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Theory Psychology 2007; 17; 243
DOI: 10.1177/0959354307075045

The online version of this article can be found at:
http://tap.sagepub.com/cgi/content/abstract/17/2/243

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Dissenters in the Sanctuary

Evolving Frameworks in 'Mainstream' Cognitive Science

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Abstract. Critiques of cognitive psychology and cognitive science principally target cognitiv*ism*, defined here as doctrinal commitment to computational processing over internal representations as a model of human intelligence. This paper reviews the principal points of critique, but argues that some prominent efforts within cognitive science currently exhibit conceptual and methodological broadening, to the point of revision or rejection of the core assumptions of cognitivism. Three such efforts are highlighted: Hutchins' distributed cognitive framework, Nersessian and Newstetter's ethnographic and historical analysis of innovation in engineering laboratories, and Tomasello's account of cultural evolution in relation to cognitive achievement. The paper claims that such research efforts and the philosophical frameworks that support them offer unrealized opportunities for enhanced dialogue and participation with cognitive science for psychologists critical of cognitivism. Conceptual and methodological advantages of critical engagement are acknowledged, with focus on the problems of innovation and cognitive failure in science.

Key Words: cognition, cognitive psychology, cognitive science, cognitivism, distributed cognition

Cognitive Psychology, Cognitive Science and Theoretical Psychology

Cognitive psychology properly comprises not merely a research specialization so much as a framework that spans most traditional domains of psychological

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DOI: 10.1177/0959354307075045 www.sagepublications.com

inquiry. Its scope is tremendous, to the point of its tenets being nearly indistinguishable from the operative terms that define 'mainstream psychology' itself, especially as currently blended with neuroscience:

> Cognitive psychology *involves the total range of psychological processes*—from sensation to perception, neuroscience, pattern recognition, attention, consciousness, learning, memory, concept formation, thinking, imaging, remembering, language, intelligence, emotions, and developmental processes—and cuts across all the diverse fields of behavior. (Solso, 2001, p. 2, italics added)

The application of a cognitive framework to even traditionally disparate areas of psychological inquiry (e.g. pattern recognition and psychotherapy) affords an historical view of cognitive psychology as hugely 'successful' in its aims and accomplishments: the most mainstream of the psychological mainstream.

The history of cognition's rise to dominance as a framework is well known, including the narrative of 'revolution' by means of which psychology found rescue from an arid obsession with behavior (e.g. Baars, 1986) and the convenient appropriation of the computation metaphor as computer technology enjoyed explosive post-war advance (e.g. Newell, Shaw, & Simon, 1958). Within this historical context and conceptually, cognitive psychology is linked to the broader, empirical and computational research of cognitive science. The former has garnered legitimacy and has been enriched by the intellectual clout and less disciplinarily-bound empirical research of cognitive science, particularly in an age of technology-adulation**.** For its part**,** the success of cognitive science as a field of empirical inquiry can be credited to many things, including the insights of early pioneers such as Turing and the remarkable achievements in early 20th-century mathematics and logic associated with Whitehead, Russell and Frege (see Newell & Simon, 1976).

There are more cynical readings of the progressive appropriation of psychology by the views of cognitive science. A less generous evaluation of its history interprets cognitive psychology as having piggy-backed on a rather dubious relation between computer technology and military advantage, and having more recently exploited the symbolic and practical privilege of computer ownership and literacy (Bowers, 1990; Galison, 1994). Computers have become so seemingly necessary to our ways of being that it seems natural to regard our own functions as parallel to and intertwined with those of computer processes. But the field's embeddedness in robust cultural moorings is not sufficient to account for what we regard as cognitive psychology's expansive confiscation of psychological domains. Other factors render cognitive psychology the disciplinary 'hit' that it appears to be. Quite apart from its formidable empirical successes, illusive idols of the theater (Bacon, 1620/1952) appear to be at play (see Tissaw & Osbeck, 2007, this issue). That is, cognitive psychology as an enterprise, institutionalized as pivotal to all subject areas in psychology, is enabled by entrenched, rarely questioned assumptions. Both

proponents (e.g. Fodor, 1980/1981) and critics (e.g. Still & Costall, 1987; Palmer, 1987) refer to *doctrine* as a basis for theory construction, the points of which are twofold:

> ... the representational theory of mind, according to which propositional attitudes are relations that organisms bear to mental representations, and the computational theory of mind, according to which mental processes have access only to formal (nonsemantic) properties of the mental representations over which they are defined. (Fodor, 1980/1981, p. 307)[1]

More ploddingly, the assumption spreading from classical cognitive science to information-processing frameworks across psychology is that the fundamental operations of mind are *computational*, and that its computations take place over *representations* of various kinds and modalities.

