

Commentary on Watkins (1990): There Are Other Solutions to the Problem of Proliferating Memory Theories

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Three different issues are emphasized in Watkins' (1990) provocative article. The first is a lament about the proliferation of theories in the field of memory, which Watkins argues is leading to a science that is not cumulative. That is, because there appear to be few constraints on the number of hypothetical constructs proposed or in the complexity of the theories in which they are embedded, it has become very difficult to assess the validity of theories concerned with memory. The second issue centers on the suggestion that mediationism, and particularly the doctrine that a memory trace is responsible for preserving information over time, is a major factor contributing to the theory proliferation problem. The argument here is that premature reliance on mechanistic (and mediational) interpretations encourages distinctions among constructs that cannot be adequately investigated with available psychological methods. The final issue discussed in Watkins' article concerns a proposal that one solution to the problem of multiplying memory models is the abandonment of theories based on mediating constructs, and greater attention devoted to the study of controlling stimuli and the search for functional laws.

Because the second and third issues are mainly speculations regarding the cause of, and a possible solution to, the initial issue, the problem of proliferating memory theories seems to be the overriding theme in Watkins' (1990) article. The major concern is that the

current emphasis on formulating theories is counterproductive to the accumulation of genuine knowledge, particularly when our analytical methods are not adequate for discriminating among alternative theories.

I suspect that the observation that memory theories have proliferated over the last 20 to 30 years would not be at all controversial. There would probably also be considerable agreement among many memory researchers that at the present time there appear to be few constraints on the number of constructs that could be incorporated into the theories or in the complexity of the theories that have been proposed. However, there are reasons to question whether the reliance on mediating constructs such as a memory trace is the source of the proliferation problem, and whether a focus on the discovery of functional relations to the exclusion of models and theories is the only possible solution to this problem.

One objection to the latter suggestion is that there are different styles of explanation, and for many people regularity in the form of a lawful relation is not sufficient as an explanation. That is, although it is true that a functional relation may provide the same level of predictability as a more detailed or mechanistic "causal chain," many researchers are also interested in *why* the relation occurs; for them, an explanation simply in terms of regularity would be considered incomplete and inadequate.

However, the primary theme of this commentary is that Watkins (1990) apparently failed to appreciate that there are a number of different types of constraints on theorizing that are available

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for adoption, and if implemented would impose important limits on the nature and scope of cognitive theories. I will begin by briefly discussing three different areas in which such constraints seem to be emerging.

First, computational models of cognitive functioning could impose the constraint of *sufficiency* because computational models must be internally consistent in order to produce reasonable simulations of the relevant behavior. Furthermore, some of the recent computational theories such as different versions of ACT (Anderson, 1993) and SOAR (Newell, 1990) have been quite broad because they have attempted to provide an integrative account of many cognitive phenomena. This feature has led to an emphasis on parsimony by restricting the number of distinct constructs included in the theory, because the same ones are postulated to be relevant to many different cognitive tasks, and by reducing the number of separate microtheories, because the same integrative principles are postulated to be responsible for all aspects of cognition.

Second, the recent merging of neuroscience and cognitive psychology is leading to new *plausibility* constraints on theorizing as cognitive models attempt to incorporate biologically realistic properties. If taken seriously, the consideration of biological plausibility could severely reduce the number of constructs used in cognitive theories because constructs might be postulated only if they are consistent with existing knowledge in the areas of neurophysiology and functional neuroanatomy.

Finally, the merging of psychometrics and cognitive psychology has the potential to emphasize *validity* constraints by clarifying the distinction between constructs and variables, and by encouraging the use of multiple indicators and converging operations. That is, a key aspect of the psychometric approach is the assumption that any single variable is only one relatively crude, or confounded, indicator of a construct because it reflects the influ-

