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PRACTICAL APPLICATIONS AND THEORIES OF MEMORY:
A NEW EPISTEMOLOGY TO SUPPLEMENT THE OLD

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ABSTRACT

This paper examines two epistemologies on the nature of theory and its role in practical applications of memory research and science in general. Although the empirical epistemology has dominated psychological research over the past seventy years, I argue that the rational epistemology is more conducive to sophisticated practical applications, and that achieving a balance between two epistemologies is needed for solving many other problems in the field.

The desire to address practical issues has a long history in psychology, and recent expressions of frustration by psychologists such as Tulving (1979) and Neisser (1985) over the inapplicability of current experimental knowledge are understandable. What applications there have been are quite unlike the sophisticated theory-based applications one sees from the advanced sciences, and are often difficult to distinguish from common sense. The present paper examines two epistemologies on how practical applications should originate in memory research and psychology in general. I will argue that the relative inapplicability of psychological knowledge is attributable in part to the domination of psychological research by the empirical epistemology over the past seventy years, that its complement, the rational epistemology, is much more conducive to sophisticated practical applications and provides an important new perspective on the metatheoretical debate currently ongoing among memory researchers (Bruche, 1985; Neisser, 1985), and other psychologists (Greenwald, Pratkanis, Leippe and Baumgardner, 1986; MacKay, in press).

GENERAL OVERVIEW OF THE TWO EPISTEMOLOGIES

The main goal of the empirical epistemology is to develop a body of reliable facts and real world applications, whereas the main goal of the rational epistemology is to develop theories which explain available facts, facilitate practical applications, and predict new facts for future test. Practical applications seem to represent an area of overlap between these two epistemologies. However, this and other surface similarities are deceptive: The next section shows that the two epistemologies approach practical applications in radically different ways.

PRACTICAL APPLICATIONS UNDER THE EMPIRICAL EPISTEMOLOGY

The empirical epistemology assumes that particular experimental findings can (and should) be applied directly to the real world and blames theories for the relative inapplicability of psychological knowledge. For example, Greenwald et al., (1986, p.227) argue that the social reward system in psychology encourages researchers to become "ego-involved advocates of theory" and to publish observations which are overgeneralized and unreliable, and thus, inapplicable.

The rational epistemology rejects the assumption that experimental findings can or should be directly applicable. Real-world problems which require creative solution are never as simple as laboratory situations, which are, of necessity, carefully and deliberately contrived. The practitioner's goal is to think flexibly about a real-world problem, to come up with as many courses of action as possible, and to try out the best ones, often in tentative, small scale fashion until an acceptable solution is found. Experimental observations cannot directly help in this process. The very fact that experimental observations originate in rigidly controlled and (hopefully) well understood laboratory situations restricts the applicability of these observations to unsolved practical problems. If an experimental observation applies directly to some real-world problem, the problem has already been solved and does not, by definition, require creative solution. For this same reason, 'impoverished laboratory environments' cannot in principle directly reflect the complex uses of memory in everyday life (see Neisser, 1985).

PRACTICAL APPLICATIONS UNDER THE RATIONAL EPISTEMOLOGY

Under the rational epistemology, sophisticated applications and characterizations of everyday phenomena derive from theories rather than from experimental observations. Because theories are flexible and general, they can apply across a broad range of practical situations, unlike experimental observations, which by definition and design are restricted to a limited range of controlled conditions. Moreover, even theories sometimes lack sufficient flexibility and generality for handling the complexity of real world problems, so that specialized practitioners must also use their experience, intuition, and ingenuity when applying a theory to practical ends.

The simplicity of theories is also essential for practical applications. Theories reduce a large number of complex empirical generalizations and their exceptions to a small number of conceptually simple hypothetical constructs. For example, hidden units (McClelland, Rumelhart and the PDP Research Group, 1986) or mental nodes (MacKay, 1987) and the simple ways they interact are easier to think about than the many empirical phenomena that they summarize. Such simplicity helps the practitioner come up with sophisticated solutions to applied problems. Unintegrated scientific observations, on the other hand, are not simple: Empirical factors and the potentially unlimited interactions between them (see Greenwald et al., 1986) are difficult to keep in mind, let alone apply. The rational epistemology attributes the relative inapplicability of psychological knowledge primarily to the lack of

viable theory, and warns that additional facts in the absence of theory can bring diminishing practical returns. As Tulving (1979) and others point out, our ability to gather facts has outstripped our ability to remember and use these facts, and some are being reduplicated out of ignorance.

