

Traditionally, human cognition has been seen as existing solely “inside” a person’s head, and studies on cognition have by and large disregarded the social, physical, and artifactual surroundings in which cognition takes place. Recently, however, research in cognition and in such fields as anthropology and cultural psychology has compelled us to reexamine our preconceptions. The essays in this volume propose that a clearer understanding of human cognition would be achieved if studies were based on the concept that cognition is *distributed* among individuals, that knowledge is socially constructed through collaborative efforts to achieve shared objectives in cultural surroundings, and that information is processed between individuals and the tools and artifacts provided by culture.

Although the phenomenon of distributed cognitions is a wide-ranging one with provocative consequences for theories of the mind, learning, and education, it has not yet been thoroughly examined. When “distributed cognitions” are the units of analysis for research and theory construction about reasoning and learning, several questions arise: What exactly is distributed and how does it become distributed? Are all cognitions always distributed? How do the distributed qualities of the mind relate to the ones that are still “inside” it? What constraints govern the dynamics of such distribution? In addressing these questions, this volume reveals their importance for such educational issues as the cultivation of mental skills, the acquisition of knowledge, and the role of social interaction and intelligent tools in the learning process.

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GAVRIEL SALOMON

University of Haifa, Israel



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Contributors

Doris Ash
University of California,
Berkeley
School of Education
Berkeley, California

Ann L. Brown
University of California,
Berkeley
School of Education
Berkeley, California

Joseph C. Campione
University of California,
Berkeley
School of Education
Berkeley, California

Michael Cole
University of California, San
Diego
Laboratory of Comparative
Human Cognition
La Jolla, California

Yrjö Engeström
University of California, San
Diego
Laboratory of Comparative
Human Cognition
La Jolla, California

Howard Gardner
Harvard University
Graduate School of
Education / Project Zero
Cambridge, Massachusetts

Ann Gordon
University of California,
Berkeley
School of Education
Berkeley, California

Thomas Hatch
Harvard University
Graduate School of
Education / Project Zero
Cambridge, Massachusetts

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Louis C. Moll
University of Arizona
College of Education
Tucson, Arizona

Kathryn Nakagawa
University of California,
Berkeley
School of Education
Berkeley, California

Raymond S. Nickerson
5 Gleason Rd.
Bedford, Massachusetts

Roy D. Pea
Northwestern University
Institute for the Learning
Sciences
Evanston, Illinois

D. N. Perkins
Harvard University
Graduate School of
Education / Project Zero
Cambridge, Massachusetts

Martha Rutherford
University of California
Berkeley
School of Education
Berkeley, California

Gavriel Salomon
University of Haifa
School of Education
Haifa, Israel

Javier Tapia
University of Arizona
College of Education
Tucson, Arizona

Kathryn F. Whitmore
University of Arizona
College of Education
Tucson, Arizona

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Series foreword

This series for Cambridge University Press is becoming widely known as an international forum for studies of situated learning and cognition.

Innovative contributions are being made by anthropology, by cognitive, developmental, and cultural psychology, by computer science, by education, and by social theory. These contributions are providing the basis for new ways of understanding the social, historical, and contextual nature of the learning, thinking, and practice emerging from human activity. The empirical settings of these research inquiries range from the classroom, to the workplace, to the high-technology office, to learning in the streets and in other communities of practice.

The situated nature of learning and remembering through activity is a central fact. It may appear obvious that human minds develop in social situations, and that they come to appropriate the tools that culture provides to support and extend their sphere of activity and communicative competencies. But cognitive theories of knowledge representation and learning alone have not provided sufficient insight into these relationships.

This series was born of the conviction that new and exciting interdisciplinary syntheses are under way, as scholars and practitioners from diverse fields seek to develop theory and empirical investigations adequate for characterizing the complex relations of social and mental life, and for understanding successful learning wherever it occurs. The series invites contributions that advance our understanding of these seminal issues.