Doctrines easily beget *isms*, collective efforts that risk rigidity and dogma as convictions solidify and influence spreads. Fodor's faith is not uncharacteristic, for example, when he asserts that 'there aren't any alternatives which seem to be even remotely plausible' (p. 309). As early as the 1970s, cautionary notes began to sound concerning what was becoming *cognitivism*. Dreyfus (1972) and Haugeland (1978/1998) are among the first to label and critically reflect upon both the achievements and limitations of the position that 'intelligent behavior can (only) be explained by appeal to internal "cognitive processes"' (Haugeland, 1978/1998, p. 9). Cognitiv*ism* remains a kind of short-hand for a strong commitment to internal or mental representation and computation as explanatory, particularly in the hands of critics (e.g, Edwards, 1997; Potter, 2000).

We shall return to the doctrinal strong points forthwith, and also to the substance of some prominent lines of its critique. The aim of this paper, however, is to suggest that several developments within cognitive science and cognitive psychology—respected, influential, even 'mainstream' developments—demonstrate significant, non-trivial conceptual distancing from cognitiv*ism* as a set of grounding assumptions, and from the taking for granted of internal representation and processing as primary. It is just this distancing, we claim, that offers opportunities for theoretical psychologists to 'engage the mainstream' more meaningfully and fruitfully. For it is not simply that such well-known cognitive theorists as Andy Clark (1998, 1999, 2003) or George Lakoff (1987) draw on Merleau-Ponty with varying degrees of verisimilitude (see Crooks, 2003), or that the cultural anthropologist Jean Lave (1988; Lave & Wegner, 1991) combines an interest in cognition with an interest in Vygotsky. Rather, we wish to turn attention to the empirical innovation and broadening philosophical horizons of mainstream cognitive science so that its theoretical and methodological sophistication might serve as a resource for theoretical psychology. We contend that it is not only possible but important to seek this engagement for the sake of developing clear and sophisticated frameworks and innovative methodologies on either side. Such dialogue can

only foster efforts to conceptualize specific problems that remain elusive within theoretical psychology *and* cognitive studies: for example, the role and nature of representation and the relative effects of sociality and cognition in the production of knowledge.[2]

Cognitivism and Its Critics

Before considering the specific possibilities for enhanced engagement, it is first important to be clear about why the very suggestion of such engagement might be controversial and unpopular. A critical philosophical response has run parallel to developments in artificial intelligence and cognitive science from at least the 1960s (e.g. Anderson, 1964), as have critiques from far corners of theoretical psychology. Indeed, responses have arisen from within and without the field of cognitive science. Here we assay a range of these critical responses, drawing from both insiders and interlopers, in order to explicate precisely how some efforts in cognitive science attempt to circumvent the very problems we identify. We intend this section principally as review and context, and recognize that much of what we discuss here will be familiar to many readers.

First, in addition to quite expected charges of homunculus fallacy (i.e. inner manipulations of knowledge tokens constitute homunculi; see, e.g., Kenny, 1990) and the related, age-old problems of parsimony and infinite regress (i.e. homunculi are invoked to explain homunculi, even if these are construed as functional sub-systems, i.e. homuncular functionalism), one set of critiques has centered on the question of whether artificial intelligence systems are functionally distinguishable from human intelligence systems, that is, whether computers are human-like systems. Haugeland's (1981) 'Semantic Engines' paper, for example, summarizes 'two quite different strategies for arguing that cognitive science is basically misconceived' launched by the wider philosophical community in response to advancements in artificial intelligence (pp. 31–32). The 'hollow shell strategy' is to argue that 'no matter how well a (mere) semantic engine (an AI system) acts *as if* it understands, etc., it can't really understand anything, because it isn't (or hasn't got) "X" (for some "X")' (p. 32), with candidates for 'X' including consciousness (most obviously), intentionality and emotional investment. In each case, Haugeland notes, we are in need of some further criterion or test for 'what it is to have the inner quality' if we want to claim that a system which acts *as if* conscious, intentional or caring is not *really* so. The 'poor substitute' strategy, in contrast, is to argue that semantic engines 'will never even *seem* to have the full range of common sense and values of people' (p. 34). Until a computer can write a play or compose a symphony, artificial intelligence remains essentially distinct from human intelligence. This has been a standard line of criticism among the humanistically inclined, and the questions it embeds have been

fodder for an array of popular cultural explorations in films, science fiction novels and other productions. Film targets, for example, run the gamut from the 'electronic brain' of *Desk Set* (Ephron & Lang, 1957) to the feeling child-android of *Artificial Intelligence: AI* (Spielberg, 2001).

Of course, the terms of metaphor are mutually informative (Hesse, 1966); for some psychologists, the focus of critique has been the assumption not that computers are human but that humans are computers. Thus another set of criticisms may be traced to the efforts to import the 'computations over representations' model that is core to artificial intelligence into an all-encompassing framework for understanding human functioning, whereby the nervous system is conceived as an information processor (e.g. Fodor, 1968). There is a tendency among critics to consider this conceptual move part and parcel of the so-called 'cognitive revolution': the widely accepted notion of a paradigm shift in the mid-20th century when behavioral explanations proved inadequate to the flood of empirical evidence in perception, attention, memory, language acquisition and other phenomena. However, writing in the mid-1980s, Baars (1986) points out that 'as a full-fledged realization this idea [that the computation metaphor is appropriate for the human nervous system] is rather recent in cognitive psychology' (p. 148). Not surprisingly, then, it is in the 1980s and into the early 1990s that one begins to see trenchant and focused criticisms of cognitive psychology from the standpoint of ecological psychology (Still & Costall, 1987), phenomenological psychology (e.g. Aanstoos, 1987; Giorgi, 1989; Wertz, 1987, 1993), discursive psychology (e.g. Edwards, 1991; Harré & Gillett, 1994), and social constructionism and critical psychology (Hofmeister, 2001; Walkerdine, 1998). Indeed, it would seem that positioning against the information-processing model and its methods has helped in each case to solidify and refine the movements into recognized theoretical alternatives to mainstream psychological theory, notwithstanding behaviorism's position as foil *sine qua non*.

