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A Model System for the Study of Learning Difficulties*

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Introduction to this issue*

This issue of the Newsletter is devoted entirely to the description of a rather extensive research project concerning school related learning disabilities. The origins of this project are important to its understanding. During the latter part of the 1970's, representatives of four heretofore disparate research programs identified with three different academic disciplines found themselves interacting in the service of their separate goals. At the Rockefeller University, a group including Michael Cole, Ray McDermott, Lois Hood, and Kenneth Traupmann puzzled over the problem of the ecological validity of psychological experimentation as one step toward building a theory of culture and cognition. (Cole, Hood and McDermott, 1978). For both theoretical and practical reasons this group settled on schooling as the arena in which to conduct its investigations. This choice brought them in touch with the other groups who eventually combined to form the present research project.

During 1977, Ann Brown and Joe Campione visited the Rockefeller laboratory to discuss that group's inability to discover strict analogues of standard psychological learning tasks in the everyday interactions of school children. In the course of these discussions they discovered that one of the Rockefeller research subjects had been diagnosed as Learning Disabled (LD). That discovery provided a very direct challenge. The Rockefeller group had been working with this child for several months in an environment chosen for the relevance of school-based skills (reading recipes, measuring) yet they had not picked this child out as different in any special way from the others. It appeared that the difficulty of cognitive task analysis outside of experiments intersected with a long standing query: Why are learning disabilities so often identified only when a person is in school? (Edgerton, 1979; Mercer, 1974). This question fed directly into the Brown-Campione concern with the schooling of retarded children (Brown and Campione, 1978).

The Rockefeller group's interest in learning environments led the Ford Foundation to ask them to advise one of their projects investigating the relation of classroom interactions to classroom learning. This contact brought together the psychological, anthropological, and psycholinguistic backgrounds of the Rockefeller and Illinois groups with the microsociological and sociolinguistic skills of Bud Mehan and his colleagues at the University of California, San Diego (Mehan, 1979). At the same time, Mehan was interacting with scholars at the Center for Applied Linguistics, who approached classroom learning from a perspective which added an interest in reading pedagogy-in-context to sociolinguistic theory. It was in this way that we came in contact with Peg Griffin.[1] (Griffin & Shuy, 1978).

When the Laboratory of Comparative Human Cognition (LCHC) was formed at UCSD in 1978, it became possible to unite many contributors to the early discussions about cognition and social interaction. The problem of cognitive task identification in different contexts, using education-related settings as the specific focus, has remained central to the work of the LCHC group. Along with the other research strategies which members of the group have employed, we spent some time exploring the implications of that initial contact with a learning disabled child in settings where he did not appear conspicuously learning disabled.[2]

The ongoing activity of Bud Mehan's group had led them to trace the institutional histories of children placed in special education programs. Mehan's work dovetailed with the research on ecological validity, and reinforced our belief that the various psychological categories which form the descriptive basis for assign-

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[1]This account is not intended to be exhaustive, but it would be improper not to note the lasting impact of Courtney Cazden and Marge Martus, each of whom acted as a significant catalyst in our early interactions.

[2]Some preliminary observations and their implications have been published; see Cole & Traupmann, 1980; Hood, McDermott and Cole, 1980.

ments of children to psycho-educational categories are frought with theoretical and practical difficulties.[3]

Before turning to the report itself, it is necessary to include another crucial ingredient of the UCSD environment provided by our colleagues in the Center for Human Information Processing (CHIP) of which LCHC is a part. Our inclusion within the organizational framework of CHIP has provided us with a stimulating environment within which to work,out the nature of a unified cognitive science. One important addition to the Laboratory's capacity to undertake the present project came from James Levin, who received his Ph.D. in cognitive science at UCSD. Jim's theoretical ideas about distributed processing mechanisms has been influential in all of our work and his expertise with microcomputers has opened up entirely new possibilities for diagnosis and training of cognitive skills. The importance of our interactions with the CHIP group will be clear in the exposition to follow.

In summary, five different research traditions (1) psychological, (2) anthropological, (3) sociological, (4) linguistic, and (5) cognitive science came together in a coordinated effort to improve our understanding of learning handicapped children. For the past two years we have been at work, and we have reached a point where we find it productive to interact with our colleagues concerning the project as a whole. It is in the hope that we will generate further interactions of the kinds to which this Newsletter is devoted that we present this report.

INITIAL PLANS

By the time we initiated this research, the participants had interacted sufficiently to have a rough idea of how to begin. We refer to these entering notions of appropriate research activities as "strands." Each strand typically involves its own methodology, although there is clear overlap among them.

The major strands of activity

Classroom observation. We videotaped the children in their reading lessons to obtain a record of their behavior in the central educational effort aimed at reading.

Standardized cognitive tasks. We administered a sample of psychometric tests which are used to classify children into one or another special education categories (primarily, the revised Wechsler Intelligence Scale for Children, WISC-R) and tests used by school district personnel that are normed to provide a scalable assessment of the individual child's progress.

Specially designed cognitive tasks. We administered a battery of specialized cognitive tasks, designed to include a wide range of procedures to pinpoint specific, theoretically motivated, cognitive processes implicated by the standardized tests in the patterns of children's responses (memory, attention, etc.). These tasks were grouped into three categories on the basis of prior research: strategic, metacognitive, and basic speed of processing measures. The tasks categorized here all have a long history of research, tying performance patterns to theories of cognition and learning (see Campione and Brown, 1978; Campione, Brown, & Ferrara, in press).

[3]See Mehan et al., 1981; Mehan, in press (a); Mehan, in press (b).

Cognitive training and transfer. The tasks in this category are a subset of the theoretically motivated experimental tasks. The emphasis in this case is on training and testing for transfer of cognitive skills plausibly claimed to play a causal role in the performance of one or more category of learning handicapped child. Thus far, we have concentrated heavily on a few test-based cognitive skills during this project: the uses of cumulative rehearsal and category clustering in free recall, *inductive reasoning rules,* and the cognitive representation of the number line are two examples.

Resource room activities. This was our name for the activities designed to be analogous to the after-school clubs that had motivated our *initial* interest in LD children. Computer-based activities were to figure in heavily in this strand.

Playground, neighborhood, and home observation. This strand was designed to provide us with a larger picture of the child's skills and interests than we could capture in classroom, resource room, or test-like activities. It would also allow us to study the interface between school and home, providing us with a crucial way to check on the "six hour LD" syndrome that is so widely reported. (Mercer, 1974; Edgerton, 1979).

Initial research strategy

The research strands listed above specified a number of component activities, but they certainly did not represent a coherent research strategy. Nor, at the outset could we specify how these strands should be integrated into a single, integrated approach; that integration was to be the product of the first few years of work. Yet to begin the research, we needed an entering strategy. We could, for example, conceive of each strand as a data domain from which to extract indicators of the child's special disability. This approach, however appealing for the efficiency it promises when the research is done, presupposes that we already know the relevant categories for coding behavior. While we had too much experience to stumble blindly into that sinkhole, we had no systematic alternative. We did, however, have a number of specific intersituational comparisons that we felt certain would be instructive, even if we did not come up with a correlation matrix to represent intersituational comparisons.

The entering strategy that we adopted involved the construction of a set of in-depth, longitudinal case studies. We began collecting data under the constraints set by our entering notions of research and the institutional constraints of a public elementary school.

We had planned to observe the children in their classrooms during their ordinary reading lessons with the teacher. The resource specialist and classroom teachers identified candidate children for research. The intrusion of videotaping was to be our only intervention in the classroom at first. We felt that the surest mark of the success of our pull-out training efforts would be evidence of academic improvement in normal lessons and tests.

The school and the kids: First try

We were fortunate to encounter a learning specialist who worked in a pair of modest working class schools close to the UCSD campus. The populations of the schools were predominantly Anglo, with a significant

proportion of Hispanic and South East Asian children.[4] Each school had a learning specialist who worked in a resource room. One had a special classroom for mentally retarded (EMR). We began there. We will call it Essa School.

