COGNITION IN PRACTICE

Mind, mathematics and culture in everyday life

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INTRODUCTION: PSYCHOLOGY AND ANTHROPOLOGY I

The problem is to invent what has recently been nicknamed "outdoor psychology" (Geertz 1983). The book is an inquiry into conditions that would make this possible. The conclusion: that contemporary theorizing about social practice offers a means of exit from a theoretical perspective that depends upon a claustrophobic view of cognition from inside the laboratory and school. The project is a "social anthropology of cognition" rather than a "psychology" because there is reason to suspect that what we call cognition is in fact a complex social phenomenon. The point is not so much that arrangements of knowledge in the head correspond in a complicated way to the social world outside the head, but that they are socially organized in such a fashion as to be indivisible. "Cognition" observed in everyday practice is distributed – stretched over, not divided among – mind, body, activity and culturally organized settings (which include other actors). Empirical support for this proposal has emerged recently from research exploring the practice of mathematics in a variety of common settings. These studies converge towards a view that math "activity" (to propose a term for a distributed form of cognition) takes form differently in different situations. The specificity of arithmetic practice within a situation, and discontinuities between situations, constitute a provisional basis for pursuing explanations of cognition as a nexus of relations between the mind at work and the world in which it works.

The problem and the project

The Adult Math Project (AMP), an observational and experimental investigation of everyday arithmetic practices in different settings, has provided a basis for the analytic and theoretical development of such an

argument. It began several years ago with simple descriptive questions about arithmetic practice: How does arithmetic unfold in action in everyday settings? Does it matter whether it is a major or minor aspect of ongoing activity? Are there differences in arithmetic procedures between situations in school (e.g. taking a math test) and situations far removed from school scenarios (in the kitchen or supermarket)? To search for answers we undertook a number of closely related studies: of "best-buy" arithmetic calculations in the course of grocery shopping in the supermarket; a simulation experiment on these same calculations; an extensive set of arithmetic tests; and observations across time, settings and activities of dieting cooks in their kitchens; and of people managing the flow of money through their households.

More general questions focused on relations between arithmetic use and its sociocultural locus in time and space. Success at problem solving, the procedures employed, and the problems themselves, varied for the same people in different contexts. For example, a teacher in an arithmetic lesson might pose a word problem for the children: "Becca has four apples and Maritza has five apples, how many apples in all?" The answer to this "apple" problem and another observed in the supermarket is "nine." But here is the problem as it appeared in the market, observed during a grocery-shopping expedition. The shopper was standing in front of a produce display. As she spoke she put apples, one at a time, into a bag. She put the bag in the cart as she finished talking:

> There's only about three or four [apples] at home, and I have four kids, so you figure at least two apiece in the next three days. These are the kinds of things I have to resupply. I only have a certain amount of storage space in the refrigerator, so I can't load it up totally . . . Now that I'm home in the summertime, this is a good snack food. And I like an apple sometimes at lunchtime when I come home.
>
> *(Murtaugh 1985b: 188)*

This is a problem in several senses other than those posed by a conventional math "word problem." There are several plausible answers – 9, 13, 21. It appears that the problem was defined by the answer at the same time an answer developed during the problem, and that both took form *in action* in a particular, culturally structured setting, the supermarket. We also observed this shopper's math practices in other settings, one of which was a test-like format borrowed from school arithmetic. A week after the grocery-shopping expedition she worked out a large number of math problems during a comprehensive survey of her knowledge of school arithmetic (e.g. integer, fraction, decimal and negative number arithmetic). Her activity in this setting offered little

useful information about her success at math in the supermarket, about the kinds of problems encountered there, or about the procedures she devised for resolving them.

The AMP investigated arithmetic practices in a variety of settings to gain a different perspective on problem solving from that found in school or laboratory. The research focused on adults in situations not customarily considered part of the academic hinterland, for no one took cooking and shopping to be school subjects or considered them relevant to educational credentials or professional success. AMP "experts" were grocery shoppers rather than physicists and none of the novice learners beginning a new dieting program was a college sophomore. In order to observe variation in (still ordinary) cognitive activity the 35 participants were chosen to reflect broad differences in schooling, age, time since schooling was completed, family size and income. We began with participant observation, analysis of the settings for their activities, and description of the organization of the activities within which we hoped to catch glimpses of arithmetic in process. All were interviewed, observed in action, and asked occasionally to vary their everyday activities in specified ways. And we asked them to endure our experimental and test-like attempts to learn about their current knowledge of school and other arithmetic procedures.

Several years of exploration of arithmetic as cognitive practice in everyday contexts had led to a kernal observation from which the argument follows. The same people differ in their arithmetic activities in different settings in ways that challenge theoretical boundaries between activity and its settings, between cognitive, bodily, and social forms of activity, between information and value, between problems and solutions.

The empirical and theoretical characterization of situationally specific cognitive activity – what it is, and why – is, therefore, the central project of the book. This subsumes a number of analytic questions. Is the absence of school-problem formations in everyday math activity to be interpreted as "the absence of school mathematics," the construction of some other mathematics, the inadequate or incomplete use of school arithmetic? How does schooling shape arithmetic activity in everyday situations? What model might best capture the unfolding character of problem-solving processes *in situ*? What constitutes an adequate, general theoretical formulation of situationally specific cognitive activity, of mundane settings, and of activity in such settings? Resolutions to these questions will be pursued throughout the book.