Despite differences among these alternative frameworks, points of critique of cognitivism overlap substantially and might be summarized rather succinctly. Among the most basic—and voiced most strongly, perhaps, by advocates of a turn to phenomenology—is that cognitivist accounts reduce the mysteries of human functioning and flourishing to mechanical rules for processing elemental information units. Aanstoos (1987), for example, describes the information-processing view of thinking as 'a series of elementary or primitive processes, combined serially according to explicit, pre-determined rules, each process of which is a formally definite operation for the manipulation of information in the form of elemental and discrete symbols' (p. 81). His suggestion that conceptual problems might be overcome by consulting Merleau-Ponty carries an assessment that what is missing from traditional cognitive accounts are holistic approaches attuned to the givens of immediate experience. Such approaches would be grounded in 'a specialized and original form of presence' (p. 192), prioritizing 'human involvement as

primordially presentational' (contrasting with representational). Rationality emerges from this relational being-in-the-world (pp. 192–193). At stake, or neglected, then, by cognitivist accounts is 'this basic engagement of person and world' (p. 193), one that positions person and world as inextricable facets of a whole. Intentionality and perspectivity, fundamental as these are to pure being, thus fall from consideration in traditional cognitive explanation as a matter of course.

Critiques drawn from ecological and pragmatist traditions ('mutualist' perspectives; e.g. Reed, 1987, 1991; Still & Good, 1992, 1998) similarly bemoan the lack of interactive engagement of world and organism in cognitivist accounts and acknowledge the essential passivity assumed of the perceiver as one 'receives' impressions from the world and draws inferences from them (see also Good, 2007, this issue). Representation and inference are mediating steps erecting a barrier or disconnection between perceiver and world. The barrier, in turn, promotes a dualistic framework which locates knowledge 'in the head', thus offering little ontological advancement over the Enlightenment *episteme.* In formal symbol systems models of human intelligence, representations perform a mediating and disconnecting role not only in perception but also in learning and knowledge acquisition. In discursive accounts the mediating function of representations and the resultant passivity of cognitive activity are similarly problematic: 'They [psychologists] have overwhelmingly failed to attend to the way practices are oriented to action, are situated and co-constructed in stretches of intention, are given sense through the categories and formulations of participants' (Potter, 2000, p. 32).

Knowledge 'in the head' and the self-containedness of symbol-processing systems are closely related notions: 'A GOFAI [Good Old Fashioned Artificial Intelligence] system has an inner playing field on which inner tokens are arranged and manipulated by one or more inner players under the supervision of an inner referee' (Haugeland, 1985, p. 117). The 'self-contained' nature of the processor requires an individualistic framework, even by definition. 'Any interest in something culturally realized—in written texts and social practices, in academic disciplines, in science, myth, or common sense—is quickly referred to individual understandings' (Edwards, 1997, p. 27).

> The 'outside world' (anything not included in the current position) is strictly irrelevant. For instance, it makes no difference to a chess game, as such, if the chess set is stolen property or if the building is on fire of if the fate of nations hangs on the outcomes—the same moves are legal in the same positions, period. ... A crucial consequence of formal self-containedness is the irrelevance of meaning. (Haugeland, 1985, p. 50)

The abstract nature of formal symbol systems invites another important criticism when employed as a model of human intelligence, namely the construal of intelligence as disembodied, indifferent to and unaffected by the material composition of the processing system. One problem is that emotions

become merely symbol systems that interact with cognitive processing; they are eviscerated as merely another input to be codified, with little attention to their specific material effects in cognition.

The disembodiment of formal symbol systems was recognized as problematic *within* the field of cognitive science, particularly as it began to interface more directly with the developing field of neuroscience. The latter made clear that a sequential processing model is not an adequate depiction of the web-like structures of neural processing. Indeed, alternative frameworks in cognitive science, most notably connectionism, arose to more adequately account for the complex organization of neural networks, with representation now understood in terms of connection strength between units rather than the units themselves (e.g. McClelland, Rumelhart, & Hinton, 1986). The computer is no longer the core metaphor (but, rather, the brain) and serial processing is replaced by the coordinated processing of a parallel distributed network (Rumelhart, Hinton, & McClelland, 1986). Connectionism, then, is an attempt to counter some problems of cognitivism by offering an embodied model of cognition (albeit an incomplete, merely brain-like embodiment). Yet, although connectionism answers the charge of disembodiment and formalism, it leaves other critiques without answer. Connectionism's representational space is still a self-contained space; representations remain *internal* representations sustaining, indeed requiring, explanation at the level of the individual processor.