After several discussions with the principal and teachers, we began data collection aimed at selecting a population of children appropriate to our aims. Using school records and standardized test results, we selected 22 children all of whom shared one characteristic: they were classified as poor readers by the school, i.e., they read significantly below the local grade-level norms. Within this population were 13 children classified by the school as LD and 9 classified as EMR (educably mentally retarded). For the first several months of the project we slowly made baseline observations of the sample population. We knew that the categories provided by the school would be problematic and we were eager to dig into the variability. We made contact with the standard diagnostic categories by administering WISC-R's to each of the children. We also videotaped the sample children in their reading activities either in their classroom or when working with the learning specialist.

The results of our initial survey gave us plenty to think about. The students were just what we wanted in one important respect; according to standard measures of academic achievement and standardized ability scores the sample included children classified as poor readers with LD, EMR and normal I.Q. patterns. However, only one of the children in the group categorized as LD by the school was LD by the criterion most widely accepted in the field: Average intelligence for a full scale I.Q., with a large difference between Verbal and Performance subtests, and an accompanying deficit in reading achievement. The matter was not improved by trying alternative categorizing schemes (e.g., the Bannatyne tripartite scheme, or a division based on tests of hemispheric influences).

While we were pondering how to proceed given this disparity between institutional and clinical assessments of the students, the classroom teachers began to express discomfort with our work. We were a nuisance, tolerated but not particularly welcomed by busy teachers, for whom our presence offered no visible benefits and some clear costs in terms of classroom activities. No matter how we explained our work, we found ourselves very limited in being able to carry out the fine-grained, intersituational study that our entering strategy demanded.

Our first response to these difficulties was a lateral move. We had started research at Essa School. When standardized testing at Delf School revealed that there was a larger population of students who tested as LD we decided to concentrate our efforts there, continuing at Essa School for specialized efforts.

At this point, the project almost came to a halt. We had barely begun to conduct initial screening of students at Delf School to select comparison samples for the LD children when the teachers asked to withdraw!! In a meeting between the teachers, the principal, and members of the research team, the reasons for this withdrawal were spelled out. Delf School, like many other schools in the District with low reading scores, is under district pressure to make improvements *now.* The District has mandated curriculum, scheduling, and amount of time to be spent on subject matter within the school in an attempt to show improvement. District mandates of curriculum and time on curriculum tasks limited teachers' freedom and flexibility to engage in other projects. These pressures also shaped their expectations about our research. The teachers had expressed interest in the project at the outset because of the possibility of improving the educational life of LD students. However, the cost of that benefit, as measured in terms of teacher time away from curriculum and planning, and removing students from the classroom (for our pre- and post-tests) became too great a burden. They asked us not to do classroom observations, and to limit our assessment.

The meeting to discuss these problems with the teachers and principal was very emotional. Although the teachers agreed to continue participation in a limited way, it was clear to us that they were exceedingly reluctant to do so. We met with the principal shortly after the meeting. Unwilling to give up and unwilling to go on under the constraints that were being imposed, we proposed moving the entire research operation from the school day to *after school* in order to take the pressure off the teachers. This idea was enthusiastically accepted. The principal suggested that we call our after-school-school Delf College. He pledged enthusiastic support of our transformation of the project.

The principal made the school library available for our use. The library is a temporary classroom structure situated across the playground from the rest of the school buildings. We invited all children who had been previously identified for our study to participate.

Opening Delf College

On December 7, 1981 we opened Delf College with 24 students 13 of whom fit the clinical definition of LD. We had been through one year together on the project, attempting to apply our entering understandings at the time we had written the proposal to start this work. None of us had been satisfied with our progress during the first year. Despite time and effort spent on developing ways to work within the school structure, we found that we had either to capitulate to a style of research that fit in better with the school's overriding demands, or get out. Our decision to attempt an afterschool program was an escape from those two, unacceptable, choices.

In its initial impulse, the decision to create an afterschool program was little more than primitive stubbornness, an unwillingness to admit defeat. But this adrenalin-charged response soon yielded to sober reflection about implementing our research plan under radically changed conditions. Our strategy for combining different research approaches had, until this time, relied on the institutional structure and content of the school to provide the superstructure for our enterprise.

For a brief time we contemplated introducing the clubs that had worked successfully at Rockefeller, until we realized that the clubs had existed in contrast to school where we had been able to make appropriate observations. What good would a club be if it was cut

[4]The schools are monolingual in English, with pull-out English as a Second Language support for Limited English Speaking children. There is no program of instruction in Spanish nor classroom use of Spanish.

off from the school? Somehow we needed to create a research setting in which *all* of the essential elements of research and teaching of learning handicapped children could take place. We needed to observe the children engaging in overtly school-like tasks and social structures in order to obtain the contrasts we were interested in. Reading was a particularly appropriate task for our theoretical goals. However, we also needed to confront our position of institutional uncertainty; while we were using a school building, we had no legal authority over the children and no means to compel them to do anything. Their attendance at Delf College would be totally voluntary; we had to compete with soccer, Girl Scouts, and any other activity children routinely engaged in after school. We also had to make our research seem worthwhile to the parents. Parents were most concerned about their children's reading abilities. We found ourselves, willy nilly, forced to put remediation on a plane with scientific analysis as an integral part of our research.

The need to integrate parent and student interest with research activities dictated the gross structure of Delf College. The children would attend between 2:30 and 4:30 in the afternoon. We could use the library and some auxiliary rooms for individual assessment and teaching. We decided to divide the time equally between direct instruction in reading comprehension, and microcomputer based games with instructional value (Riel, 1982).

This macrostructure worked exceedingly well. To accommodate 24 children, we arranged two groups, with some children coming on Mondays and Wednesdays, while others came on Tuesdays and Thursdays. Friday was used for preparation, rest and repair.

INSTITUTIONAL AND CLINICAL DEFINITIONS OF LD: IMPLICATIONS FOR AN ALTERNATIVE RESEARCH STRATEGY

One of the major findings of our recent research has been the frequent disparity between "clinical" definitions of special education students and "institutional" definitions of special education students. Mehan, Meihls, Hertweck & Crowdes, 1981; Mehan, 1982).

Special Education Law. The federal law governing special education (PL 94-142, "The Education for All Handicapped Students' Act") is very specific concerning the population of students to be served by the law, and hence, special education. Handicapped students are:

> . . . mentally retarded, hard of hearing, deaf, orthopedically impaired, other health impaired, speech impaired, visually handicapped, seriously emotionally disturbed, or [are] children with specific learning disabilities who by reason thereof require special education and related services [P.L. 94-142 Sec. 4 (a) (1)].

For each designation, e.g., "mentally retarded," "learning disabled," there is an accompanying set of defining criteria. So, for example Mehan and his colleagues found in research in another Southern California school district that a child is considered to be "learning disabled" when s/he falls into one or more of the following categories:

1. Whenever there is severe discrepancy -- at least two years -- between the child's capacity and his/her school achievement. This discrepancy can be for either one or more academic subjects.
2. Whenever there is evidence of a severe skill deficit, for instance in motor or perceptual development.
3. Whenever there is a behavior disturbance of such a degree that the child is unable to profit from the regular classroom experience.

School districts that operate under the guidelines of PL 94-142, establish special education programs to serve the needs of students who meet these (and other) defining criteria. These programs include special classrooms set aside for students, "pull-out" activities (in which students are removed from their classrooms for special assistance for a part of the day), and in-class remedial assistance (in which an aide or tutor works with the student within regular classroom hours, or assistance is provided to the regular classroom teacher). The special education referral process is an important aspect of this special education program. PL 94-142 directs school districts to establish a systematic procedure to identify, assess, and place students in appropriate learning environments -- learning environments that can best meet their special educational needs. In the school district Mehan et al. (1981) studied (similar procedures exist at Essa and Delf schools), the referral process was composed of a series of actions, including school-site committees, psychological assessment, parent conferences, and district-level committee meetings. The purpose of this process is to meet the needs of the handicapped student by developing an "individualized educational plan" (IEP). It is the purpose of the IEP to match the *needs* of the student to the *characteristics* of a special education program.