THEORIES UNDER THE TWO EPISTEMOLOGIES

Why do the two epistemologies characterize practical applications so differently? One reason is a hidden difference in what the two epistemologies mean by "theory". Both epistemologies seem to share the same surface definition of theories: Theories contain theoretical terms embedded within a small number of interrelated and logically consistent propositions related to existing and yet-to-be-observed empirical phenomena. Because the two epistemologies characterize "theoretical terms" so differently, however, this surface definition is deceptive.

Operational definitions of theoretical terms were once deemed necessary under the empirical epistemology, and are still considered possible and desirable. For example, Greenwald et al. (1986) claim that observations and operations fall at the positive end of a desirability continuum, and that theoretical constructs become less desirable the greater their distance from operations and observations. Under this definition, the term "theory" embraces empirical hypotheses, empirical generalizations, unique observations, guiding ideas, opinions, and metatheories, in addition to what the rational epistemology calls theories and theoretical constructs.

Under the rationalist perspective, theoretical constructs such as hidden units and nodes begin with purely presumptive status and are potentially unobservable. The relatively simple interactions between these hypothetical constructs (e.g., altered linkage strength) purport to describe how things (e.g., minds) work universally and inevitably for all time, space, and hypothetical examples or Gedanken experiments (see Kuhn, 1977). These interactions also predict and explain empirical generalizations, such as the law of speed-accuracy trade-off, a regularity emerging from many experiments and thousands of observations of the relationships between two or more empirical variables.

The rules of correspondence which map theoretical constructs onto empirical observations are modifiable and open to extension under the rational epistemology. This flexibility allows theoretical constructs to survive for extended periods of time, outlasting existing means of observation, and suggesting future observations, lines of research, and practical applications which are currently unimaginable. For example, by altering rules of correspondence and adding new ones, the theoretical term 'sound wave' has survived for 1800 years, explaining thousands of initially unimagined observations of an ever more direct and precise nature (Holland, Holyoak, Nisbett, and Thagard, 1986). However, flexible correspondence rules make it impossible to develop complete operational definitions for theoretical constructs: unlike empirical terms such as errors, theoretical terms cannot be completely and explicitly defined. Insisting on operational definitions violates the hypothetical status of newly proposed theoretical constructs, and destroys the flexibility which is required for developing viable

theories and applying them to practical problems.

THE ORIGINS OF THEORY UNDER THE TWO EPISTEMOLOGIES

How do theories fitting the rationalist definition arise? The empirical epistemology seems divided on this (and the next) issue. One faction maintains that data come first and drive theories, which emerge spontaneously to explain a large enough body of data. Thus, Underwood (1957, p.186) argued that many areas of psychology lack theories because their stock of preliminary data fall below the critical mass required for theory construction. Neisser (1976, p.141-142) adds qualitative prerequisites to the critical mass, suggesting that theories of memory are premature "until we know more about memory in the natural contexts in which it develops". Another faction in the empirical epistemology has refused to postpone what they consider the first step toward theory construction: "miniature models" closely tied to specific experimental paradigms (e.g., the memory search paradigm). The ultimate goal is to integrate these paradigm-specific models into a single general theory, but so far these models have only proliferated rather than merged (see MacKay, in press).