Collectively, these charges of mechanism, dualism, passivity, disembodiment, individualism and isolation from context have done much to raise awareness of the shortcomings of cognitivism as a psychological paradigm. The charges are bolstered by related critiques of the methodologies invited or required by cognitivist models. Valisner (1991) argues, for example, that cognitive psychology has 'merely reorganized the "scientifically acceptable" language use norms in psychology without a corresponding change in their theoretical rigor or methodological innovation in the discipline' (p. 481). As with behaviorism, a recurring theme among methodological critiques has been the artificiality of a methodological focus on abstracted units of thought observed under controlled laboratory conditions, as though these bear any resemblance to the kinds of things people do from day to day, or do together, or experience as meaningful. Currently, a number of disciplinary approaches within cognitive research have turned to practice; more specifically dialectically constituted, situated activity (Lave, 1988, p. 175), very often among 'just plain folks' engaged in everyday activity. Thus 'person-acting arenas and settings appear to be implicated together in the very constitution of activity' (p. 170). Indeed, Lave argues that 'the conception of situation as separate from, and only arbitrarily related to activity might be better transformed into a concept of dialectially constituted, situated activity' (p. 175).

This brief summary of some of the problems identified with the cognitivist framework makes evident that it is the *individualist* and *formalist* aspects that

have received the most attention from critics and that have inspired the most fervent turns to alternative frameworks and methodologies.

Babies and Baths

Yet, dare we say, critiques of cognitive science perhaps have been too successful in some circles. They have effected a view of research in cognition as an enterprise in which the most narrow of definitions and methodologies are regnant. Well-founded criticisms of the individualistic, internal, formal and representational model that define archetypal cognitive psychology tempt whole-scale rejection of cognition as a field of research. Consider the (in)frequency with which cognitive psychology's traditional foci—the complex activities of thinking, reasoning, problem solving, imagining, decision making and remembering—are taken up seriously and explicitly within the regular circles of theoretical and philosophical psychology.[3] But there is of course a long recognized and crucial distinction between

> … cognitivism as a field of research (i.e. the psychology of cognition) and cognitivism as a dogma: the presumption that all psychological explanation must be framed in terms of internal mental representations (or rules) by which these representations are manipulated and transformed. (Still & Costall, 1987, p. 2)

Still and Costall make clear that it is this *dogma* that they call into question in the 1987 volume and against which they later position themselves against in *Against Cognitivism* (1991). Still and Costall also claim that many other theorists have insisted upon this distinction, naming Atherton (1978), de Gelder (1985), Lundh (1982) and Monk (1978) and as examples. Similarly, Wertz (1987) demarcates the broader cognitive psychology that includes 'such diverse theorists as Piaget, Chomsky, Bruner, Bandura, and Schacter' from the 'more narrowly homogenous group of psychologists who utilize cybernetic, information processing models' (p. 104). Indeed, Dewey, James, McDougall, Bartlett, Brunswik, the Gestalt theorists and most psychoanalysts might be added to the list of those who, in their different ways, focused centrally on such topics as problem solving, consciousness, judgment, memory and perception. They are cognitive researchers in the broad sense, though hardly cognitivist doctrinaires.[4] With different emphasis, Edwards (1997) calls cognitivism 'both more and less than the study of cognition' (p. 27). The aspect that is 'more' is the extension to the whole range of traditional psychological topics, as noted above, and the treatment of 'knowledge-based processes (or even a particular, information processing version of them) as primary, the foundation of all the rest' (p. 27). It is 'less' in its principal focus on the programming and content (the rules and representations) of the individual mind.

Yet the shadow of the internal representation dogma has been cast onto cognitive science as a whole, whereby the distinction between cognitivism and cognitive research becomes easily blurred. The conflation appears to have convinced many theoretical/critical psychologists that explicit analysis of traditional cognitive categories (at least outside of Vygotskian and related frameworks) is irrelevant to any socially grounded analysis. The estrangement has fostered unproductive binaries. Helen Longino (2002), for example, describes an entrenched cognitive–social divide evident in science studies: that is, the tendency to regard cognitive (rational) explanations of science process as in dichotomous relationship with sociocultural accounts (see also Nersessian, 2005). Despite the increasing preoccupation of social and cognitive psychologists (especially in the US) with 'social cognition' (which retains the individualist framework, framing social knowledge in terms of internal representations of others), this is a problem of which psychology's mainstream and theoretical divide is equally symptomatic (see, e.g., Misra & Gergen, 1993; Stetsenko & Arievitch, 2004). The situation is unfortunate, not least because there remains something deeply interesting and important about problem solving and thinking that cannot be captured easily by discursive frameworks, interesting and important as these are in themselves.