Theoretically, and according to Federal guidelines, there should be a match between special education programs and student populations. That is, programs that have been established for the "learning disabled," the "educationally handicapped," or the "dysphasic" should be populated by students who meet the special education criteria for that designation. When Mehan and his colleagues examined the ways in which a school district implemented the provisions of special education laws, they found a gap between clinical and institutional designations of students. Students with clinical designations such as "learning disabled" were not necessarily in LD programs; special education programs established for a certain category of special education student were not necessarily populated by students with that designation.

There were "good organizational reasons" for this arrangement (Garfinkel, 1967). The educators in the district, like the educators in any other district attempting to implement this law, were faced with a number of economic, legal, and practical considerations. These practical circumstances constrained placement decisions and the processes by which the decisions were reached.

Implications for Delf College: Sample selection. Many of the observations made by Mehan and his colleagues apply to the school in which we are working. Observations of the school and discussions with key educators in the special education referral process reveal institutional practices that are very similar to those reported above. At least some of the students who have been institutionally defined as "LD" or "EH" do not have clinical profiles that match those designations. That is, students are placed into Special Education programs such as LD or EH on the basis of existing numbers of stu-

dents already assigned. Students can be moved into the full LD program only if another student is moved out. Likewise, a student is unlikely to be moved out until another student is ready to take his place. Students may be placed in a program because it has a vacancy, not necessarily because it matches their clinical profiles.

Because of this state of affairs, we early chose a sample population that was likely to permit us to evaluate the interplay of institutional and clinical/educational factors in creating heterogeneity among presumably LD children. We started with the category "poor reader," an institutional category provided to us by the school. We then divided this group into two groups. One was composed of students institutionally defined as "LD"; the other was composed of students *not* institutionally defined as LD. Most of this latter group of poor readers were participating in a remedial reading program (the State of California Miller-Unruh program).

The next branching was defined by the project, and separates the children according to their performance on a battery of standard cognitive tasks. One subgroup performs at a normal level on an overall I.Q. scale but has noticeable differences in performance levels on specified sub-skills that are often a part of full-scale I.Q. tests. The other group has a normal overall I.Q., but few differences between scores of these specified sub-skills.

Our screening battery is a combination of the Peabody Picture Vocabulary Test (PPVT), the digit span subtest from the WISC-R, the comprehension subtest of the WISC-R, the picture completion subtest of the WISC-R, and the coding subtest of the WISC-R. The choice of this specific battery was based upon a number of considerations from our past work. The number of children we needed to screen initially was too large to administer a full scale WISC-R to all children. The PPVT is less difficult to administer and provides a mental age equivalence for a general I.Q. estimate. Since a large part of our population come from homes where English is not the primary language, we were interested in the PPVT as a special case of a language biased test. We included in the battery a procedure developed by Nelson and Warrington (1980) which uses base-line PPVT performance in a training task and which allows for a comparison between children who quickly and easily extend their listening vocabulary and those who do not. The digit span subtest of the WISC-R was chosen because of the central role it has historically played in descriptions of LD children. The comprehension score was included for two reasons. It represents a good estimate of verbal ability, and it can be used to obtain both "standard" scores (obtained under standard testing conditions) as well as estimates of the children's ability to elicit and use help from adults as part of their repertoire of social-interactional skills.

In addition to the digit span and comprehension scales, two performance-type tasks were included in our abbreviated battery, picture completion and coding. Inclusion of these items allowed us to estimate any performance/verbal discrepancies for each child, a widely used criterion for LD; the coding task lent itself well to a more specific question. It is a task which provides a measure of speed of learning. Consistent with this view, in work by Bryant, Brown, and Campione (1982) coding scores were the best predictor, among a number of items, of learning rate assessments obtained from our zone of proximal development research.

In summary, this battery allowed an efficient means for obtaining data relevant to a number of topics we wished to address, including:

--overall intelligence test scores
--estimates of performance vs. verbal abilities
--forward and backward digit spans
--speed of learning, both relatively directly and following intervention

We have used this battery to screen 24 Delf College students, eight certified as LD and 16 who have been designated as poor readers.

As a brief summary, the following table shows the mean I.Q. scale scores for the LD and Poor Reader (PR) groups on the four subtests.

Group/Subtest	Picture Completion	Comprehension	Digit Span	Coding
LD (n = 8)	11.9	12.4	6.0	11.0
PR (n = 16)	11.1	11.4	6.8	10.0

As can be seen, the mean scaled scores are virtually identical for the two groups, with the digit span subtest yielding the poorest performance.

The LD and PR groups also overlap substantially in terms of a number of reading tests administered to the students. Metropolitan and Ginn test scores reveal that both groups tend, on the average, to be reading about two years below grade level. Further, the "lag" distributions are similar. In both groups, about half the children are two years below grade level, with about a quarter either one or three years behind. These results agree nicely with those obtained from the WISC battery we administered in showing that the LD and PR groups are generally quite similar, despite differing institutional labels. Taken as a whole, the diagnostic results make it clear that whatever reasons lay behind the educational interventions that go with such labels as "LD" or "poor reader," these treatments are not related in principled ways to existing cognitive research.

The Curricula

SOME THEORETICAL CONSIDERATIONS

Once we had committed ourselves to teaching reading to this group of children, we faced the central problem of how to do the teaching: What curriculum ought we adopt and how should it be implemented? A few guiding principles and some severe practical constraints guided our choices.

The primacy of comprehension. Although comprehension is the goal of reading, elementary school reading curricula seldom focus on teaching children how to comprehend (Brown, Palinscar & Armbruster, in press; Durkin, in press; Resnick, 1979). In the ordinary reading curriculum a great deal of time, effort, and systematic instruction is devoted to helping children to decode accurately, that is, to derive the oral equivalents of the letters, words, and sentences that they encounter in written language. When there is time, the children are asked about the meaning of what has been read. When a poor reader cannot answer, the teacher must

answer or call on another child. Teacher's manuals and workbooks provide *separate* exercises in comprehension-related skills like "getting the main idea" or "inferences," but there are no hints about how to teach a child *to comprehend a passage.* Passage comprehension is treated as a matter of memory: you comprehend by decoding and remembering what the oral version says and then you report this memory to answer someone else's question. The manuals do not help a teacher to repair a child's miscomprehension or to begin to define comprehension as the goal of reading. Durkin (in press) observed teachers working with a selection of the most popular reading manuals. Little time was devoted to the direct instruction of comprehension. Teachers, following the guidelines of reading series, spent the major part of reading lessons helping children decode.

Analysis of videotapes collected at Essa school during our first year, show this strategy of reading instruction in the classrooms. The lessons include a great deal of oral reading, sometimes in chorus, often with round-robin turns. Work on the meaning of passages is minimal: there are occasional comprehension exchanges and there are separate exercises on meaning in workbooks, but the teacher's role is limited to providing feedback.[5] There is little support in teaching materials or pedagogical theory for anything else.

Toward an interactive learning theory. We were unhappy with the standard reading pedagogy for several reasons. To begin with, the psychological model underlying this pedagogical strategy does not reflect contemporary research and theory on skilled reading. As the work of McClelland and Rumelhart (1981a,b) demonstrates, skilled reading cannot be reduced to discrete translation processes between "constructing the word" and "knowing what it means." Rather, the different processes that assemble both letter and word recognition, and comprehension are the products of activity at many levels of the cognitive system. Like McClelland and Rumelhart, we believe that reading occurs through the interaction of "top-down" (comprehension) and "bottom-up" (feature, letter, and word identification) processes.

Our own approach differs from the work of our colleagues in certain respects. The central differences arise as a result of the fact that we are not modeling letter recognition processes among skilled readers. Instead we are attempting to teach reading to novices. (Formal modeling, to date, has concentrated on simulations of steady state, skilled reading systems). Another difference arises because the level of activity which concerns us (reading for meaning) has not yet been explicitly modeled in computer simulations. A final difference arises because the reading interactions that have been modeled on computers occur between a person and an experimental task, often involving a machine and precluding much social contact with the experimenter, while the interactions that we have to consider occur in large part between reader-student and reader-teacher. Hence, we must find a way to interpret the teaching of comprehension that is consistent with, but not yet specified by, such models.