It may seem odd that the work has been concentrated on participants

and activities rather far removed from school and laboratory, and yet focused on arithmetic – school subject and exemplar of beliefs about the rational, scientific mind. Both the sites and content of the research reflected our assumptions about the cultural construction and distribution of mathematical knowledge. It seemed crucial to take into account the web of relations among academic cognitive theory, the organization of schooling, the socialization experiences of people in school, and their theories (as alumni) of cognition, schooling, and "proper" arithmetic practice. This seemed especially important because research on the ongoing activities of AMP participants suggested that our understanding was entangled with institutions and dilemmas which, for purposes of cognitive research, are usually treated as if they had no direct bearing on each other.

One example of these intricate ties is a widely shared belief that "scientific thought" is a proper yardstick with which to measure, diagnose and prescribe remedies for the "everyday thought" observed in experiments and schooling. This belief has long historical roots (see chapter 4) that have influenced cognitive theory, the institutional form of schooling, and folk theories alike. Further, Western culture links science, schooling, and everyday practice in a hierarchical ordering of the kinds of thinking and knowledge supposed to be characteristic, respectively, of professional experts, "laypersons" (a term that should give pause), and "just plain folks" (jpfs).[1] There are influential networks of communication between academic psychology, the school establishment that educates both laypersons and scientists, and the alumni of these institutions. These networks ensure that psychological theories affect, though not reliably, both educational theories and educational practice, which in turn shape and are shaped by the beliefs of students. Alumni of schooling are the objects whose after-(school)-life is theorized about by psychologists and educators, who at the same time *are* the theorists, the teachers, and the parents of children in school.

At the center of this cultural web lies the concept of learning transfer, reflecting widely shared assumptions about the cognitive basis of continuity of activity across settings. Conventional academic and folk theory assumes that arithmetic is learned in school in the normative fashion in which it is taught, and is then literally carried away from school to be applied at will in any situation that calls for calculation. There are conventional opinions about how well this works: "most kids fail to learn in school so the world must be made up of un-numerate people who cannot multiply or divide," or "school arithmetic algorithms are used routinely in the everyday lives of school alumni (there is

no other kind of math to use)." The most common view distinguishes successful alumni from the unsuccessful, attributing constant and skilled use of school knowledge to the former, and rare, often erroneous, use to the latter. None of these propositions is given support by AMP research. Nor would one expect them to be if arithmetic practice were in any serious sense constructed *in situ*.

All of this suggests that schooling is implicated in any analysis of arithmetic activities in everyday practice. But there is a further implication: to the extent that the interconnections among cognitive theory, schooling and everyday practice are not taken into account as such, they form a major impediment to penetrating a cultural edifice whose monumental character has, arguably, prevented anything *but* confirmation of conventional, socially and culturally organized beliefs about cognition. One remedy for this state of affairs is to focus studies of cognition on situations as far removed from school and laboratory as possible, not in order to achieve the impossible feat of neutralizing their influence on practice, but to refract it from a different angle while keeping relations with schooling continually in view. The other is to approach and analyze *cognitive theory* as a routine, unexceptional aspect of Western culture.

There is still pending the question of why arithmetic is the subject matter of these studies. In earlier research on relations among educational forms, cognitive theory and everyday practice, with Vai and Gola tailors' apprentices in Liberia (Lave 1977, 1982, in preparation: Reed and Lave 1979), the focus on arithmetic was initially motivated by methodological concerns. Math provided a basis for comparison, since both apprentices and school children learned and used it in their everyday educational activities. But the longer I have pursued the matter, the richer the reasons for continuing to do so. Briefly, arithmetic is an accepted topic for research within cognitive psychology, hence observational research in settings other than laboratories offers opportunities to compare results and raise questions about the ecological validity of experimental studies. Arithmetic is a sympathetic "medium" for the researcher who wishes to study activity in open-ended situations, for it has a highly structured and incorrigible lexicon, easily recognizable in the course of ongoing activity. For the same reason it is more easily analyzed in the absence of complete process data. And it allows us to focus on activity whose specific presence in the web of relations among academic psychology, school organization and folk models, was as explicitly available for examination as possible.

Another, powerful, reason for focusing on math lies in relations

these assumptions as does the very category "information processing."[4]

More specifically, functional theory treats processes of socialization (including learning in school) as passive, and culture as a pool of information transmitted from one generation to the next, accurately, with verisimilitude, a position that has created difficulties for cognitive psychology as well as anthropology. Neither discipline appears to be theoretically equipped to elaborate a theory of active social actors, located in time and space, reflexively and recursively acting upon the world in which they live and which they fashion at the same time.

Functional theory underlies the web of relations between academic, novice and jpf "worlds." In this theory, duality of the person translates into a division of (intellectual) labor between academics and "the rest" that puts primitive, lower class, (school) children's, female, and everyday thought in a single structural position *vis-à-vis* rational scientific thought (see chapter 4). Functional theory arose in the early nineteenth century as an argument of the new industrial bourgeoisie against aristocratic privilege in Great Britain (Cooter 1979), an argument that if all individuals were given equal opportunities to advance in life, those who were superior physically, mentally and morally would naturally rise to the top. Those who lacked these qualities would stay where they justly belonged. Schooling, and relations that are assumed to hold between schooling, the academy, and the world of work, reflect this belief in a meritocracy. Functional theory permeates rationales, explanations, and the organization of schooling in American society, and imbues much of anthropological, educational, and psychological theory with its particular logic (cf. McDermott and Goldman 1983; Apple 1979). In particular, it is enacted in schools by their claim to treat all children alike (cf. Varenne and Kelly 1976; Bourdieu 1973) and its view that unequal ranking is an epiphenomenon of differential merit.