Roy Pea
John Seely Brown

Editor's introduction

The idea for this book was born in stages. It all began on the beach of Tortola, the British Virgin Islands, in the summer of 1989, where three of us – David Perkins, Roy Pea, and myself – participated in a small conference about computers and learning convened by the Social Science Research Council. Perkins spoke there of representations for mathematics and science learning, I spoke of intellectual partnerships with computers, and Pea introduced the idea of distributed cognitions. It became immediately evident that the three of us, while sharing similar concerns, had different views about distributed cognitions and the purposes of education. We thought of this diversity of views as providing a potentially unique opportunity for stimulating debate and raising new questions. We created such an opportunity by planning a symposium at the 1990 American Educational Research Association conference in Boston. The participants in this symposium – Ann Brown, Jerome Bruner, Roy Pea, David Perkins, and myself – decided then that the ideas formulated and presented there, together with the ideas of other scholars in the field, would constitute an interesting, thought-provoking book. This is the book you are holding in your hands, a fine product of distributed cognitions.

A scholarly community often settles on an agreed-upon way to view a phenomenon and a unit of analysis to match, and then studies the phenomenon in ways that are congruent with that consensually held conception. The more such research is done, the more the initial conception appears valid and “correct,” supporting the prevailing view of that phenomenon. Karl Weick (1979) has commented that, as consensus grows, the views become “refractory to disproof” and appear to be so self-evident that alternatives are rarely discussed. But

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then, for whatever reason, the phenomenon suddenly becomes examined in a new context, which, quite disturbingly, requires new units of analysis, leading in turn to the formulation of new perceptions and definitions of that phenomenon. The result is the birth of a new phenomenon.

Consider, for example, the current state of memory research. In a recently published debate about the validity and scientific merits of research on memory in real-life situations, Banaji and Crowder (1989) argued that “the more complex a phenomenon, the greater the need to study it under controlled conditions, and the less it ought to be studied in its natural complexity” (p. 1192). This position assumes, of course, that the phenomenon studied under tightly controlled conditions is the *same* as the one encountered in real-life circumstances. Unfortunately for that approach, memory (like other psychological phenomena) changes profoundly in nature, appearance, and function when studied in its natural complexity, as contrasted with its study under highly controlled conditions. The laboratory-based study of episodic memory, as Conway (1991) points out, although ostensibly examining the same phenomenon as the study of autobiographical memory, is *in fact* a study of something quite different: Everyday, autobiographical memory deals with memory infused with prior knowledge and personal meanings, which the memory-in-the-lab arrangement tries to “control for.” This contrast, then, raises a principled issue that transcends the specific boundaries of memory research: Changing the unit of analysis or changing the context in which a phenomenon is studied may reveal a qualitatively different phenomenon (e.g., Ceci & Bronfenbrenner, 1991).

There is a striking parallel between the study of memory in the two contexts and the study of cognition in the laboratory versus its study in daily-life settings. Traditionally, the study of cognitive processes, cognitive development, and the cultivation of educationally desirable skills and competencies has treated everything cognitive as being *possessed* and residing *in the heads* of individuals; social, cultural, and technological factors have been relegated to the role of backdrops or external sources of stimulation. This perception is fine as far as it goes, allowing us to examine in great detail some specific mechanisms of information processing, problem solving, and learning. But once human behavior is examined in real-life problem-solving situa-

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tions and in other encounters with the social and technological surrounds, a rather different phenomenon emerges: People appear *to think in conjunction or partnership* with others and with the help of culturally provided tools and implements. Cognitions, it would seem, are not content-free tools that are brought to bear on this or that problem; rather, they emerge in a situation tackled by teams of people and the tools available to them (e.g., Lave & Wenger, 1991). Consider a team that works cooperatively to plan a political campaign, an economic planner who does her thinking with a powerful computerized spreadsheet, or a student who studies history while filling out note cards, marking the margins of the textbook, and constructing on paper “networks” of facts to remember. The thinking of these individuals might be considered to entail not just “solo” cognitive activities but *distributed* ones. As Perkins points out in Chapter 3 of this volume, what characterizes such daily events of thinking is that the social and artifactual surrounds, alleged to be “outside” the individuals’ heads, not only are sources of stimulation and guidance but are actually *vehicles of thought*. Moreover, the arrangements, functions, and structures of these surrounds change in the process to become genuine *parts of the learning* that results from the cognitive partnership with them. In other words, it is not just the “person-solo” who learns, but the “person-plus,” the whole system of inter-related factors.