[5]The important but limited value of such corrective feedback is demonstrated by the work of Brown and Palinsar (1982).

Adding social interaction. Recognition of the special properties of teaching activities as contexts for reading has forced us to broaden existing cognitive science reading models. We believe that this is the kind of extension called for by Norman (1980, p. 2-3) when he says:

> The human is a physical symbol system, yes, with a component of pure cognition describable by [conventional information processing models]. . . .But the human is more: the human is an animate organism, with a biological basis and an evolutionary and cultural history. Moreover, the human is a social animal, interacting with the environment, and with itself. The core disciplines of cognitive science have tended to ignore these aspects of behavior.

The Delf College project can be viewed as one instantiation of this broadened Cognitive Science effort. In it we address the problem of incorporating interactions with people and interactions with objects into a single framework. In undertaking such a chore, we sought out other areas of social science theory which might guide our efforts. Here our prior exposure to the work of Soviet psychologists and the sociolinguistic/micro-ethnographers has provided a very useful supplement to American cognitive/educational psychology. Assuming that the sociolinguistic/micro-ethnographic work is accessible to our readers (see Erickson & Schultz, 1977; McDermott & Gospodinoff, 1979; Griffin & Shuy, 1978; Mehan, 1979; Hood et al., 1980), we will concentrate our exposition here on our use of concepts derived from Soviet sources.

The Soviet school. A number of ideas pioneered by Vygotsky and other Soviet cognitive theorists provide a systematic way to think about the connections between social interaction and cognitive interaction.[6] As a matter of principle, Soviet psychologists distrust dichotomies in the analysis of psychological processes. They emphasize the interpenetration of the social and object worlds as a fundamental aspect of human beings, the creatures on earth distinguished for their power to change the environment within which they live. This emphasis leads them to point out that many of the objects surrounding us are in fact *social* objects, objects whose form embodies their function and the past history of human interactions that produced them.

Soviet psychologists emphasize the importance of everyday activities as the contexts which give shape to our psychological functioning. These ideas are nicely summarized by Leont'ev as follows:

> In activity, the object is transformed into its subjective image. At the same time, activity is converted into objective results and products. Viewed from this side, activity emerges as a process of reciprocal transformations between subject and object. . . . (Leont'ev, 1981, p. 46)

Education is given a central place in Soviet psychological theorizing (along with industrial production) because education is, theoretically, the activity which prepares young people to participate effectively in the adult activities of the society. The result of this common orientation is a theory of cognition in which social and object interaction are seen as constantly mediating each other, a theory which focuses on common practices as the starting point of analysis and which shares with American social science the belief that school activities are a central concern.

[6]See in particular: Leont'ev, 1981; Luria, 1978; Rubinshtein, 1957; Vygotsky, 1978.

One of the key notions that we have adopted in constructing all of our activities at Delf College is Vygotsky's "law of cultural development"

> . . . any function in children's cultural development appears twice, or on two planes. First it appears on the social plane and then on the psychological plane. First it appears between people as an interpsychological category and then within the individual child as an intrapsychological category. This is equally true with regard to voluntary attention, logical memory, the formation of concepts and the development of volition. (Vygotsky, 1978, p. 57)

We would add the development of reading to this list.

Vygotsky referred to the contexts organizing the social-to-psychological transformation of thinking as *zones of proximal development.* Vygotsky used the term to characterize the difference between the level of problem difficulty that the child could engage in "independently" and the level that could be accomplished with adult help.[7] We use the term zone of proximal development (ZOPD) to refer to contexts arranged as mediums for people to accomplish goals in interaction with each other. This rather abstract definition permits us to view all educational interaction as a mutual accomplishment involving both teacher and learner in a single system.

From Luria we have adopted the notion that human interaction is virtually always organized into functional systems, whose parts are coordinated around the higher order goals of the system. In the work for which Luria is best known in this country, the functional systems considered are often those which are easy to characterize as "intrapsychological" so that his work is easily related to American psychologists' interest in how the higher level goals of an individual subject coordinate the behaviors of that subject. Our perspective broadens this reading in two ways: (1) there is no principled reason to exclude multi-partied systems from Luria's theories; and (2) there is good reason, given Luria's intellectual biography, to see that the zone of proximal development can be analyzed as an interpersonal functional system. The goals embodied in the zone of proximal development, the goals of the educator in an educational activity, can be treated as the goals of the functional system. We can treat as *the same kind of unit* the system of the child in his (more or less) independent activity and the system of the teacher-child joint activity. In our case, "the system" refers to reading activity or some other task encountered at Delf College.

In addition, Luria articulated a research strategy which combines general laws from basic research with clinical information about individuals. In his essay on "Romantic Science" (Luria, 1979) he illustrates the way in which normative scientific information can be combined in systems of therapy. As will become clear in the exposition to follow, Luria's work provides a model for our multiple-strand case study project.

From his earliest research, Luria was disappointed with a science of psychology whose creators had agreed to accept a fundamental split between psychology as an explanatory science working with the classical procedures and inferential techniques of the natural sciences and a descriptive science, that aspired to retain all of the richness of living reality. He recognized that this division of labor was built directly into the observations and data collection procedures that scholars in the two halves of the science accepted as legitimate. He believed that each approach provides the analyst with certain crucial information about the nature of mind, but that having divided the labor of analyzing reality, no single account could suffice to account for a single case.

Concepts provided by Leont'ev and Rubinshtein have also proved useful in the design and execution of the curriculum at Delf College. Leont'ev's notion of activity as a nested set of coordinations, bounded at the upper level by very general human motives, has provided us a way of thinking about units and levels of analysis within instructional zones of proximal development. For instance, the innermost nesting, the operations (behaviors accomplished under certain conditions) may *appear* to be independent child productions but in fact be coordinated by the goal oriented action of the teacher in the zone of proximal development functional system. Thus, the Vygotskian general law receives greater specificity: the first appearance on the social plane leaves to the adult the organization of the operations with respect to the educational goal while the second appearance, intrapsychologically, would see the whole functional system coordinated by the child's independent goal oriented actions.

Also central has been Rubinshtein's emphasis that because cognitive interactions are interpersonal, multiple realities must be conceived to converge in the context of problem-solving. Rubenshtein and his students (e.g., Brushlinskii, 1979) have adopted the term *analysis by synthesis* to characterize their view. In their terms, individuals bring their own analyses to bear in an activity within which a synthesis is constructed of the individuals' behavior *in situ.* In this view, the outcomes of such synthetic activities are in the changed individual analyses which the participants carry away with them. The functional system of educational activity (a ZOPD) is a real time synthesis in which the teacher's analyses and the child's analyses interact. We are most interested in tracking how the child's initial analyses of reading change as a result of synthesis with the adult's analyses. The public, observable, aspects of the synthesis (reading group, for example) provide us with a chance to view some parameters of the child's analyses; at the same time, the child's, the teacher's and the researcher's analyses all have an opportunity to change, i.e., we learn from each other.

If we are not mistaken, Rubinshtein's version of analysis-by-synthesis is very similar to the interactive activation model proposed by McClelland and Rumelhart. In their model, analyses of features interact with analyses of letters and words to accomplish word recognition in a way analogous to the way that elements of individual or social functional systems synthesize in the Soviet view of educational activity. The major difference in viewpoints seems to be that in work published to date McClelland and Rumelhart have not yet taken on the problem of learning. From discussions among our research groups, it appears that when they take up the problem of learning, they too will seek ways to keep track of individual analyses over time.

With this preliminary orientation, we will turn back

[7]We place the notion, independent, in scare quotes to signal that we recognize that independence is rarely achieved among interactants; it is, rather, an analytic fiction that has to be wrestled with constantly to maintain a coherent theory of learning systems.

to describe the reading curriculum. It is our hope that this brief excursion into conceptual approaches guiding our efforts to unite curriculum implementation and psychological theories of learning and reading will assist interpretation of our experiment in theory and practice.