The functionalist sociology of education has been elucidated too thoroughly to require rehearsal here. But it may not be as well understood that the functionalist position contains a theory of learning: in particular, that children can be taught general cognitive skills (e.g. reading, writing, mathematics, logic, critical thinking) *if* these "skills" are disembedded from the routine contexts of their use. Extraction of knowledge from the particulars of experience, of activity from its context, is the condition for making knowledge available for *general* application in all situations. Schooling reflects these ideas at a broad organizational level, as it separates children from the contexts of their

own and their families' daily lives. At a more specific level, classroom tests put the principle to work: they serve as the measure of individual, "out of context" success, for the test-taker must rely on memory alone and may not use books, classmates, or other resources for information. Arguably examinations are also condensed, symbolic, ritual ordeals which inculate the essence of the theory.

Cognitive psychology accounts for stability and continuity of cognitive activity across settings through the psychological mechanism of learning transfer. That is, knowledge acquired in "context-free" circumstances is supposed to be available for general application in all contexts, widely transportable but relatively impervious to change in the course, and by the process, of travel and use. The central role of learning transfer reflects the functionalist assumption of literal culture transmission that informs broad conceptions of socialization and more specifically, the conceptualization of relations between school and everyday practice. In sum, even this short survey of the general functional model of cognition, culture, continuity and the social world confirms that there are strong, common theoretical assumptions in cognitive studies in psychology and anthropology. A discussion of their contemporary dilemmas will also show common patterns of concern across disciplines.

Cognitive anthropology has traditionally applied linguistic models, notably classical formal semantics, to classificatory paradigms of general cultural knowledge (e.g. kinship, plant, and color terminologies), an interest with direct roots in early twentieth-century functionalism. This theory came under critical analysis when cognitive anthropologists raised questions about relations between cultural knowledge and actors' cultural practice, one aspect of the problem of intracultural variation. Pelto and Pelto (1975) argued that:

> the predominant tendency in anthropological . . . theory-building continues to be made up of constructions reflecting fundamental assumptions of cognitive homogeneity and behavioral sharing. *(1975: 6)*

They suggest that the use of quasi-linguistic models, "based on a mentalistic meta-theory of human behavior" (1975: 7) has contributed to uniformist views and a strong penchant for treating culture in the same terms as language, concluding that:

> the monolithic view of behavioral causation that makes culture the cause of culture – with perpetuation of cultural patterns neatly through the generations by means of child training and other socialization – must be discarded. *(1975: 10)*

Cognitive psychologists have also espoused simplifying assumptions of cultural uniformity. Anthony Giddens, a social theorist who persistently raises issues about conventional conceptions of social actors and their relations with action, structure and social systems, has pointed out that:

> It is clear that much work on the psychological development of the individual is deficient as an account of socialization, in so far as the overriding focus is upon the differentiation of personality within an undifferentiated "society." This is true also in some considerable degree of the theory that has long dominated child psychology in respect of cognitive development: that associated with Piaget. *(1979: 129)*

The Laboratory of Comparative Human Cognition (LCHC 1981) has made the same point in relation to cross-cultural research on cognitive style.[5] But they are exceptional in a field not known for its self-critical views (see also Bronfenbrenner 1979: 258), perhaps because the problems raised by such critics are so easily avoided merely by honoring conventional limitations on subject matter.

The concept of cultural uniformity reflects functionalist assumptions about society as a consensual order, and cultural transmission as a process of homogeneous cultural reproduction across generations. It has served as a mandate to treat culture in cognitive studies as if it were a constant, as if nothing essential about thinking would be disturbed if its effects were controlled experimentally. This is surely one means by which cognitive psychology has kept within the bounds of the division of labor between the study of the individual and anthropological studies of culture and social organization. For such a strategy legislates away major questions about social diversity, inequality, conflict, complementarity, cooperation and differences of power and knowledge, and the means by which they are socially produced, reproduced and transformed in laboratory, school and other everyday settings. (These same questions are more difficult to avoid when the arena of investigation is the lived-in world.) It is worth keeping in mind that the specific character of this division of labor strongly influences theoretical speculation about the sources of continuity of activity, as well as methodological questions about the ecological validity of experimentation.

Indeed, validity is another of those issues that has been raised in both cognitive anthropology and psychology, though in slightly different guises. In the late 1960s, cognitive anthropologists began to worry about the psychological validity of their componential analyses of semantic categories. The problem is closely related to the question of intracultural variation, for it depends on recognition that people within a single culture have various means for classifying the same things (e.g. Wallace

and Atkins 1960; Burling 1964, Romney and D'Andrade 1964, Wexler and Romney 1972). Responses within cognitive anthropology included sophisticated attempts to model processes of choice and decision making (Gladwin and Gladwin 1971; Gladwin 1975; Quinn 1976) and statistical modeling of variation (e.g. Romney, Shepard, and Nerlove 1972; Shepard, Romney, and Nerlove 1972). There have also been explorations of richer and more-sophisticated theories of semantics (notably Quinn on the concept of marriage 1982) and logic (Hutchins 1980; D'Andrade 1982), reflecting the seriousness with which cognitive anthropologists have queried cognitive science for new theoretical perspectives. The psychologists' version of the problem concerns ecological validity, a critique of laboratory experimentation as a basis for generalizing about cognitive activity in other settings, especially those of everyday life (Bartlett 1932; Barker 1963a, 1968; and especially Cole, Hood and McDermott 1978). But though the problem is widely recognized within the discipline, psychologists themselves have been critical of what they fear are only *pro forma* efforts to rethink experimental methods. Neisser has pointed out the exasperatingly programmatic character of many quick pitches for ecological validity – "Like so many admonitions to virtue, it emphasizes the superior righteousness of the moralizer without giving much guidance to the moralizee" (1976: 33–34; see also Siegel 1977: 192).