More to the central point at hand, a prominent faction of cognitive science recently has broadened its disciplinary boundaries in the directions of sociology, phemenology and anthropology, challenged its core assumptions and models, and explored new methodologies. Thus some new approaches and reflections within the field of cognitive science depart radically from the GOFAI that incited the critiques reviewed above. Debates internal to cognitive science and which typically retain its core categories, even as they broaden its conceptual and methodological base, have generated creative solutions to some of its disciplinary impasses. In short, much of cognitive science no longer embraces cognitivism.

Cognition, Not Cognitivism

Although many examples of the foregoing claim could be given here, for the purposes of this paper we highlight three that serve to illustrate that there is more theoretical overlap with alternative psychologies, more concerted effort to rethink ontologies, and more interesting methodologies than might be acknowledged by cognitive psychology's critics.

Hutchins: Cognition in the Wild

Trained as a cultural anthropologist, Edwin Hutchins was a pioneer in cognitive anthropology, a field oriented around the question of what representations an individual needs to acquire (hence the person needs to know) in order to

function competently as a member of a culture. As a field, cognitive anthropology was caught up in and a contributor to the cognitive revolution. But Hutchins (1995a) found cognitive anthropology's focus on knowledge acquisition rather than skill or practice and its consequent individual focus to be 'a burden' (p. xiii) and obstruction in the effort to understand human cognition. Thus he and his research group, though firmly ensconced in a cognitive science department (University of California San Diego), have moved increasingly toward the goal of understanding 'naturally situated cognition' (p. xii) in everyday, real-world problem-solving capacities, understood as local communities of practice. Practice communities include the navigation bridge of a working Navy ship (Hutchins, 1995a), the cockpit of a commercial airline (Hutchins, 1995b) and, more recently, science research laboratories. Alač and Hutchins (2004), for example, detail efforts to understand the process of interpreting brain images in an fMRI laboratory, an activity grounded in visual experience but requiring fine-grained coordination between scientists to render the images meaningful. In each case, the goal is to understand how the whole community in question functions cooperatively in the effective performance of a complex practice. The ostensive goal is to understand cultural and cognitive processes as not only interrelated but also *co-constitutive*, afforded and constrained by the social and physical features in which problem solving and learning take place.

Hutchins and his associates ground these projects in an understanding of cognition as *distributed* across a landscape of human actors, communications and inscriptions, the practice traditions situating the activities performed, and the material culture of instruments, artifacts and devices used in the creation and dissemination of meaning as specific to each context. Explaining the title of his 1995 *Cognition in the Wild,* Hutchins (1995b) notes:

> The phrase 'cognition in the wild' refers to human cognition in its natural habitat—that is, to naturally occurring culturally constituted human activity. I do not intend 'cognition in the wild' to be read as similar to Lévi-Strauss's 'pensée sauvage,' nor do I intend it to contrast with Jack Goody's (1977) notion of domesticated mind. Instead, I have in mind the distinction between the laboratory, where cognition is studied in captivity, and the everyday world, where human cognition adapts to its natural surroundings. I hope to evoke with this metaphor a sense of an ecology of thinking in which human cognition interacts with an environment rich in organizing resources. (pp. xiii–xiv)

The unit of analysis in *Cognition in the Wild* is the whole navigation system of a functioning Navy vessel as it makes its way on a complicated voyage. Using comprehensive ethnographic analysis, Hutchins thus unpacks the fundamental question rooting the practice of navigation ('where am I?'), the social hierarchy of classes, ranks and ratings arranging crew members (e.g. officer and enlisted), their negotiated roles and identities, the physical properties of the ship and the surface on which it moves (the sea), the function of each instrument and device used in navigation, and the nature of the

representations produced, community inscriptions (charts, maps and manuals), the specific tasks performed, the schema of communication and the parameters of training for tasks. The analysis then leads to an explication of, for example, the 'social formation of competence in navigation' (p. 279) and the evolution of the context 'as partial solutions to frequently encountered problems are crystallized and saved in the material and conceptual tools of the trade and in the social organization of the work' (p. 374).

If this project and this understanding of cognition sound like a departure from traditional cognitive science, specifically artificial intelligence, this is intentional. Hutchins describes his account of problem solving as based upon a 'broader sense of computation' than the traditional sense, namely the view of problem solving as applying a sequence of internal rules for re-representing the problem so that its solution becomes transparent (e.g. Simon, 1981). Indeed, Hutchins' historical reading of the cognitive revolution itself is a departure from the received view in which the information-processing view of human functioning is rooted. Hutchins (1995b) argues that what Turing originally modeled and what was expressed in the formal symbol system hypothesis was not, as assumed, the functioning of an individual mind. It was, rather, the *socio-cultural system* in which the functioning is embedded. Indeed, the grand failure of cognitive science, the source of so many of its deep and abiding problems, is rooted in this conflation:

> Having failed to notice that the central metaphor of the physical-symbol-system hypothesis captured the properties of a socio-cultural system rather than those of the individual mind, AI and information-processing psychology proposed some radical conceptual surgery for the modeled human. The brain was removed and replaced with a computer. The surgery was a success. However, there was an unintended side effect: the hands, the eyes, the ears, the nose, the mouth, and the emotions all fell away when the brain was replaced by a computer... the definition of cognition has been unhooked from interaction with the world. (p. 363)

Hutchins' work represents an explicit conceptual and methodological distancing from GOFAI and may be read as a concerted effort to dissolve boundaries between individual, social and technological realms. As such, it bears much in common with projects supported by constructionist, phenomenological and ecological agendas, and their numerous philosophical and psychological precedents (e.g. Gergen, 2000; Harré & Gillett, 1994; Segall, Campbell, & Herskovitz, 1966; Vico, 1709/1965; Vygotsky, 1930/1978; Wittgenstein, 1953). But over a decade after its publication, *Cognition in the Wild* has yet to figure into theoretical psychology's prominent discourse in any serious way.