The rational epistemology rejects the critical mass approach to theory construction on hypothetical, historical, and epistemological grounds. The hypothetical ground is that it is difficult to imagine how well-established scientific theories could have originated solely as a result of collecting more and more data, no matter how precise, extensive, or qualified these data are. Consider for example the observation that uranium is yellow whereas hydrogen is a colorless gas: It is difficult to imagine how specifying the conditions under which these observations hold or do not hold could lead in principle to the theoretical concepts that uranium atoms have about 238 electrons, whereas hydrogen atoms have only one. The historical ground is that these theoretical concepts did not originate in this way whatever it is imagined to be. In the actual history of science, theorists often develop highly successful theoretical constructs, such as atoms and sound waves, long before any experimental data whatsoever has accumulated (see Holland et al., 1986). The epistemological ground is that theories as defined under the rational epistemology cannot in principle originate by collecting more and more data. No observations, however extensive, can apply across all time, space, and hypothetical examples. Rationalist theories originate as products of creative cognition rather than situation-specific observation. This same epistemological objection also applies to the 'miniature model' approach to theory construction: Paradigm-specific models have not been converging into ever larger theories because this approach to theory construction cannot work in principle. Theories summarize a wide range of empirical generalizations: They don't directly describe events specific to particular experimental paradigms or situations.

FACTS AND THEORY REVISION UNDER THE TWO EPISTEMOLOGIES

Another faction within the empirical epistemology maintains that theories are revised or abandoned if and only if contradicted by experimental data (as per Hull), and interprets the failure of Hull's hypothetico-deductive program as justification for a stance which is

both antitheoretical and antiexperimental: According to Neisser (1985, p.272-3), both theories and theory testing have been tried and found wanting, and should be replaced, at least for the time being, by straightforward descriptions from everyday life. The rational epistemology questions this stance on two grounds. One is that neither a theoretical epistemology nor theories as defined under the rational epistemology have been tried or found wanting in psychology (see MacKay, in press). The other is that Hull's method is neither necessary nor usually sufficient for revision of genuine theories. Data of any kind are unnecessary and often insufficient for revising or abandoning rationalist theories, and experimental tests often play less of a role in actual revisions than factors such as elegance, internal consistency, and "making sense" (see MacKay, in press). Researchers working within an empirical epistemology often misunderstand this crucial point, as when Bruce (1985, p.86) complained that Neisser accepted echoic memory as a theoretical construct in 1967 and rejected it in 1983, both without empirical test.

CONCLUSION

The current metatheoretical debate in memory and psychology at large (see MacKay, in press) has been largely entrenched within the empirical epistemology. However, dissatisfaction with studies of memory as they apply to everyday problems is best directed toward developing a new epistemology and a new type of theory. As MacKay (in press) points out, developing this new epistemology to supplement and balance the old is also needed for solving many other problems in the field.

REFERENCES

- Bruce, D. (1985). 'The how and why of ecological memory', *Journal of Experimental Psychology: General*, 114(1), 78-90.
- Greenwald, A.G., Pratkanis, A.R., Leippe, M.R. and Baumgardner, M.H. (1986). 'Under what conditions does theory obstruct research progress?', *Psychological Review*, 93(2), 216-229.
- Holland, J.H., Holyoak, K.J., Nisbett, R.E. and Thagard, P.R. (1986). Induction: Processes of inference, learning, and discovery. MIT, Cambridge, Mass.
- Kuhn, T.S. (1977). 'A function for thought experiments', in Thinking: Readings in cognitive science, (Eds. P.N. Johnson-Laird and P. Wason), Cambridge University, Cambridge.
- MacKay, D.G. (in press). 'Under what conditions can theoretical psychology survive and prosper? Beyond Greenwald, Pratkanis, Leippe and Baumgardner (1986) and the empirical epistemology', *Psychological Review*.
- MacKay, D.G. (1987). The organization of perception and action: A theory for language and other cognitive skills. Springer-Verlag, New York.

Neisser, U. (1976). Cognition and Reality. Freeman, San Francisco.

Neisser, U. (1985). 'The role of theory in the ecological study of memory: Comment on Bruce', Journal of Experimental Psychology: General, 114(2), 272-276.

Tulving, E. (1979). 'Memory research: What kind of progress?', in Perspectives on memory research: Essays in honor of Upsala University's 500th Anniversary, (Ed. L.G. Nilsson), Erlbaum, Hillsdale, N.J.

Underwood, B.J. (1957). Psychological Research, Appleton-Century-Crofts, New York.