The question has been given impetus by difficulties in exporting laboratory experimental paradigms to cross-cultural research situations (e.g. Cole, Gay, Glick and Sharp 1971; Scribner 1977; Lave 1980). The cognition-and-culture psychologists have been critical of claims that laboratory experimentation is a sufficient basis for generalizing about cognitive attributes of individuals. Bartlett (1932) provided a historical charter for the enterprise, characteristic also of more recent work (Cole, Hood and McDermott 1978; Scribner and Cole 1981; Bronfenbrenner 1979). These critiques have two dimensions. Bartlett (1932, chapter 1) argued that generalizing about "how people think" on the basis of what transpires in laboratory experiments is a contradiction in terms. For if experimental situations are sufficiently similar to each other, and consistently different from the situations whose cognitive activities they attempt to model, then the validity of generalizations of experimental results must surely be questioned. He proposed that observation of everyday activities in context should form the basis for the design of experiments. Experimental findings would, in turn, inform further observation. Secondly, critics have focused on laboratory experiments

as a class of activities in and of themselves, as socially and culturally structured events (LCHC 1981; Bronfenbrenner 1979: 123; Lave 1980 and in preparation).

The responses within both anthropology and psychology to uniformist dilemmas and those of research validity have been mildly reformist, at best. In part this represents a withdrawal from issues that are easy to identify but difficult to resolve. In part it reflects beliefs that modest modification of existing practices is all that should be required. But if the pervading theoretical position is the source of dilemmas which have assumed substantial significance, and these are intractible even when explicitly delineated, tactical change may not be sufficient. A different logic seems more appropriate, and indeed, timely, for there appears to be a growing legitimacy for alternatives to a functionalist/positivist theoretical position. There are numerous general critiques of functionalist theory (e.g. Giddens 1976, 1979; Jarvie 1968; Warren 1984) and a growing body of serious critiques of cognitive theory (e.g. Dannefer 1984; Danziger 1979; Dreyfus 1979; Samelson 1974; Sampson 1977; Henriques, Hollway, Urwin, Venn, and Walkerdine 1984). The critical literature on functionalist sociology of education is notable: (e.g. Apple 1979; Bourdieu 1973; Bowles and Gintis 1976; Collins 1979; Giroux 1981; Hurn 1978; Willis 1977). Others have argued against isolating theorizing about cognition from analysis of the activity of which it is a part, in the social world of which it is also a part (e.g. Bourdieu 1977; Minick 1985; Mehan in press). In short, a virtual functionalist consensus in the social sciences 20 years ago has dispersed (though notably less in cognitive studies than in many other arenas in the social sciences). While elsewhere in anthropology and sociology variations on the questions raised in the present discussion are to be found within the epistemological perspectives of (post)structuralists, Marxists, and phenomenologists as well as functionalists. The natural attitude, *praxis*, activity, cultural practice, *habitus*, dispositions and practical consciousness are embedded in a diverse spectrum of theoretical formulations of the social and cultural character of human thought and action, and in different conceptions of culture, structure, knowledge, self and body, not to mention the nature of theory and method.

While there are clearly burgeoning opportunites for reconceptualizing common concerns, one *caveat* is in order before we proceed. These rich theoretical possibilities must create a new generation of problems for cross-disciplinary relations. Collaboration between cognitive anthropology and cognitive psychology, never a simple matter, becomes

domains, routine maintenance and productive activity, or manual routines and creative mental work. "Everyday" is not a time of day, a social role, nor a set of activities, particular social occasions, or settings for activity. Instead, the everyday world is just that: what people do in daily, weekly, monthly, ordinary cycles of activity. A schoolteacher and pupils in the classroom are engaged in "everyday activity" in the same sense as a person shopping for groceries in the supermarket after work and a scientist in the laboratory. It is the routine character of activity, rich expectations generated over time about its shape, and settings designed for those activities and organized by them, that form the class of events which constitutes an object of analysis in theories of practice.

If everyday experience is the major means by which culture impinges on individuals, and vice versa, then functionalist and social-practice theories imply different answers to questions about *what* cognitive activity is the appropriate object of analysis. In traditional cognitive experiments subjects' performance on laboratory tasks are compared to a normative model, to an ideally meritocratic performance. In practice, theory attention shifts to everyday activity, which becomes both the measure of the experimenter's ability to design generalizable experiments, and the source of explanations for varieties of performance in those experiments (chapter 5). This motivates, as we shall see, a different set of problems and questions than the study of virtuoso performance and peoples' failures to produce such performances.