ence of numerous specific factors and the particular methods of assessment in addition to the influence of the theoretical construct. Experimental psychologists have typically attempted to increase the precision of construct assessment by devising more specific or esoteric procedures, but this has the disadvantage of leading to narrower and more restricted constructs. Furthermore, it does not eliminate the potential confounding effect between the construct and a measure based on one particular method of assessment. In contrast, the psychometric approach to the assessment of constructs involves the use of multiple indicators, or converging operations, in an attempt to average out the method-specific variance and thereby emphasize the construct variance of primary interest. The psychometric approach also includes very powerful methods of evaluating exactly what a construct is assessing through the examination of convergent and discriminant validity. Application of these types of psychometric methods would likely ensure that the constructs are simultaneously broad, in the sense that they are defined by several measures that are at least moderately correlated with one another, and distinct, in the sense that the measures have only weak correlations with measures of other constructs.

As the field of cognitive psychology evolves and strengthens linkages with related fields, therefore, new sets of theoretical constraints seem to be emerging. Moreover, distinctions such as that mentioned by Watkins (1990) between the study of memory per se and the study of the physical substrate of memory (pp. 330, 333) may be fading as the breadth and scope of cognitive psychology expand. Although I agree that the proliferation of theories without adequate means of investigation is a problem, it seems too extreme to suggest that all attempts at theorizing should be abandoned because potentially relevant constraints have not been employed in the past. Indeed, I strongly suspect that if the constraints

of sufficiency, plausibility, and validity were to be applied to existing theories, then the number of theories that are still viable would shrink dramatically, and the survivors would almost certainly be less complex than those in the current literature.

The breaking down of boundaries between disciplines is also resulting in the appearance of new and more powerful analytical methods. This brings up another point with which I differ from Watkins (1990), who suggests that this will lead to "an even more entrenched confusion" (p. 333). From my perspective, the need to have a terminology that is meaningful across disciplines seems more likely to lead to clarification and eventually to broader and deeper understanding. Furthermore, it seems reasonable to expect that the blurring of boundaries will result in more powerful investigative tools because we will no longer be limited to those originating from within a single discipline.

The new analytical methods should also expand our ability to address issues such as the viability of hypothetical constructs like the memory trace. For example, if repeated attempts to construct effective computational models without some type of mediating construct were not successful, then the assumption that a memory trace is not necessary could be questioned. Of course, support would be provided for the view that the concept of a memory trace is not necessary if computational models reveal that powerful explanations of cognitive phenomena could be constructed without invoking a representation of the original stimulus. Neuroscience research with functional neuroimaging or with single-cell recording might reveal particular regions of the brain, or specific cells, that are active primarily during the retention interval in a memory task, and therefore are presumably responsible for preserving relevant information over time. To the extent that this occurs, then those regions or cells might be considered to be the biological substrate of the mem-

ory trace. And finally, psychometric research could be relevant to the construct validity of the notion of a memory trace, or of a storage stage in memory, if measures postulated to reflect storage or retention were correlated with one another (i.e., they exhibited convergent validity), but were not correlated with measures postulated to reflect theoretically distinct constructs such as encoding or retrieval (i.e., they exhibited discriminant validity).

It is not clear what the outcome of research of the type just described will be, but the questions seem to be meaningful, and they seem to be addressable with currently available analytical tools. To the extent that these assertions are true, then mediational constructs such as the memory trace may serve a useful role because the relevant questions can be investigated by objective empirical methods. Constructs such as the memory trace may have appeared to be sterile, or even counterproductive, in the past because only a limited set of methodological procedures were considered to be relevant for their investigation. However, new analytical tools are becoming available as the field of cognitive psychology merges with related disciplines, and they have the potential to lead to new insights about both old and new constructs.

Summary

To summarize, I agree with Watkins (1990) that there has been a problem of too many theories and too few constraints in contemporary research in memory and cognition, but I disagree as to the source of the problem or its likely solution. Any discipline should evolve, and in the process establish linkages with related disciplines. Those other disciplines can then be a valuable source of constraints on theories, and can also provide powerful new sets of methodological or analytical tools. It remains to be seen whether those constraints and tools will be effectively employed in the field of memory re-

search, but the fact that they exist and are starting to be recognized suggests that Watkins' (1990) prognosis may be too pessimistic.

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