The idea of distributed cognitions is not necessarily new. As Cole and Engeström show in Chapter 1, one could find its origins in the writings of turn-of-the-century psychologists and philosophers (see also Phillips, 1976). For example, Dewey wrote more than a century ago: “The idea of environment is a necessity to the idea of organism, and with the conception of environment comes the impossibility of considering psychical life as an individual, isolated thing developing in a vacuum” (1884, p. 285).

There is an interesting affinity between the consideration of cognitions as socially and culturally distributed and the study of human behavior as part of a wider system entailing cultural, social, situational, and technological elements. Such functionally oriented study would treat individual *and* environment, social, cultural, or physical, as integrated units, such that the activities of the individual would be seen as “processes of the full situation of organism-environment”

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(Dewey & Bentley, 1946, p. 256). But this approach was often associated with “holistic,” “soft,” and qualitative modes of inquiry, closer to anthropology than to “hard-core” scientific psychology. No wonder therefore that it was (and to some extent continues to be) in the shadow of mainstream psychological and educational research, which emphasizes individuals’ behaviors and cognitions while largely disregarding their distributed nature.

Perceptions are changing. With a growing acceptance of a constructivist view of human cognitions comes a serious examination of the possibility that cognitions are situated and distributed rather than decontextualized tools and products of mind. Accompanying this possibility is the acknowledgment not only that social and other situational factors have a strong impact on “in-the-head” cognitions but that social processes should be treated *as* cognitions (Resnick, 1991).

Such conceptual changes do not emerge out of nowhere. A cursory examination of recent developments in cognitive and mainly educational-cognitive thought suggests at least three sources for the surge of interest in distributed cognitions. One is the increasingly important role that activities with computer tools have come to play in handling intellectual tasks. It becomes observable, if not patently evident, that the collaboration of individuals and computers is often characterized by intellectually superior performance that cannot easily be accounted for by individuals’ cognitions alone (Salomon, Perkins, & Globerson, 1991). A second source appears to be the growing interest in Vygotsky’s cultural-historical theory, a theory that situates individuals’ cognitions *within*, rather than just interacting with, social and cultural contexts of interaction and activity (e.g., Moll, 1991). A third source appears to be the growing dissatisfaction with cognitions as in-the-head tools, shifting focus to their situated, context-dependent, and thus potentially distributed nature (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991).

If social and possibly other “external” processes are to be taken as integral parts of the cognitive process, maybe the whole concept of cognitions ought to be reexamined. Are they perhaps distributed rather than located in the head? And if intellectual processes and products can be seen as being distributed among individuals or between individuals and culturally provided implements, may it not also be the case that intelligence is an emerging quality rather than a “possession”?

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Serious consideration of the notion of distributed cognitions opens up a whole range of questions and suggests a long list of provocative implications for education. This book is an attempt to explicate, illustrate, and critically examine the idea of distributed cognitions in its general and educational manifestations. If cognitions and cognitive abilities are not to be seen as “wired” possessions but as situationally, socially emerging qualities, what exactly are they? How do cognitions become distributed? What is distributed about them? What compels us to acknowledge that cognitions are (sometimes?) distributed? How are cognitions distributed in different situations and in different activities? Given the distribution of cognitions, what role, if any, do we want to ascribe to individuals’ “solo” cognitions? How does the distribution of cognitions differ from “division of labor,” “sharing of ideas,” or “mutual stimulation”? How can we identify distributed cognitions, and where would it be most interesting and useful to look for them? Educationally, what of the cultivation of cognitive abilities and proclivities if these are not to be seen as the developing possessions of the individual? If cognitive performance is a distributed quality, what should education’s goals be? How should the learning environment be designed? What should be examined and studied? What roles should teachers play and what role students?

The contributors to this volume are not of the same mind, nor do they necessarily share the exact meaning of the term “distributed cognitions.” In this sense, this book is an attempt to raise questions and start a debate rather than present a unified view with worked-out implications. The authors have different opinions as to how individuals’ cognitions should be dealt with once the reality of distributed cognitions is partly or fully acknowledged. In fact, the authors present two somewhat different conceptions of distributed cognitions. One such conception, perhaps the more radical, is presented by Cole and Engeström, Pea, and Moll, Tapia, and Whitmore. According to their view, while individuals’ cognitions are not to be dismissed, cognition *in general* should be reexamined and conceived as principally distributed. As pointed out elsewhere by Cole (1991), the proper unit of psychological analysis should be the *joint* (often, but not necessarily) *socially mediated activity* in a cultural context. This might be taken as the strong version of distributed cognition, since it proposes a deviation from the common view that cognitions are possessed by individuals and serve as tools ready for application in daily situations.