FROM THEORY TO PRACTICE

The standard instructional setting is sufficient to foster reading comprehension improvement for most children. Although comprehension teaching in many classrooms is limited, many children learn to read with comprehension. One account for this success is that ordinary readers get a lot of practice reading texts that gradually become harder; they keep up with, and grow with, the changing demands of the material. The structuring of the books in a primer series is sufficient for comprehension for such children. Even if current theories and teachers' manuals cannot support teachers to create an interactional zone of proximal development, a zone is available.

For *poor readers*, the situation is different: they never get past the beginning emphasis on an oral rendition of the written material. They may never get a chance to use comprehension as an aid to decoding written material. They may never get taught how to start out comprehending even the easiest written text. The zone of proximal development that the primers provide for good readers may not be one that poor readers can enter; if we have an especially limited resource to create a zone of proximal development *for comprehension*, then children experiencing difficulty are without an appropriate instructional environment.

As if responding to a vacuum, the poor readers make their own sense of the time they spend reading. The children at Delf College appear to be operating with a classic "poor reader" interpretation: reading is reading outloud; reading is decoding; discovering the meaning is something mysterious that other people do in order to answer questions about the words just read. Reading group time is the time for personal negotiations about behavior limits and/or daydreaming and waiting.

Delf College reading activities were designed to confront this interpretation on every dimension: children don't read outloud; "what it says" and "what it means" have an intimate relation; *children read for meaning.* The challenge was clear: we needed to create an environment in which children who read poorly would read for comprehension.

We have found that the children are very good at what *they* do in reading time. They are very effective in maintaining *their* interpretation of reading and reading group time. One of our central tasks was to resist being drawn into "reading" as the children see it; if we failed, we became both teaching and research disabled. It is important to understand that we were not introducing them anew to reading or to reading group; we were attempting to transform their "poor reader" notions of reading and reading group into notions that our theory says are functional for literacy development. The zones of proximal development that we set up had to include these children with their histories and their analyses of literacy activities. We could then *reorganize their reading experiences into a series of functional next steps.* As we succeed, as we fail, and as we analyze our successes and failures, we specify ever more closely what it means to be a poor reader and how we might be able to assist the children so that they could leave that identity behind.

Recent academic and public discourse about children's reading deal with the nature of the written material presented and with the kinds of reading activity promoted by the materials. The material that is read at Delf College purposefully differs from ordinary elementary school reading material. We are persuaded by Bettelheim and Zelan's eloquent plea (1982) that material for young readers should display respect for and a challenge to their intellect. Such material should respect the circumstances they face in their real-life activity of growing up in our culture. We also share concerns expressed by Calfee and Calfee (1981) about the infrequency of non-narrative prose in reading instruction despite its importance for the activity for which reading is of crucial importance: further education.

We would like the children to believe that quite a bit that can be learned from reading is relevant and useful to their lives; we would like that belief to become a support, a motivation, for learning to read. Hence, we avoid the often trivial narratives available in primers. At Delf College, students read expository texts about television cameras and computers, about color-television technology and debugging programs. In short, the reading curriculum is about the technology that is a large part of children's lives and a part of their experience at Delf College.[8]

The Four Reading Groups

Between January and the end of the school year, four reading groups, embodying four different models of comprehension activity, met twice weekly. The first model, described below, focuses on a single aspect of general comprehension activity, speeded lexical access. Passage comprehension activities focused on specific texts are the primary activities of the other three models; components of general comprehension are *not* dealt with in isolation. The number of students involved and the amount of time spent in reading groups are both too small to allow for meaningful quantification of the differences among the models, or among the results. The report and comparisons that follow are based upon analyses of video recordings, participant observation notes and on-line observation notes.

Increasing comprehension through increasing lexical access. A program developed by Isabel Beck and her colleagues at the University of Pittsburgh is used with one group (Beck, McCaslin, & McKeown, 1980; Beck, Perfetti, & McKeown, 1981). It is a fully specified instructional program designed for use in an elementary school setting. The theory underlying this approach, supported by experimental use of the program, establishes a link between a well-developed lexicon and enhanced ability to comprehend prose text. Words are presented in clusters that emphasize the categorical taxonomic/semantic network in which the words fit; words are studied for five days in instructional settings which establish their functional schema-relevant nature. Affective associations with the words are highlighted. Throughout the five days, these multiply accessible new words are involved in exercises requiring speeded access

[8]The reading material comes from trade books that function as children's encyclopedias, e.g., *Charlie Brown's Fifth Book of Super Questions.*

to the newly developing lexicon.

The Beck program differs from the others we are using in an important way. Comprehension activities are secondary, undertaken only for the purposes of promoting the semantic networks and/or schema frames for the words in the cycle.

We implemented the program with a mixed age and ability group of eight children, many of whom displayed difficulty on the Peabody Picture Vocabulary Test and some of whom are non-native speakers of English. We developed nine cycles of words for our curriculum taken from the Ginn 720 reader that corresponded to the level of the most advanced reader in the group, *(How it is Nowadays)*. We taught six of the cycles. Following the Beck model, we constructed and administered a synonym test that included the 57 words that we taught and 49 similar words that were not taught. We provided review practice for 29 of the words outside of the cycle in which they were introduced, in order to assess the influence of extra distributed practice.

We have pre- and post-test data for five of the children in this group. In January, the children spent approximately forty minutes on the test. On the average, they got 32 correct answers on the 106 items. However, the children were quite unhappy during the test, requesting and receiving a great deal of help from the teacher. With help on the various items, (i.e., with the test reconstituted as a zone of proximal development) they averaged 43 correct answers. In June, the post-test took them only half as long. The children took the test in a more matter of fact way, neither asking for nor receiving any help. Every child improved and the group averaged 56 correct answers. Furthermore, there is the expected progression of correctness when the results are compared for the subcategories of items: words that were reviewed often were answered correctly more often than words that were taught only during the cycle in which they were presented. Both of these "experimental" categories received higher scores than the words that were not taught at all in the cycles.

Because of the apparent success of this program to date, and the apparent ease with which many of the activities can be implemented on the microcomputer, we plan to put speeded lexical access games into software for the microcomputers. This will make much of this program available to all the children at Delf College.

Comprehension as internalized problem solving. The second curriculum was developed by the Kamehameha Early Education Program in Hawaii (KEEP, 1981). It was designed for use in a special demonstration school for poorly achieving students of native Hawaiian ancestry. The theory, which is supported by research, holds that the children's ability to comprehend written text will improve as a result of *internalizing a problem solving approach to comprehending written text.* In a small group, the children work with the teacher interpsychologically to solve comprehension problems that a text presents. The lesson begins by requiring the children to bring their prior *Experience* in and out of school to the text (the E phase of the lesson). Then, they read silently for a purpose -- to get information that the particular text can provide (the Silent reading phase of the lesson). Then they come to a consensus and a justification of a group interpretation of the *Text* (the T phase of the lesson). Finally, they *Relate* their comprehension of the text to other aspects of their life (the R phase of the lesson). We implemented the program with a mixed ability and mixed ethnic group of children and with non-narrative texts.

The Delf College children's entering notion that the *only* purpose for reading is to read outloud was a problem. The teacher would remind them often of the information question that was supposed to guide the reading; but the children would struggle along reading outloud and, at the end, be unable not only to answer the question but to remember what it might have been or even that there had been one. The teacher refrained from evaluating or collaborating on the oral reading and, at the same time, complained that all the reading aloud was disturbing her reading. A major result of the five month's of work is that the children have learned to engage in silent reading.

Comprehension as an activity that precedes text processing (the E phase of the lesson) represented another new routine for the children: they talk about it as different from their school reading, sometimes as unlike "real" reading. They now expect this routine during reading at Delf College and comment on its absence. The discussions about the text topic and text vocabulary prior to the presentation of the paragraph to be read are lively, coherent and extensive.