Nersessian and Newstetter: Distributed Innovation in the Laboratory

Nancy Nersessian, a philosopher of science, has been pioneering in the cognitive study of science and technology. Her earlier work, which examined the model-based reasoning practices of historical scientists in periods of conceptual

change, made evident the social, cultural and material situatedness of these cognitive practices (Nersessian, 1984, 1992, 2002). With Wendy Newstetter, an ethnographer and linguist by training, she is now examining innovative cognitive and learning practices in interdisciplinary university research laboratories. They draw on research that theorizes cognition in relation to culture, what Nersessian (2005) calls 'environmental perspectives', including that of Hutchins, to frame the laboratories as cognitive-cultural systems at the outset. They have assembled a multi-disciplinary research group to carry out the interpretive analysis.

The problem-solving activities in the laboratories are analyzed as *situated* in localized interactions among humans and among humans and artifacts, and as *distributed* across systems of humans and artifacts. Nersessian and colleagues broaden the understanding of cognition as distributed to include not only contexts in which successful performance of a routine task is achieved, but also contexts in which the problems to be solved and the technology developed are constantly evolving and the range of applications is open. Nersessian and Newstetter attempt to understand scientific innovation using frameworks that establish individual contributions as embedded in context, context that is both social and artifactual. They investigate communities whose goal is to develop cutting-edge applications and ideas at the frontier of knowledge in interdisciplinary settings, often when few existing precedents and guidelines are available. Communities investigated include a tissue-engineering laboratory that develops artificial blood vessels, a neuro-engineering laboratory studying learning in dishes of cultured neurons through giving them 'bodies' in computational worlds or mechanical devices, and a bio-robotics laboratory exploring emergent intelligent behavior. Each laboratory is construed not only as a physical context of instruments and devices, but also as an organized interdisciplinary social group of practitioners with both shared and individual commitments (Nersessian, Kurz-Milcke, Newstetter, & Davies, 2004). Thus the problem-solving agenda of each is evolving, dynamically influenced by the ongoing framing, formulation, accomplishments and insights of all members of the laboratory community. Moreover, each laboratory is viewed as embedded within a history and in a set of conceptual and practice relationships to the wider field and its traditions (Kurz-Milke, Nersessian, & Newstetter, 2004). The interdisciplinary nature of each laboratory community contributes to a distribution of expertise, creating the need to seek help and construct informal social networks by which to obtain it.

Nersessian and Newstetter's group uses a mixed methodology of ethnographic research and cognitive-historical analysis (using historical records to interpret cognitive practices; e.g. Nersessian, 1984, 1992, 2002; Tweney, 1985) to interpret cognitive and interactional practices ('cognitive-cultural practices') in the laboratories ('cognitive-cultural systems'). Interviews with researchers, from novice student participants to principal investigators, are combined with observations of research 'on the benchtop', guided tours of the

laboratory, recordings of journal club and research group meetings, and examination of notebooks, diagrams, 'cheat-sheets' and computer representations. Nersessian's particular focus is on reasoning *through* interlocking models, mental and physical, understood as a practice in which models that synthesize interdisciplinary understanding are constructed, used and modified in the practices of researchers. Analysis includes consideration of the situation of these models in various disciplinary traditions and in the local history of the laboratory in question. The concept of 'model' used in Nersessian's investigations thus differs substantially from that of the mental modeling framework of traditional cognitive science (e.g. Craik, 1943; Johnson-Laird, 1983) precisely because 'model' is understood not as an internal representation but, rather, as one that requires the cooperative participation of the material and artifactual environment within which the science practice is situated. Dynamic interlocking model systems serve to define the problem space and facilitate communication by abstracting and organizing the information provided in different representational formats and communicative acts. Nersessian's research group labels such cooperative practices 'cognitive partnering' (Newstetter, Kurz-Milcke, & Nersessian, 2004; Osbeck & Nersessian, 2006). This research is leading both to an integrative understanding of research practices in science and engineering and to the development of problem-based learning environments in instructional settings that are modeled on effective practices in the research settings.

Tomasello and the Cognitive–Social Divide

Michael Tomasello's prodigious empirical research and innovative contributions to fields as diverse as child development, language acquisition, cognitive science, primate research and culture and cognition could be used to further a number of the general tenets of this essay. His work serves as an exemplar of how cognitive science no longer is confined to representational, computational, 'inside the skull' and individualistic interpretations of human thought (see especially Tomasello, 1999, 2003; Tomasello, Carpenter, & Call, 2005). In particular, his conception of the relation between culture and cognition is theoretically subtle and builds on findings in language acquisition and child development.