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The second, less radical conception is presented by Perkins, Salomon, Hatch and Gardner, and Brown et al. According to them, “solo” and distributed cognitions are still distinguished from each other and are taken to be in an interdependent dynamic interaction.

The eight chapters of this book are of two kinds. The first four are mainly theoretical. The next three are partly theoretical as well, but their main focus is on specific educational case studies of distributed cognition. The book ends with a critical examination of the concept and its potential contribution to the study of cognition and to education.

Leading the theoretical part of the book is Chapter 1, by Cole and Engeström. The authors examine the origins of the distributed-cognitions idea, tracing it back to the writings of Wundt and Münsterberg. In the light of these roots and the cultural-historical theories of such scholars as Vygotsky and Luria, Cole and Engeström present the argument that cognitions are to be seen as culturally mediated, part of whole activity systems that include culture, community, tools, and their self-regulatory counterparts – symbols. Inspired by recent anthropological work, Cole and Engeström extend the cultural-historical view by noting that cognitions are distributed in the medium of culture, whereby “the combination of goals, tools, and setting . . . constitute simultaneously the context of behavior and the ways in which cognition can be said to be distributed in that context.” Cole and Engeström also point out how cognitions are distributed neuropsychologically – different parts of the brain process different kinds of experiences and stimuli, socially and temporally. The presentation of two detailed examples, the acquisition of reading (in which cognitions are distributed among teacher, learner, other learners, and cultural artifacts) and the reorganization of medical work in a Finnish clinic (working through a new division of labor among the health-care providers so that the distributed cognitive resources of the system will be better exploited), allows the authors to show that once the idea of mediation through artifacts and other individuals is seen as a central distinctive characteristic of humans, the adoption of the distributed view of cognitions is inescapable.

Chapter 2, by Pea, is intended to provoke new inquiries. Pea disagrees with the widespread, indeed dominant, conception of intelligence as the property of the mind. Rather, he argues, intelligence is

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to be seen as *accomplished* rather than *possessed*. Distributed intelligence, as Pea sees it, is ever present in the tools, modes of representation, and other artifacts we create to off-load what would otherwise be a heavy and error-prone cognitive burden. According to Pea, the phenomenon of distributed cognitions makes apparent how external resources change the nature and functional system from which activities emerge, profoundly affecting our conception of what, how, and why one needs to know. The goal of having everyone possess the knowledge of, say, long division or the multiplication table gives way to the goal of estimation and problem solving – activities of reasoning with tools rather than independently of them. It follows that one would wish to place greater emphasis on access to tools to think with than on solo understanding without tools, on partnership rather than on the cultivation of in-the-head cognitions. Clearly, computer tools and programs designed to cater to distributed cognitions, emphasizing partnership and access, will be very different from tools aimed at the cultivation of solo abilities. This, then, is likely to change the conception of educational goals from mastery to jointly accomplished performance.

Perkins (Chapter 3) generally accepts the notion of distributed cognitions as a system that entails both person and surround, a new unit of analysis that jointly participates in thinking as well as learning. To this conception he applies the *equivalent access hypothesis*, according to which what is important is the kind of *knowledge* present, the way it is *represented*, how readily it is *retrieved*, and how it is *constructed*, rather than where all this takes place. To the extent that a joint system, the “person-plus,” entails the four access characteristics, it does not much matter where the knowledge, the representation, or the construction resides. Using this framework, Perkins examines the way the executive functions, on the one hand, and higher-order knowledge of a field, on the other, are distributed. While the former can and often are socially distributed (they are ceded to teachers and textbooks), higher-order knowledge, in the form of heuristics, patterns of explanation, and modes of inquiry, is represented nowhere and cannot become distributed; it does not meet the four access criteria except *within* the person-solo. It follows that while many cognitions are often distributed, particularly during inquiry activities, not all cognitions can be so distributed. Higher-order knowledge, a crucial

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element in mastering a field and in the operations of the executive functions, is a matter of the person-solo.