Comprehension activities subsequent to the text processing have had mixed results. On the negative side, the careful textual exegesis that characterizes the T phase of the original KEEP lessons in Hawaii seldom occurs. Most of the time the Delf College reading group could not resolve differences in interpretation by re-processing words or sentences in the text. They sought the "bottom-line," the product of the interpretation by a good reader in the group or by a teacher; they resisted engagement in the process of reaching an interpretation by manipulating printed text and common sense.

On the positive side, comprehension activity after examining the text did extend beyond the short recall questions the children were used to from ordinary school reading lessons. The children became comfortable with participating in discussions about how what they had read relates to other texts or to aspects of their daily lives and future aspirations.

We have no quantitative pre- and post-test measures specifically related to this group's reading program. Our field notes and video recordings of early and late sessions indicate that results were different for different parts of the KEEP curriculum. Summarizing our description, it appears that there was progress with respect to silent reading, and to the E and R phases of the lessons. The T phase, however, showed little of the desired change.

Comprehension training through guided anticipation of meaning. The remaining two programs work from basic research which no one but our research group has implemented in elementary instructional settings. The curriculum discussed in this section is a reading program derived from a procedure that Fillmore, Kay and their colleagues at Berkeley developed as a method of investigating the structure and interpretation of connected prose (Fillmore & Kay, 1981). Subjects are presented with a small piece of text and asked to exploit fully what it might mean and what text might be being

constructed using this piece as a start; they are then presented with the original piece plus another small piece and again interviewed about possible interpretations and predictions. So, for example, an early segment presented might be, "Sally entered." The subjects are asked what they know so far and what they think the text will say next. After a response, the next larger piece is presented ("Sally entered the restaurant") and the procedure is repeated.

We noticed that Fillmore and Kay's research interview constitutes a zone of proximal development for comprehension skills. It appeared to us that as the interview progressed, not only would the structure of the text become more apparent and the interpretation more certain, but the subjects would became "better" at responding to comprehension-type questions, possibly better at comprehending. We wondered, then, if these procedures might be adaptable as comprehension training procedures at Delf College.

In order to implement this research paradigm as a small group instructional activity, we developed a simple microcomputer program which cuts a text into the pieces that an instructor specifies and produces successively larger segments of the text. Each segment is printed out in primary type and xeroxed for group work.

The children are told and reminded often that they need two things to read: themselves and something written. On the majority of occasions, the teacher holds the pile of xeroxed text segments until the group discussion assists a child in guessing what the segment says (or a close approximation); for these segments, information from the children themselves is most important for comprehension. What the children know about the topic, the prior text, and language and the world in general is the material for comprehension. On some occasions (the minority), the teacher puts the pile of xeroxed segments on the table and the children each take one and read it; for those segments, information from the written text is most crucial for comprehension.

Comprehension as a goal for reading is engineered in an unusual way by this program. In the instructional programs that the children experience during the regular school day, comprehension can be considered an end-state, but not necessarily a goal which can direct action. By this we mean that while the teacher and the multi-year curriculum have comprehension as a goal, that goal is not accessible for the children in reading groups. For them, comprehension is simply an end-state, something done after the written text is decoded. As Vygotsky (1978) pointed out, children acquiring cultural objects like literacy must acquire a process that is adequate to the product (reading) which was created by a long socio-historical process. If a part of that product, its orientation toward comprehension as its goal, is not made accessible to them *inter*psychologically in reading group lessons, then the process that the children acquire intrapsychologically is likely to be inadequate.

Bruner, working with Bernstein's neurophysiological model of activity to examine the development of skills among infants, points out an important distinction: "Note that *activity* contrasts with mere *movement* in that the former requires coordination and regulation of the latter *in the attainment of some particular objective.*" (1968, p.26). In the ordinary school reading experience, both comprehension and decoding can be accomplished as mere literacy movement; that is, they fail to be coordinated or regulated by a literacy objective. Instead, they may be coordinated and regulated by objectives like answering a question or finishing a page in a workbook or pleasing the teacher.

However, in this curriculum, the word or phrase that the group comprehends in oral discourse as the plausible next piece of text serves to coordinate and regulate the decoding of the written text when the next segment is finally distributed to the children. The decoding appears, then, as more than movement because it is undertaken in the service of verifying that the "next" piece of text is, in fact, what the prior comprehension predicted. Decoding is coordinated and regulated by a literacy objective: verifying the product of the comprehension discussion. The sequential ordering of instructional behaviors in this program is crucial. The teacher presents the "prepared goal" of comprehension. The group achieves the comprehension of the particular next segment, and that comprehension is then available to regulate and coordinate the children's text processing.

Although accurate, this summary glosses over an important part of this curriculum: how "the group achieves" comprehension. The teacher, holding back the written text, directs the children to the various aspects of "themselves" that are the required materials for comprehension. Questions or statements are made about the prior text, about the relevance of particular aspects of the children's out of school knowledge, and about the obligatory and high frequency patterns of the language that they use in their ordinary talk. The categories that Fillmore and Kay use to describe their data provide us with a typology of the teacher's work: lexical knowledge, cultural knowledge, text-semantic knowledge, schematic knowledge, grammatical knowledge.

Although there has been no quantitative pre- and post-testing specific to this curriculum, field notes and video-recordings of the activity of the group allow three conclusions to be drawn. Most important, there is no way for the "poor reader" view of reading to maintain itself in this reading environment and it does not appear. *The children read for comprehension.* Consider the situation in the middle of a lesson: the children get a new sheet of text that has all of the old text on it and, at the end, a small new segment. Most often, the small new segment has already been produced orally, without the text in prior speculations about the future text. No child has been moved to read the whole text outloud. When the newly added segment is different from the exact wording produced in the discussion, or when a child has missed hearing the final accepted guess in the discussion, children may utter words outloud as a part of a reaction to the text, but not as a simple oral rendition of what is printed: "It says 'engine' instead of 'machine'; or "I should've known, 'computer,' geez."; or "Hey, that's not how you spell 'which'!"

On occasions when the text with the new segment is presented in the absence of group discussion, the children hardly ever utter the text aloud because the need to know what the next piece of text says overshadows any oral rendition of the piece itself. So for instance, when the children get the name "Babbage" as the beginning of a new paragraph, what they say outloud isn't "Babbage" but rather things like the following:

"Invented?" "Tried to make a new one?" "Gave up again?" "Finally did it?" They do not read aloud; they move right along to predict the next segment. They appear to accept the prepared goal of comprehension, regulating and coordinating decoding by this goal.

This is not an ordinary approach to reading for these children: they often say how unusual the procedures are, sometimes complaining that it isn't "really" reading. This group, like the others, initially offered reading aloud as the to-be-approved behavior in reading group. Now, when a new-comer to the group reads aloud it is noticeable as a breach of group procedures and the definition of reading. It appears that the children trained in the Berkeley method aren't willing to let reading outloud get in the way of reading!

The second result of the Berkeley curriculum concerns the teacher's role. After the first weeks, when the children understood the basic routine of the lesson, the teacher's role changed dramatically. Her behaviors resembled those expected of someone in the role of a coach. There was a lot of physical movement as the teacher dashed off to get the next piece of text and maneuvered to keep the pile of xeroxes away from the children or to distribute them at the appropriate time. The teacher's verbal behavior was more like coach than teacher also. Getting the group to achieve comprehension prior to seeing the next piece of text entailed discussing strategies particularly appropriate for particular children, dropping hints about their past successes, encouraging partial successes, and generally providing support for the group and the individuals to get on to the next piece. It is quite exciting to see *the children* grappling with the text and the teacher assigned to the sidelines.

The coaching metaphor is useful in describing a third way in which the children demonstrated a grasp of the program, particularly how readers use "themselves" to comprehend. Although the children quickly learned to chant the answer to the question, "what do you need to do reading," they were slower to admit that something other than physical work might be involved. They would often answer that they needed the text and their eyes. Gradually as the teacher elicited this framing statement, the confidence in "eyes" as a part of the answer waned and the need to include more of themselves appeared in their answers. Another kind of student statement suggests that the children were being drawn into the program: when adult or child visitors attended the group, the children would coach them on the procedures, pointing out in particular that what one had to do was to make a good guess about the next part of the reading. On one occasion a group member, who for several months did not appear to be participating successfully in the group, "discovered" the role of guessing and his peers verified for him that in fact that *was* the name of the game.

