & Frith, 1995a; Fletcher et al., 1995b; Perani et al., 1993).

CONCLUSIONS

The main issue here is whether there is support for the multiple memory systems approach (e.g. Schacter & Tulving, 1994b; Squire & Knowlton, 1995). Shanks (this issue) concludes that the support is quite weak. In contrast, we would argue that the support appears to be growing stronger each year. It is not only comprised of dissociation evidence, but also of evidence from functional neuroimaging studies (for reviews of relevant neuroimaging data, see Buckner & Tulving, 1995; Nyberg, Cabeza, & Tulving, 1996; Ungerleider, 1995). The point to remember is that an issue as complex as that of multiple memory systems does not hinge on the interpretation of the data from a few single experiments; it will be decided by the overall picture that emerges from a massive research effort. The final word has yet to be said and so the search for memory systems continues. We invite Shanks and others who wish to understand memory to contribute constructively to future research.

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