In Chapter 4, the last theoretical chapter, I go one step further in raising critical questions about the radical version of distributed cognitions. I argue that not all cognitions are *constantly* distributed, not all of them *can* be distributed, and no cognitive theory, particularly one that attempts to account for *developments and changes* over time, can do without reference to individuals' mental representations (or their equivalents). These, after all, are the "substance" that enter into situations of distributed cognitions. Having arrived at this conclusion, I offer an interactive, spiral-like dynamic view of how "solo" and distributed cognitions interact over time, affecting each other and developing from each other. In this way, I overcome the situational determinism I see in the radical view of distributed cognitions and the intrapersonal determinism in radical solo views of cognition. Elaboration of this interactive approach, in turn, suggests implications for the selection of educational goals – the cultivation of partnership together with the cultivation of solo capabilities – as well as for educational design.

In the first of the three case-study chapters (Chapter 5), Moll, Tapia, and Whitmore employ the prism of (mainly socially) distributed cognitions to examine qualitatively two activity settings that offer distributed "funds of knowledge": a household of a Mexican-American family close to the Mexican border and a whole-language classroom in which socially mediated learning activities are an organizing principle. The purpose of the chapter's ethnographic studies is to translate the conceptual notions of distributed cognitions into specific dynamics of distributed cognitive resources. Examination of the family household reveals how active it is in coping and how interconnected it is with other households with which it shares and exchanges knowledge, skills, and other resources needed for their daily functioning. The story of the classroom reflects a similar distribution of intellectually shared resources. Social processes and cultural resources mediate learning activities, thereby manifesting the socially shared nature of learning.

Another case is provided by Hatch and Gardner in Chapter 6. Unlike the anthropologically oriented work of Moll and associates,

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the case that Hatch and Gardner present is aligned with a child-development tradition. Hatch and Gardner challenge the prevailing view of intelligence as a unitary, in-the-head, and stable possession of the individual. They suggest that three interdependent forces contribute to cognitions in the classroom: personal, local, and cultural. The three are seen as concentrically arranged, such that the personal forces are at the core and the cultural ones serve as the outer circle. Intelligence, enmeshed as it is in all of a person's activities, reflects the influences of the local affordances and constraints, the cultural values and expectations, and the personal proclivities and accumulated experiences. This concentric model is examined in a child-centered kindergarten in which four children are observed for a number of months during free play at the sand table and the art table. The authors draw two important conclusions from their detailed observations. First, although personal, solo forces play an important role in the authors' scheme, they are seen to reflect the cultural and local forces at work in the settings and activities in which the children are engaged. Changes and variations in the cultural and local forces are thus reflected in changed and diverse manifestations of intelligence, which thus explains the variability in human performance. Second, the way the personal forces become manifested and possibly developed is greatly dependent on the local and cultural forces, thus highlighting the extent to which such intelligence can be said to be locally and culturally determined.

Chapter 7 by Brown and her associates complements the anthropologically and more developmentally oriented case studies with an instructional intervention study. The authors describe how a classroom learning environment can be designed and implemented to foster a community of learners who engage in guided appropriation of meanings through mutual negotiations, thus gradually creating a *distributed network of expertise*. Such environments are places where students learn to learn, becoming "intelligent novices" who – in their interactions with teachers, peers, materials, and computer tools – create overlapping zones of proximal development. The question of distributed cognitions thus shifts from where cognitions reside to how the classroom can be so designed as to foster the development of a community of discourse in which expertise becomes distributed in

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ways that provide the seeding ground for mutual appropriation. The authors provide a detailed description of such classroom design, anchored in theoretical constructs that support its psychologic.

The book ends with Nickerson's discussion in Chapter 8 of each of the chapters and a critical examination of the concept of distributed cognitions and its implications. Nickerson asks what is new about the concept of cognition and intelligence as distributed, what new theoretical and practical mileage it affords, and where it leads us. He then offers some middle ground on which both individuals' and distributed cognitions could be jointly considered.

So heated conversations initially held on the Tortola beach have gradually matured into formulated positions that can be accompanied by real-life examples and appropriate manifestations in medical clinics, households, kindergartens, and classrooms. I hope that the assortment of theoretical positions and case studies presented here will stimulate further debate and exchange of ideas. If nothing else, I hope that this volume will shake the dust off old notions and long-cherished conceptions, thereby contributing new and exciting ideas to the domain of cognition and intelligence as they pertain to educational matters.

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