As regards the general aims of his work, Tomasello argues that researchers in psycholinguistics should be more interested in the findings and methods of cognitive science. Ironically, against key criticisms of cognitive science noted earlier, Tomasello urges the move toward cognitive science precisely because it is more wholistic, contextual and social than many traditional approaches to language acquisition. Questioning the psycholinguist's penchant for focus on the structure of language alone, either in terms of its properties as a representational system (including some PDP approaches) or in terms of its grammatical and formal properties, Tomasello advocates an examination of language acquisition as a social and pragmatic activity, operating in simultaneity with

other cognitive abilities and environmental affordances, including the presence of other speaking beings. Drawing on his research and that of colleagues, Tomassello aims to refute the nativist approach to language with its emphasis on syntactical formations and formal constraints.

Tomasello tackles the question of grammar by arguing that humans' language skills are ratcheted to a new level through the fact that they must not only describe and manipulate objects or imitate another speaker, but must also aim to refer to perspectives and intentions of others as these are evinced through language. Grammar organizes position, which situates the speaker in relation to his or her intentions and events but also to the intentions to which one is referring the sentence. Organizing words, narratives and sentences refer to a world but also to virtual points created by the various perspectives and the ensuing interactions of those speaking. Speaking thus refers to the intentions of others as well as objects of the world and/or their representations. In fact, Tomasello is quite fascinated with a meta-level of intentions, the empirical basis of which he demonstrates but which cannot be iterated here. Speaking develops so that it refers not only to *my* intentions as speaker or to *yours* as listener, but also to what I understand as your intentions towards my intentions: there is the ephemeral slice of intersubjective intentions that allow for and enrich any cognitive act, giving it another horizon or referent, that is, meaning that circulates through another's intention. 'The understanding of a communicative intention is therefore a special case of the understanding of another person's intention toward my intentional states. Understanding this is clearly more complex than understanding another person's intention *simpliciter*' (Tomasello, 2003, p. 24).

The underlying intersubjective nature at the intersection of language and cognition inspires Tomasello's assertion that human cognition entails a cultural as well as biological basis. The objects of the world serve as a 'third' to the dyadic interactions between speakers (in language acquisition). As the third, objects and one's actions towards them help language along, but also allow language to subvert the simple brute referent. The difference between sharing and giving a toy or a gift is predicated on contextual and linguistic use. Language introduces multiplicity and intentionality into the very being of things and those instrumental actions that surround their use:

> ... the intersubjective and perspectival nature of linguistic symbols actually undermines the whole concept of a perceptual situation by layering on top of it the multitudinous and multifarious perspectives that are communicatively possible for those of us who share a certain set of linguistic symbols. (Tomasello, 2003, p. 53)

Tomasello has thus located a space in the middle of world and subjects wherein one could begin research into how the subjective (multitudinous and multifarious perspectives) and the world of objects intermix in cognition: that is, how the social and the cognitive work together (and sometimes may seemingly

work apart.). Tomasello's 'joint attentional frame' constitutes a reality infused by intersubjectivity and language, or rather by the multiplicity and order introduced by the fact *that* we speak (see Tomasello, 1999), despite its presentation as what may be regarded as traditional research on language acquisition and cognition. It may seem a great stretch to see in Tomasello's references to communicative intentions what is implied in Alexandre Kojève's reading of Hegel (Lacan, 1956/1968), which emphasized the dialectics of recognition in the emergence of self-consciousness, or the psychoanalyst Jacques Lacan's notions of desire as the desire of the Other, or symbolic interactionists' notion of identity formation through others (e.g. Blumer, 1969). But one rather apparent application relates to Helen Longino's (1993) notion of a pluralistic science as requiring a certain sort of 'communicative space' in order to function maximally. That is, researchers and apprentices must sense a place for their words as affecting and being recognized by an Other in order for knowledge production to be fully cultivated.

Conclusions

We have focused on recent innovations in the field of cognitive science that counter the individualistic and formal proclivities of cognitivism which have been the most frequent targets of critique. We are led now to the task of considering the range of purposes to be served for theoretical psychologists by pursuit of familiarity or, better, dialogue with these efforts.

First and most rudimentarily, there are quite obvious things to say about the increased potency of critiques based on accurate depiction and fair (current) representation of research efforts. A particular strength of the 1991 Special Issue of *Theory & Psychology* on 'Cognitivism and Its Discontents' is its detailed coverage of specific research trajectories under the broad umbrella of 'cognitive psychology', including categorization theory (Edwards), decision making (Sahlin) and theory construction (Fieldler). The Special Issue thereby identifies particular conceptual inconsistencies and methodological shortcomings even as the papers collectively are aimed at 'dismantling' cognitivism more generally (Gergen & Gigerenzer, 1991, p. 404). In a sense we are, on smaller scale, attempting a similar move: grounding our critical assessment and qualification of cognitive research in more detailed responses to the field; responses that do not assume that cognitive science, however mainstream, can be reduced to a singular set of commitments.