Practice theory has eclectic roots in the work of Marx, Bourdieu, Sahlins, and Giddens among others, and might be described as a cluster of theories about the nature of practice which agree about the importance of a broad range of issues and levels of analysis embodied in the focal concept. This work emphasizes the dialectical character of relations fundamental to the socially constituted world – dialectics provides an obvious relational model for synthesis. And it is focused in part on experience in the lived-in world. Giddens argues:

> Social analysis must be founded neither in the consciousness or activities of the subject, nor in the characteristics of the object (society), but in the duality of structure . . . The subject/object dualism has . . . also to be overcome in the rather different form in which it appears in theories of socialisation. That is to say, we have to avoid any account of socialisation which presumes either that the subject is determined by the social object (the individual as simply 'moulded' by society); or, by contrast, which takes subjectivity for granted as an inherent characteristic of human beings, not in need of explication. *(1979: 120)*

Bourdieu, anthropologist turned sociologist, whose *Outline of a Theory of Practice* (1972; English edn 1977) has given strong impetus to synthetic theorizing, locates the enterprise in the study of everyday practice:

> We shall escape from the ritual either/or choice between objectivism and subjectivism . . . only if we are prepared to inquire into the mode of production and functioning of the practical mastery which makes possible both an objectively intelligible practice and also an objectively enchanted experience of that practice. *(1977: 4)*

This last includes:

> all that is inscribed in the relationship of familiarity with the familiar environment, the unquestioning apprehension of the social world which, by definition does not reflect on itself and excludes the question of the conditions of its own possibility. *(1977: 3)*

And, to add a third, anthropological, voice, Comaroff (Comaroff and Roberts 1981; Comaroff 1982; in preparation) proposes a dialectical theory that takes the constitution of sociocultural order and political economy as one term of a dialectical relation, and individual experience of, and action upon, the lived-in universe as the other.

> In formal terms, this dialectic has its genesis in the dualistic character of all historical systems, which exist at two analytically distinct levels. On the one hand, they consist in the social and material relations which compose the everyday lived-in world of any society, a world of appearances that represents itself, in the consciousness of experiencing individuals, in the form of substantive rules and relationships, values and interests, constraints and conflicts. On the other hand, behind this lived in world lies a constitutive order. The latter subsists simultaneously as a semiotic system, a cultural *langue*, of signs, symbolic oppositions and categorial relations, and as a set of organizational principles which structure the material and social universe, its component productive and political arrangements. *(in preparation: 16)*

All of these social theorists are critical of functional (and also phenomenological) problematics.[7] They are notably concerned with dialectical synthesis, and assume the partially determined, partially determining character of human agency, thus emphasizing the impact of practice on structure as well as the reverse. Their work recommends the study of social practice in spatial and temporal context. For the synthetic character of these theories makes it difficult to argue for the separation of cognition and the social world, form and content, persons acting and the settings of their activity, or structure and action. Internalization is a less-important mode of contact with the world than action in the world.[8] In sum, theories of practice do offer fields for action within which to fashion a theory of everyday activity. And they are major sources of

theoretical claims for the centrality of practice in the reproduction of society.

In recommending "practice" as a focal concept, Ortner has nonetheless criticized studies of social practice for their individualistic, narrowly rationalistic bent, a tendency to emphasize utilitarian interests as the motivation for human action (1984). Everyday arithmetic provides especially apt subject matter for considering the problem she has raised. AMP analysis suggests that the motivations of mundane arithmetic are varied, being far more complex and specifically constructed than they are assumed to be when reduced to the global self-interested calculation of a "rational economic man" (sexism intended). But there *is* a disturbing parallel between practice theories and existing cognitive theory, as both tend to reduce activity (or cognition) to narrowly defined rational action. Foucault provides a reminder that there have been very different historical forms of description and meaning imposed on everyday life, and that ours is but one, culturally constituted, possibility. He traces the uses and meanings of everyday life through early-Christian confession, to seventeenth- and eighteenth-century *lettres de cachet* addressed to kings (Morris and Patton 1979: 84) to a diffused, depersonalized version of "the everyday" in today's academic discourse. Instead of "disputes between neighbours, the quarrels between parents and children, the domestic misunderstandings, the excesses of wine and sex, the public bickerings and many secret passions" (quoted in Morris and Patton 1979: 86), today the everyday is addressed in research journals as a field to be colonized and improved by psychologists and educators, styled as a technological field of mental skills, rational interests and problem solving. Instead of petitioners and enforcers of royal directives, there are novices and experts whose goals, respectively, are to acquire scientific knowledge, and to engage in professional, normative science.

If the analytic concept of the individual is reduced to a self-contained, disembodied technology of cognition, knowledge is reduced to scientific "discoveries," and society to a set of actors whose lives are structured only by self-interested motives, then both the analyses and conclusions that follow must surely involve deep impoverishment and distortion of their object. It will be argued here, instead, that a more appropriate unit of analysis is the whole person in action, acting with the settings of that activity. This shifts the boundaries of activity well outside the skull and beyond the hypothetical economic actor, to persons

engaged with the world for a variety of "reasons;" it also requires a different version of the everyday world.

It is within this framework that the idea of cognition as stretched across mind, body, activity and setting begins to make sense. But we have arrived at the limits of the sociological theories of practice, for they do not specify a novel theory of cognition itself. Instead, "cognition" seems to represent one limit of the field of their inquiry. Bourdieu takes cognition in its conventional sense as an unexamined primitive element of his concept of dispositions (though at the same time he blurs the distinction between mind and body by emphasizing the knowledge-ability of the body (e.g. 1977: 15ff)). Giddens uses "stocks of knowledge" stored in memory, an ethnomethodological construct, in much the same manner that a cognitive psychologist such as Simon might picture long-term memory as an encyclopedia. These views continue to relegate culture, acquisition of knowledge and memory to an internalized past, closing it to the investigator except as it "surfaces" in present action. Giddens requires actors to bring to bear "typified schemas" in everyday situations, arguing essentially for the importance of learning transfer conceived in conventional terms (1984: 22).[9] A major task of the book, then, is to work out conceptual and methodological forms that will allow us to theorize about cognition in everyday practice. But we shall also come back to the social theorists to locate practice within their more encompassing views of social order.