One quantitative measure of the children's participation emerged accidentally and had an impact on the conduct of the group, transferring some of the evaluative control of the lesson from the teacher to a kind of score (in keeping with the coaching metaphor). With so many little stacks of paper (a copy of each text segment for each child), the teacher had to number them to be sure that she picked the correct next segment when it was needed. The children were quick to notice the numbers and to use them to estimate their progress through the text. At times this bench mark was the occasion for celebration because an especially sage prediction allowed the group to move several segments ahead. At other times the clear lack of progress gave teachers and children a common understanding that certain behaviors disrupted progress toward figuring out the text. We take these changes in the interactional dynamics of group reading to be one of the significant outcomes of this effort because it provides a clear example of how different ways of organizing the reading materials can constructively transform the entire process of reading.

Future analyses will take advantage of this numbering to provide a way to summarize changes in the number of comprehension problems solved as the program proceeded in time. Further analyses of the field notes and video-taped records will be undertaken to track how variations in the teacher's support activities are related to the children's success.

Reciprocal teaching reading curriculum. On the basis of several years of experimental research on basic learning mechanisms among slow learners, Brown, Campione, Palincsar and their colleagues have been developing a program of direct instruction in comprehension based on an interactive reading game. Pilot data available at the start of this project, and data collected during the project by the Illinois group have served as the basis for the fourth curriculum initiated at Delf College.

The basic idea underlying this line of work is that effective learners engage in systematic self-questioning as they read and study. This permits the learner to generate hypotheses, evaluate what has been read, and revise his understanding accordingly. Novice readers, according to these accounts (See Brown & Palincsar, 1982; Brown, Palincsar & Armbruster, in press; Brown, Palincsar & Purell, in press; Palincsar, 1982), have difficulty checking and guiding themselves as they read for meaning.

It is often assumed that the teacher fosters comprehension activities by modeling appropriate behaviors, by monitoring the children's behavior, and by activating relevant knowledge through her questions and comments. The question arises: how do the appropriate questioning, predicting, checking and revising behaviors get transferred from the teacher to the child so that they can become a part of the child's tool kit of comprehension-fostering skills? The answer proposed by Brown and Campione draws on Vygotsky's notion of internalization. If the child can be induced through interaction to engage in the appropriate behaviors as part of the interpersonal coordination between child and teacher, the child is in a position to internalize his/her previously "social" external behaviors, making them part of his/her personal cognitive repertoire.

In a series of studies, Palincsar and Brown adapted reciprocal questioning procedures, such as those of Manzo (1969), to include four main activities: *paraphrasing, questioning, clarifying,* and *predicting.* All of these activities appear as academic tasks in their own right; for example, it is a common practice to call on a student to summarize or answer questions on a passage. However, these activities, if engaged in while reading, serve to enhance comprehension and afford an oppor-

tunity for the student to check whether it is occurring. That is, they can be both comprehension-fostering and comprehension-monitoring activities if properly used. Self-directed summarization is an excellent comprehension-monitoring technique. Monitoring one's progress while reading, to test whether one can pinpoint and retain important material, provides a check that comprehension is progressing smoothly. If the reader cannot produce an adequate synopsis of what she is reading, this is a clear sign that comprehension is *not* proceeding smoothly and that remedial action is called for.

Similarly, self-directed questioning concerning the meaning of text content leads students to a more active monitoring of their own comprehension. Thus, closing one's eyes (metaphorically) and attempting to state the gist of what one has read, and asking questions of an *interpretive* and *predictive* nature are activities that both improve comprehension and permit students to monitor their own understanding. These are also the kinds of active and aggressive interactions with texts that poor readers do not do (Brown & Palincsar, 1982). And it was these activities that were incorporated into the reciprocal teaching instruction.

During the reciprocal teaching curriculum, the teacher and the students engaged in an interactive learning game that involved taking turns in leading a dialogue concerning each segment of text. First the dialogue leader would read the title and then predict the possible contents of the passage and discuss the relation of the passage to her own prior knowledge. For example, if the passage was entitled *Poisonous Snakes,* the teacher and student would discuss what they already knew about snakes, etc. Then, both the teacher and the student would read the first paragraph silently and the student would be instructed to "keep thinking while you read of how you will teach me about this section. Keep thinking of the important questions you might ask me to make sure I was reading carefully." After finishing silent reading, the dialogue leader would; 1) *paraphrase* the main idea; 2) *predict the possible questions* that might be asked about the segment; 3) *clarify and interpret* any confusing elements; and 4) *hypothesize* about the content of the remaining passage. After the dialogue, the dialogue leader asked the other member of the dyad a question concerning that segment. Then the roles were reversed.

Throughout the interventions, the students were explicitly told that these paraphrasing, questioning, and predicting activities were general strategies to help them understand better as they read, and that they should try to do something like this when they read silently. It was pointed out that being able to say in your own words what one has just read, and being able to guess what the questions will be on a test, are sure ways of testing oneself to see if one has understood.

When we opened at Delf College, these procedures had already proved extremely successful for teaching comprehension skills to poor readers at the seventh grade level. They worked on both an individual and small group basis. Continuing work at Illinois points to the variations in the procedure as children of different ages and characteristics participate in the procedure and as different teachers adapt it to their situation. (See Brown, Palincsar & Purell, in press; Palincsar, 1982 for full discussion).

For the Delf College group engaged in the reciprocal teaching procedure, task specific quantitative pre and post measures are not available. However, field notes and video records provide evidence that the children exhibited change over time related to the curriculum.

As with the other Delf College groups, an important result is that reading outloud was extinguished. This group was especially active; large movements and loud noises particularly characterized their behavior. However, after just a few weeks, there would be sporadic freeze-frames as the noise and movement disappeared from the group and a period of silence ensued, each child and the teacher with bowed heads. The precedent to these freeze frames was not an oral directive from the teacher, but the distribution of xeroxes of the portion of the printed text that was to be read and used as the basis for reciprocal teaching. Their silent reading was particularly noticeable because of their ordinary behavior with which it contrasted.

Comments by the children demonstrate their acquisition of the idea that reading means *silent* reading; their talk also displays the novelty silent reading has for them. For example, a child's parent visited the group one day. She sat next to her son, who on that day began to read aloud quietly during the silent reading time. Another child reprimanded him, telling him to be quiet because his reading aloud was disturbing everybody's reading. The teacher had often issued this complaint early in the group's history when all of the children were reading aloud and looking to her for evaluations. By the time this parent visited in May, reading aloud was an "occasioned" event in the reading group (evoked, for instance, by a parent's presence). It appears that the children internalized that part of the Illinois reading program.

Another novelty for the children was the procedure of asking questions rather than just answering ones posed by teachers or books. Here, too, the records indicate that the children acquired the behaviors that this reading curriculum was intended to promote. When reciprocal teaching is done in groups rather than in one-to-one situations, some consideration must be given to managing the discourse: who will ask which questions, who will answer them, and when will which kind of question be asked. As in the one-to-one situations, the range of question-types is modeled and prompted by the teacher; however, the distribution of turns is negotiated and accomplished with the help of various cultural routines and objects. The repeated process of negotiation for turns at questioning and answering demonstrate the children's progress in the program.

Further evidence that the children in this group became adept at reciprocal teaching comes from a contrast available in our records for May. We tried to incorporate question-asking by the children into one of our other groups. When we told the children that *they* would ask questions and the teacher would answer, they responded first with disbelief and then with cheers. However, the task was too hard for them. They couldn't make questions; all but one found it too difficult even with the teacher's collaboration; they became discouraged, frustrated and angry. The group who failed were more advanced in age and in the school reading program than the children from the reciprocal

teaching group, who by May, had learned to ask questions about the reading.

