Commentary/Newell: Unified theories of cognition

Newell's treatment of language emphasizes a number of key features, including the importance of symbol processing in cognition, the role of language in shaping human thought, and the need to develop a comprehensive theory of cognition that can account for the diverse range of cognitive processes. Newell's theory is rich in detail and draws on a wide range of empirical evidence from various cognitive domains. However, the acceptance of Newell's ideas has been somewhat limited, partly due to the complexity of the theories and the lack of a clear-cut empirical base.

The book by Newell is not an easy read, and it is evident that the author has attempted to deal with the troublesome details of language learning, comprehension, and production. However, the book has not been very successful in providing a unified theory of cognition that can account for the diverse range of cognitive processes. Newell's theory is rich in detail and draws on a wide range of empirical evidence from various cognitive domains. However, the acceptance of Newell's ideas has been somewhat limited, partly due to the complexity of the theories and the lack of a clear-cut empirical base.

This brings me to a final point that is an outgrowth of reflection on the relation between connectionism and SOAR. Central to connectionism is the fundamental role of probabilistic considerations in all animal and human learning and performance. Except for the simplest sorts of highly structured tasks, probabilistic considerations enter at every level, in uncertainty faced in perception, in uncertainty faced in planning, in uncertainty faced in task execution, and in uncertainty faced in learning and change. In working in the framework of computer programs, as is the case with SOAR, it is very tempting to leave too little room for these pervasive probabilistic features of both the world we live in and our methods for dealing with them. Certainly Newell mentions such probabilistic aspects of SOAR's performance here and there but SOAR does not have a central place for the probabilistic features that are so pervasive in the world and in actual behavior. In particular, the fairly lengthy discussion of preferences and decision procedures (pp. 170–74 and elsewhere) takes surprisingly little notice of the large literature on probabilistic theories of decision making in psychology, which are so naturally congenial to connectionists. The brief mention on pp. 435–36 is written as if pertinent to psychologists of the concepts of subjective probability and uncertainty issued mainly from experiments of relatively limited interest on "choices among abstract gambles" (p. 436). To paraphrase Svengali (as played by John Barrymore), in the bright lexicon of Newell's theory of cognition there is no such word as Bayes.

Unified theories and theories that mimic each other's predictions

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First, the well-deserved paeans of praise; this book represents an important advance because: (1) Attempts at unified theories are so rare in cognitive science. (2) It collates and draws relationships among a diverse, if far from exhaustive, set of empirical phenomena. (3) Bearing the personal stamp of the author, it aids the reader in attaining a global perspective on the empirical phenomena and at least a glimpse of some alternative theoretical approaches. (4) It is quite clearly and elegantly written.

Now for the disagreements. First, I make a few comments about unified theories in general, and then devote most of my space to a topic that may receive less attention from other reviewers. This topic concerns model and theory testability in light of the ability of many models based on opposing psychological principles to mimic one another's predictions.

Yes, we need more unified theories in cognition, but not many more. I suspect that although the "regularities" selected by Newell are impressive, ten different theorists would make ten lists with little significant overlap. Whether noncoincidence of empirical reference would greatly affect the resultant unification is not at all clear presently. The unified theory would also probably vary significantly depending on whether it was mostly verbal (still the prime mode in psychology), adhered to the production system approach (Newell 1973c), adopted the in-vogue connectionistic strategy, attempted closed form mathematical modeling, and so on. How are such theories to be compared? What if they describe the same data sets just about equally well? Newell does not see the merit in investigations of model identification (pp. 21, 244; more on this topic below).

In addition, countries where the history of the behavioral sciences has not facilitated the growth of a strong empirical base or where lack of funding has encouraged an imbalance of "grand
Commentary/Newell: Unified theories of cognition

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The concept of a unified theory of cognition is as attractive as it can possibly be. Having lived through generations of microtheories that rose or fell on the basis of a single experiment or narrowly defined experimental paradigm, it is refreshing to read such an eloquent, ingenious, clear, powerful, and even elegant speculative exposition of a different point of view by Allen Newell. There is no question that this is a master work of one we can happily claim as a cognitive psychologist. As one of the authors of another integrated model (Uttal et al. 1992), I applaud Newell's goals and admire his accomplishments with the SOAR system. However, it seems to me that while Newell has provided some signposts and goals, he has not yet achieved the general goal of a truly unified theory of cognition that he so effectively champions.

Since the integrated model my colleagues and I have developed is a perceptual-motor one and not a cognitive one in the sense that Newell uses the terms, I am not going to consider the specific details of the SOAR model. Rather, I will concentrate my comments on the general properties of models of this sort and on what models may mean.

First, let us deal with one of the major limitations of Newell's work. To achieve his impressive level of accomplishment, he had to circumscribe that which he considers to be cognition as tightly as any other theorist who has the presumption to attempt something of this sort. Newell appreciates that his model does not deal with perceptual and motor systems; we appreciate that