Answers and questions

The book is divided into two parts. The first, "Theory in practice", is a critique of the practice of cognitive research, developed in part by constructing an empirical case for the situational specificity of arithmetic activity. Chapter 2 analyzes experiments on learning transfer, since this concept specifies the conditions for general learning and continuity of activity across settings in the conventional functionalist perspective. In chapter 3 arithmetic activity in the supermarket is extracted from grocery shopping, to compare AMP participants' performances, procedures and errors in price/quantity ratio arithmetic in the supermarket with those occurring in paper and pencil arithmetic sessions. These and other analyses (e.g. the work of Carraher, Carraher, and Schliemann, and that of Scribner) provide evidence for situational discontinuities in math practices. They recommend a move away from functionalist to

some form of practice theory, and from "learning transfer" as the explanation for cognitive continuity across contexts, to an analytic approach in terms of the dialectical structuring of the activity of persons-acting in setting.

The first part of the book also addresses evidence for the cultural specificity of cognitive theory. It is puzzling that learning transfer has lasted for so long as a key conceptual bridge without critical challenge. The lack of stable, robust results in learning transfer experiments as well as accumulating evidence from cross-situational research on everyday practice, raises a number of questions about the assumptions on which transfer theory is based – the nature of cognitive "skills," the "contexts" of problem-solving and "out of context" learning, the normative sources of models of good thinking and less than perfect "performances." Transfer theory may well owe its longevity to its central location in the web of relations discussed above, institutionalized in divisions between the disciplines of anthropology and psychology, in schooling, and in dichotomies between scientific and everyday thought. Basic and profoundly embedded assumptions govern the persistent loyalty to transfer and all that it stands for, and a strong break with this tradition, though costly in theoretical consensus, is a promising means for moving the study of cognition into the larger social world (chapter 4).

But establishing empirical evidence for the situated construction of arithmetic activity does not constitute an explanation of the phenomenon, nor does it offer a positive alternative. The second part of this book ("Practice in theory") addresses these issues. A comparative analysis of two experimental approaches to the study of proportional reasoning in the supermarket (chapter 5) introduces the concept of structuring resources in activity and their articulation in varying proportions across situations. A series of questions explored in chapters 6 and 7 address further the possibility that math activity takes forms not captured in school-like procedures. What constitutes "a problem" in the supermarket or kitchen? What motivates problem solving if not demands for compliance by problem-givers? To what extent is means/ends analysis an adequate description of arithmetic practice or other activity? Some answers have begun to take shape: quantitative procedures in the supermarket appear to take their character in ongoing activity rather than to imprint canonical forms of problem solving on spaces between segments of grocery shopping. People do not have a math problem unless they have a resolution shape – a sense of an answer and a process for bringing it together with its parts. Problem solvers

2

MISSIONARIES AND CANNIBALS (INDOORS)

In the conceptual schema of cognitive psychology, cognitive transfer (or its absence) is held responsible for continuity (or discontinuity) of activity across situations. This genre of research speaks only in hypothetical voice about what cognitive activities outside school might be like, relying on the concept of transfer to provide a plausible account of relations between schooling, the workplace, and the everyday lives of jpfs. Learning transfer is assumed to be the central mechanism for bringing school-taught knowledge to bear in life after school.

Because transfer is so central, it seems logical to begin an investigation of everyday cognitive activity with a reexamination of this formulation of relations between cognition and the everyday world. These relations are reflected in the typical practices of research on learning transfer, broadly structured in sequences of laboratory experiments in which subjects are set tasks of formal problem solving. Normative models for correct solution are used to evaluate subjects' performances, and these evaluations of cognitive preparedness are extrapolated from experimental to everyday situations. I have drawn on several reports of experiments on learning transfer in order to analyze the culture of transfer research. "Culture" here includes both the cultural context within which the experimental enterprise is embedded and its customary beliefs, practices and interpretive forms. Together they help to explain the conventional conceptual boundaries which shape particular sets of meanings of "context," "culture," "knowledge," and the social world.

History, myth, and learning transfer

Learning-transfer research had its beginnings in Thorndike's critique of the doctrine of formal discipline. Any form of mental discipline was

supposed to improve the minds of school pupils in a general way. This rationale, a popular defense for Latin instruction in the early 1900s, is still heard in the 1980s in defense of geometry, other branches of mathematics – and Latin.[1] In functionalist psychological theory, mind and its contents have been treated rather like a well-filled toolbox. Knowledge is conceived as a set of tools stored in memory, carried around by individuals who take the tools (e.g. "foolproof" arithmetic algorithms) out and use them, the more often and appropriately the better, after which they are stowed away again without change at any time during the process. The metaphor is especially apt given that tools are designed to resist change or destruction through the conditions of their use.

