

Epsitemic Logic: from knowledge to Cognition

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The purpose of this lecture is

- to signal a broad trend toward a more dynamic logic of cognition
- to survey and compare various logical approaches to this effect
- to show how techniques from standard modal logic remain relevant.

Standard logic is mainly concerned with declarative propositions, and standard epistemic logic describes the various qualifications that may be attached to these: 'known', 'believed', 'doubted', and so on. But the essence of cognition consists just as much in the procedures by which we arrive at such attitudes or modify them, and hence the essence of epistemic logic lies also in the cognitive procedures that we live by (such as strategies of argumentation, learning or testing). In recent years, an emphasis on cognitive procedures rather than mere knowledge representation has become a prominent theme across philosophy, linguistics, computer science and AI. Moreover, there has been a tendency to locate such concerns, not just 'on the outside', in the stories that we tell about the supposed working or the proposed implementation of some logical system, but rather 'inside' the very design of logical systems themselves, where static declarative propositions and various procedures connected with these should live on a par. Such a joint emphasis has a long philosophical and logical tradition, witness 'language games' in the philosophy of language or 'operational views' in the philosophy of science, and we shall trace it even further back.

What kind of logical structure can be used to bring out this intrinsic cognitive dynamics? There are at least three possible routes available in the logical literature, that will each be considered in their turn:

- *dynamic logics
- *constructive logics and type theory
- *logical game theories.

These three approaches will be compared in the end, both technically and as to their possible applications.

First, we present a dynamic logic extending standard epistemic systems which has at least the scope of most current theories of belief revision, showing how it generates a systematic theory of updating, contraction and revision from first principles. Its basic statements are of the familiar modal form $\langle p \rangle A$ (action p achieves effect A). Moreover, we analyze some new emergent phenomena, such as the issue which notions of ‘valid inference’ and which ‘logical constants’ are appropriate to the new cognitive setting. After all, the design of standard declarative logic need no longer be optimal here (and in fact, it is not).

Next, we analyze intuitionistic logic, itself a long-standing rival to modal epistemic logic, whose ‘constructive’ character has always had a cognitive slant, with more general pretensions in the theory of linguistic meaning. The preferred dynamic co-existence here has employed the notion of ‘proofs as algorithms’, which is brought out conveniently by type assignment statements $p : A$ (procedure p achieves effect A). We show how this format too, can be employed as a general theory of cognitive action, looking at the earlier issues from a more proof-theoretic perspective.

Third, the game theory is introduced here merely as a ‘dark horse’ for a side bet, which might become a winner at some later stage, as it involves some genuine intuitions about cognition that seem *sui generis*.

We conclude with a general comparison with more ‘standard’ epistemic logic, pointing out what happens to its concerns (including ‘omniscience’ and ‘common knowledge’) in this setting of cognitive activity, and how its technical apparatus, based on the model theory of Modal Logic, generalizes to the new setting.