Second, although distributed and situated accounts depart substantially from traditional cognitive science, this does not render them immune from criticism. Not only is cognitive science not uniformly open to expansion along the dimensions here described, but the newer frameworks remain of necessity incompletely defined, especially when they hang on to some of the bulky categories of earlier cognitive models. Thus there is work to be taken

up in the more traditional tasks of philosophy of science. In this vein, for example, Osbeck and Nersessian (2006) acknowledge distributed accounts of representation, for example in Hutchins (1995b), to be conceptually problematic for different reasons than those affecting GOFAI. They seek an account of representation that would be more compatible with the central claims of distributed cognitive perspectives.

Third and most important, however, is that despite acknowledged limitations and lingering puzzles in the developing frameworks of cognitive science, the frameworks are opening arenas where there may be substantial agreement in sentiment and intention with many lines of theoretical psychology, including those that were instrumental in launching historical critiques of cognitivism. To summarize all we have said here: if we can agree with cognitive scientists that we have stumbled on a (decidedly moving but) functional space where the social and cognitive intersect, the essential differences between perspectives would not be categorical, but rather a matter of where the researchers' gaze is directed. Perspectives such as those reviewed above bring creative and nuanced empirical research, both experimental and qualitative, to the problem of how best to conceptualize the individual in the collective—a problem that continues to vex psychology's best theoretical efforts. One modest response is to harvest the new conceptual spaces and modalities of research that have been opened up by similarly concerned cognitive scientists.

Through these opening vistas, cognitive science not only offers general conceptual and methodological advance, but also suggests specific ways to erase the boundary line between the cognitive and the social. For example, accounts of innovation as a distributed phenomenon (Nersessian, 2002, 2005) rely on integrative narratives, drawing from field observations with concrete examples of practices and justificatory accounts by researchers in context. The task of understanding how social networks and laboratory artifacts contribute to cognitive practices (modeling, analogy use, diagram construction, proposition formation) might be refined further by examining how different cognitive practices bear a meaningful relation to specific social categories (e.g. race, gender). An integrative approach to innovation communities would attempt to see how intersubjective, social and instrumental features intersect as consonant or disjunctive within any given act. These dimensions may facilitate each other, or one may disrupt the operation of the other. With regard to this intersection, the disturbing reports of minority students in many science settings suggest that subtly these dimensions of cognition and sociality are not always working in concert (Hamilton, 2004).[5]

Finally, new developments in cognitive science offer methodological possibilities to be explored. The intermixing of methods required by neuroscience, on the one hand, and anthropology, on the other, makes recent innovations in cognitive science particularly interesting for those of us who wish precisely to engage empirical work more richly and robustly. Put differently, here is a resource for making more progress on the method question in

psychology and for rethinking forms of methodological rigor. A related *conceptual* payoff is the opportunity to forge a more interesting relationship between psychology and science than has hitherto been realized. This is no trivial matter if choices to date have included reification and emulation of a particular view of science against strategies of critiques which, despite worthy efforts, seem to perpetuate insularity.

Notes

1. The enormous appeal of deferring to mental representations as the root cause or final explanation is longstanding with varied religious and philosophical roots. From Plato to Augustine and onward to Descartes, ideas about perfectly preserved bits of mental content have been defended conceptually, in part, by an appeal to their connection with the Divine. Note that Haugeland's (1985) discussion of the historical roots of cognitive science credits the late medieval obsession with ideas (precursors of representations) to the desire to explain the created world as first existing as ideas in the mind of God.
2. This issue plagues almost all histories of science, including psychology, and also marks the nature of any 'real time' approach to studying psychological phenomena, leading to a number of methodological variants in research such as participation-action research, which in turn received some fairly strong criticism from the tradition (see Morawski, 1994).
3. As Edwards (1997) makes clear, such cognitive categories themselves fall out when discourse and not representation is at center stage. Indeed it would be surprising if this were not the case.
4. Of historical interest is a 1957 volume titled *Contemporary Approaches to Cognition*, the first chapter of which is a paper by Brunswik ending with the following statement:

   > ... only by detailed analysis of ecological textures can the cognitive problem be restored from mere utilization problems to its full scope of achievement problems and thus again become the key to the core question of psychology, that of the adjustment of the organism to a complex environment. (p. 30)

5. For example, the superiority of men in visual/spatial tasks may have become codified as social practices *qua* cognitive practices in the way math is taught (Monastersky, 2005). The social/conversational style of women may be implicated differently in word problems than it is for men (Valian, 1999). The widespread neglect of interactions of this kind underscores the extent to which we fail to understand problems as communicated within an intersubjective situation, one to which each person brings cognitive skills honed in various interactional contexts.

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ACKNOWLEDGEMENTS. This research was supported by a grant from the National Science Foundation REC0450578 and Fellowships from the Radcliffe Institute for Advanced Study and the National Endowment to the Humanities awarded to Nersessian. Professor Malone's work was further supported by the Spencer Foundation.

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