Two theories of learning transfer follow from the notion of knowledge as tool: one argues for many special purpose tools, the proper one for each task, while the other argues for a few general purpose tools to be used in the largest number of circumstances. Indeed, there have been roughly two schools of thought about the mechanisms of learning transfer. Thorndike (1913: 397) suggested that the more two situations shared specific components, such as "ideas of method and habits of procedure," the more likely the "spread of improvement" from one situation to the other. Judd (1908), a student of Wundt's, proposed that learning transfer depended upon generality of understanding: the more general the principle, the more likely the recognition that a newly encountered problem might belong to a class of problems already known. Both Thorndike and Judd reported some successes and numerous fruitless attempts to demonstrate learning transfer in laboratory and school settings.

Studies of transfer became a highly technical matter of warm-up effects and stimulus predispositions in the 1950s and 60s (Ellis 1969). But recent studies bear a closer resemblance to work early in the century. Simon, for example, in describing "new" advances in the theory of learning transfer, presents merely a conjunction of the theories of Thorndike and Judd:

> Transfer from Task A to Task B requires that some of the processes or knowledge used in Task B be essentially identical with some of the processes or knowledge that have been learned while acquiring skill in Task A . . . [And secondly] to secure substantial transfer of skills acquired in the environment of one task, learners need to be made explicitly aware of these skills, abstracted from their specific task content. *(1980: 82)*

This continuity with turn of the century psychology will come to light many more times in the course of the discussion, reflecting the roots of

current functionalist theory in the social sciences of that time (see especially chapter 4).

The "ethnographic" exercise which follows is based on four well-known papers describing some 13 learning transfer experiments. Reed, Ernst and Banerji carried out research on river crossing problems (1974), Hayes and Simon on a version of the tower of Hanoi (1977), Gick and Holyoak (1980) on Duncker's "radiation problem" (1945), and Gentner and Gentner on models of simple electrical circuits (1983). The papers fall into a chronological sequence and the later ones take into account the results of the earlier studies. The experiments, which took place in laboratories, with high school and college students as subjects, consisted of sequences of puzzle-solving tasks. Learning transfer is inferred in several different ways, but the most common criteria are an increase in efficiency or accuracy of performance, or use of a general form of the solution to one problem in solving other problems. The cast of characters in these experiments is quite colorful – missionaries, cannibals, jealous husbands, teeming crowds, flowing water, forts and revolutionaries and strategies for reducing tumors through radiation, as well as monsters and globes instead of the more usual pegs and rings in the tower of Hanoi problem.

Table 1 summarizes general features of the experiments, which are described in the next section. I have called this an ethnographic inquiry to suggest that the goals of analysis here are different from those of cognitive experimenters as they assess each other's work. The descriptions of experiments are intended to provide a basis for elucidating their underlying assumptions, especially those concerning relations between cognition, activity and the social world. There is the immediate question of whether the experimental evidence confirms that learning transfer is an important medium for the achievement of continuity in activity across time and situations. But there are more fundamental issues as well. First, since problem solving is ubiquitous and central to the definition of experimental tasks, there is an opportunity to look closely at the meaning of "problems" and what constitutes "problem-solving activity" in this genre. Next, whatever the conception of problem solving it must affect research strategy, especially the development of normative models of "good" or "correct" procedures and solutions, and diagnoses and proposals for the remedy of deficiencies of transfer. And since cross-situational transfer implies that situations or contexts are units of analysis, careful consideration will also be given to their role in the transfer literature.

Table 1 *Characteristics of four sets of learning transfer experiments*

Problem	Form of transfer expected	Transfer?	Rationale	Researchers	Publication date
Missionaries and cannibals	algorithm	no	understand problem solving	Reed *et al.*	1974
Tower of Hanoi	algorithm	(yes)[a]	understand problem solving	Hayes and Simon	1977
Radiation	analogy	(yes)	important to science	Gick and Holyoak	1980
Electric circuits	generative analogy	(yes)	important to science	Gentner *et al.*	1983

[a] () = a conditional answer

The everyday practice of cognitive research

(1) Reed, Ernst and Banerji set out "to study the role of analogy in transfer between problems with similar problem states" (1974: 437). They began with a formal analysis of the missionary and cannibal problem, a flow diagram showing all permissible moves for transporting pairs of people across a river in such a fashion that cannibals do not outnumber missionaries on either bank. This was paired with a formally isomorphic but slightly more complicated problem, "the jealous husbands," in which each husband-and-wife pair has a unique identity. To investigate transfer, defined as significant improvement in performance from one problem to the other, Reed *et al.* compared solution time, number of moves and number of erroneous moves for each pair of problem-solving attempts, looking for statistically significant improvement.[2] In one experiment the subjects were not told that the problems were analogous. In another they were instructed that "the easiest way to solve the [second] problem is to take advantage of your correct solution to the [first]" (1974: 440). Subjects could use objects to represent characters in the problems, their comments were recorded as they talked aloud, and measures were obtained by analyzing the tapes. The results reported by the experimenters were more pessimistic than warranted by the data, since they did not control for the initial difficulty of the problems in their measures of transfer. But their negative conclusions were basically correct; when subjects were not told about the relationship between problems they failed to transfer. Moreover, there was transfer from the more complex to the simpler problem only when subjects were *directed* to do so.

(2) Hayes and Simon (1977) were concerned both with exploring the sensitivity of problem-solving activity to small differences in textual presentation of problems and with transfer of training between isomorphic problems. The tower of Hanoi, given a new disguise in terms of monsters and globes, provided the form for these problems. Half were "transfer" problems: monsters or globes moving from one place to another. The others were "change" problems: the monsters or globes changed sizes. There was a second, cross-cutting dimension. In half of the problems the monsters were agents, responsible for transforming or moving things. In the rest monsters were moved or transformed (i.e. as the object of the action, or "patient"). This produced four types of problems: transfer/agent (TA), transfer/patient (TP), change/agent (CA), change/patient (CP).

difference in initial solution times for patient and agent problems, these results also disconfirm the original hypothesis.

Given such confusing and contradictory goals and evidence it is small wonder that the experimenters sum up their results in the most concrete terms:

> We have shown that differences among the texts of isomorphic problems influence problem-solving behavior strongly in three ways:
> a. Problems involving transfer operators were solved much more quickly than problems involving change operators.
> b. Both the agent–patient variation and the transfer–change variation influence the notation which the subjects use to solve the problems.
> c. Transfer between two problems is greater when the difference between the problems is an agent–patient variation than when it is a transfer–change variation.
> *(1977: 41)*

Even these claims seem too strong. Nonetheless, this paper is cited by Gick and Holyoak as having "demonstrated positive transfer" (1980: 347).

(3) Gick and Holyoak wished to move beyond computational problems, to "the kind of ill-defined problem for which an analogy from a remote domain might trigger a creative insight." (1980: 308). They asked subjects to read a story describing a problem and its solution, and then observed how subjects used this puzzle-solving exercise analogically in solving a subsequent target problem. They constructed a propositional analysis of various stories to demonstrate the formal correspondence of relations among their elements (similar to the flow diagrams in Reed *et al.* 1974). The common problem in all their experiments was to figure out how to destroy a tumor by radiation without also destroying healthy tissue (Duncker 1945). One solution is to administer a number of small doses of radiation from different angles so that they intersect at the site of the tumor; the radiation doses to other tissue are smaller than the accumulated dose to the tumor and hence cause minimal damage to healthy tissue. Duncker found that only two out of 42 respondents gave spontaneous solutions of this kind to the radiation problem.

In the first experiment analogous stories were presented one after the other, first what they called a "base analogy" story, then the "target domain" story, Duncker's problem. Subjects were asked to think aloud as they worked, and were instructed "to try to use the first story problem as a hint in solving the second (radiation) problem" (1980: 320). The experimenters made elaborate efforts to increase the use of analogic problem solving procedures:

> Subjects in the experimental conditions who at first failed to generate the analogous solution were eventually prompted to reread the instructions. If they still did not produce the analogous solution, they were then reminded to use the prior story as a hint. *(1980: 320)*

In tandem with the radiation problem subjects were given various irrelevant, complete and partly analogous stories (e.g. to move small groups of revolutionaries close to a fort they are to attack without being detected). In this experiment, as in others, subjects given analogous base stories and heavily coached, consistently made the analogic connection; those uncoached and without initial analogue stories almost never arrived at the "correct" analogue solution to Duncker's problem.

Gick and Holyoak envision analogic problem solving as a three-step process. First the subject must represent a base puzzle with its solution, and a target puzzle in propositional form, then detect a small number of correspondences between them which make it possible to assign many more. The elaborated mapping may then be used to generate a solution to the second problem parallel to the first. The central issue explored in the sequences of experiments is why people might not be able to use analogies – failures to apply them, failure to locate an analogy in memory, or failure to see its relevance to a new problem. Thus, following the initial experiment, four others were designed to counter specific competing interpretations of features of the first. One substituted written for oral instructions to eliminate the possibility that interaction with the experimenter was leading subjects to a solution, though the hints given orally in the first experiment were also included in the written instructions. In another experiment subjects generated their own solutions to the base story, instead of being told a solution. Half of them produced the experimenters' favored solution, and 40% of these solved the radiation problem analogically (20% of the group, compared to 76% in the more constrained experiments). Interpretation of this experiment was focused on the possible distracting effect of generating several solutions.

Their remaining experiments began with a critique of the first three:

> In many cases of everyday problem solving in which an analogy could help, the person would have to spontaneously notice the correspondence between the target problem and some analogous problem, either of which might be stored in memory. The two experiments reported below begin to investigate the effect of such additional processing requirements on analogical problem solving. *(1980: 341)*

That is, they ignore their speculation about everyday problem solving in order to follow up the question of memory load. They concluded that:

Most previous research on human cognition has focused on problem-solving, and has confined its investigations to the laboratory. As a result, it has been difficult to account for complex mental processes and their place in culture and history. In this startling – indeed, discomforting – study, Jean Lave moves the analysis of one particular form of cognitive activity – arithmetic problem-solving – out of the laboratory into the domain of everyday life. In so doing, she shows how mathematics in the 'real world,' like all thinking, is shaped by the dynamic encounter between the culturally endowed mind and its total context, a subtle interaction that shapes *both* the human subject and the world within which it acts.

The study is focused on mundane daily activities, such as grocery shopping for 'best buys' in the supermarket, dieting, and so on. Innovative in its method, fascinating in its findings, the research is above all significant in its theoretical contributions. Lave offers a cogent critique of conventional cognitive theory, turning for an alternative to recent social theory, and weaving a compelling synthesis from elements of culture theory, theories of practice, and Marxist discourse. The result is a new way of understanding human thought processes, a vision of cognition as the dialectic between persons-acting and the settings in which their activity is constituted.

The book will appeal to anthropologists, for its novel theory of the relation of cognition to culture and context; to cognitive scientists and educational theorists; and to the 'plain folks' who form its subject, and who will recognize themselves in it, a rare accomplishment in the modern social sciences.

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