We also observed some transfer of strategies from the teacher to the students with respect to the content of the questions that were asked. The teacher early on took notes as she read; when the text was covered up following the silent reading, the teacher would refer to the notes as she formulated questions and answers for her turn. In February and March, when she collaborated with a child who was having difficulty formulating a question, the teacher made notes for the child, dictated materials for notes and provided writing materials, queried the child about the contents of notes the teacher was taking, and finally simply directed the child to take notes. In May, the children "automatically" sought writing materials in preparation for the silent reading phase of the lesson and extended the bowed-head, quiet period to include time to jot down notes. Their notes were mnemonics only for formulating questions, never for answering them. The collaborative tasks suggest such an outcome. While the teacher modeled notes used for answering, she never used the notes while collaborating on an answer with a child, rather she returned to the original text.

In summary then, there is evidence of progress in this curriculum for the children involved with respect to silent reading, to the questioning task, and to the use of aids in question formulation. Further analyses of the video records can take advantage of the coding and measurements developed by the Illinois group during that phase of the development of this curriculum.

The Three Comprehension Curricula: Comparisons

Figure 1 compares key features across the three curricula. Consider the first two rows (Features 1, 2). These three curricula share a common theoretical assumption: a "whole task" accomplished socially *among* people is the basis for learning, which we conceive of as subsequent independent accomplishment *within* a person (Vygotsky, 1978). In this case, the whole task is reading for meaning (Feature 1). The three are also similar in that reading out loud is not done, while talking about meaning is done extensively (Feature 2). Thus all three curricula provide us with a context in which the "whole task" of reading occurs, and therefore for the task specific diagnosis and remediation that we seek.

The differences among the curricula are equally important, providing specific contrasts that pit one feature of the whole task against another. These contrasts are important for gaining information about the heterogeneity in the population. Features 3, 4, and 5 highlight one important contrast: strategies for unifying specific and general cognitive skills. Our experimental curricula include two different strategies for uniting the *specific* text processing skills and the *general* reading skills needed for remediation. The K and B programs concentrate explicitly on *specific text interpretation,* only implicitly revealing general strategies in the teacher's prompts that shape the children's answers into a normative interpretation of the text. In contrast, the I program concentrates on teaching a *general self-questioning strategy,* explicitly providing practice for the children on the strategy. In the teacher's turns at questioning and answering, the I program implicitly provides a model of specific text interpretation.

There are two corollaries to this contrast. First, as is indicated by Feature 6, the I program has a discrete turn-taking system. This allows the Teacher to model comprehension activity for the children without competition from other talk. The multiple overlapping student answers built into the K and B programs provide a wide pool of answers for the teacher to work with in shaping a normative interpretation from the students' first answers. Each strategy is plausible; what we seek is information on their relative utility for poor readers in general, and children diagnosed as LD in particular.

The second corollary to this specific/general contrast involves the relation between comprehension and decoding. In the K and B programs text-specific comprehension tasks are undertaken prior to work with the written text. As a result, comprehension is available in the child's prior activity to coordinate the decoding of the text. The I program was originally designed for use with students adept at decoding who experience difficulty with comprehension and it does not involve as much organized comprehension activity prior to text processing.

Another set of differences distinguish the K and the B curricula. Most noticeable on the surface is the size of textual units that are presented to the students (Feature 7). In the K and I programs the text is divided into paragraphs which the teacher and students deal with successively until the whole text is completed. In contrast, the B program presents a very small segment (a single word or a phrase). Each step in the instructional sequence adds a new small segment to the preceding small segment until the final segment includes

Figure 1

The Three Comprehension Curricula: Comparisons

	Features	*Curricula* *K*	*B*	*I*
(1)	Reading group emphasizes meaning of text (*Yes* or *No*)	Y	Y	Y
(2)	Children read *silently,* not aloud (*Yes* or *No*)	Y	Y	Y
(3)	Focus on specific strategies for particular text (*S*) or on general strategies (*G*)	S	S	G
(4)	Teacher models intact, expert, specific text interpretations (*M*) or teacher shapes children's text interpretations to normative ones (*S*)	S	S	M
(5)	Answering practice for children (*A*) or both questioning and answering practice (*B*)	A	A	B
(6)	Children have individual discrete turns (*I*) or many children respond in overlapping turns (*G*)	G	G	I
(7)	Paragraph-sized large segments of texts introduced at once (*L*) or smaller phrases introduced progressively (*S*)	L	S	L
(8)	Teacher and expected subsequent student behavior coordinated by abstract model of reading process (*A*) or coordinated by concrete demands of specific text (*C*)	A	C	A

K refers to the KEEP curriculum, internalyzed problem solving
B refers to the Berkeley work, guided anticipation of meaning
I refers to the Illinois work, reciprocal teaching
Other letters signified in feature descriptions

the whole text.

This contrast in materials is related to the "abstract-concrete" difference marked in Feature 8 of the figure. The B curriculum relies on the structure of the text to organize the lesson: the phases of the lesson and the types of teacher prompt used at different points are coordinated by the concrete textual material. When a next text segment should be predictable (based upon prior text, language or cultural knowledge available to the students), the Teacher withholds the text until the children have developed a reasonably accurate hypothesis about what it is likely to say. The teacher's prompts, as she coaxes interpretive guesses, are constrained by the structure of the text. In contrast, the K and I curricula are instantiations of abstract models of the reading process. The K teacher coordinates phases of the lesson that embody the "Experience, Text, and Relationship" activities that the theory claims are aspects of skilled reading; the children are expected subsequently to read independently having internalized the three activities, coordinated by the abstract model. The I curriculum teacher also relies on an abstract model which emphasizes the importance of reader-generated questions in the comprehension process. The teacher and children's activities are coordinated by reciprocal teaching and answering; the children's subsequent internalization is expected to be similarly coordinated by the abstract model.

Transfer Measures

In addition to examining the *in situ* measures for evidence specific to each of the reading group curricula, we are interested in determining whether progress within the curricula transfers to progress for the children in other settings. Two indicators of such transfer are standardized pre- and post-tests and teacher reports. In January and in June we tested the children on alternate forms of the Gates-MacGinitie Reading Tests for their grade levels. The teacher report data include interviews with the teachers, their assessment on report cards and special material prepared for the assessment of children who are treated according to the Federal guidelines for educationally disabled children.

Our records are incomplete, for reasons that will be familiar to those who have worked with similar populations. Children are absent at times tests are scheduled; children become upset at the format of standardized testing and tear up tests or cry until an adult intercedes; records are filled with comments by the test proctors that call into severe question the validity of the score as a measure of anything but severe stress or avoidance: all these are old stories.

To the degree that report cards reflect a transfer to classroom performance, some effect of Delf College appears to have been felt. Of 17 children for whom we have complete data, 11 received higher marks in the report periods after they began attending than in the report period before. Grades went down for 2 children and were mixed for the other four. The reported grades for spelling tests were the ones that showed improvement for most children.

The principal and the teachers reported interactions with the children to us that they felt were related to the children's attendance at Delf College, and parents have commented that they noted effects out of school. So far neither these pleasant comments nor the tests nor the report cards have amounted to anything that we can analyze as related to particular aspects of the reading training provided at Delf College. We hope to be able to gain more access to the curriculum and teaching interactions used during the ordinary school day in future years of our project. Then we would be in a better position to look for transfer, or to arrange for it.

In the standardized testing situation, the fifteen children for whom we currently have pre- and post-data showed unusual gains only for the speeded vocabulary test, not for the vocabulary and comprehension subjects. The increased reading skills displayed *in situ* have not yet accrued to the point where broad transfer can be observed.

However, following daily sessions of the KEEP (1981) program, impressive improvement in standardized tests of both comprehension and decoding have been reported. Similarly, one semester of daily instruction in the reciprocal teaching program produced transfer to classroom settings and to other reading tasks, together with a two year improvement on standarized comprehension scores. We are hopeful, then, that the somewhat narrow range of transfer found at Delf College thus far is a consequence of restricted exposure, rather than restrictions built into the activities themselves.

Our evaluation of the reading programs at Delf College is leading us to consider some revisions in our procedures. Although we have had only about 30 hours of instruction time in each of the programs, we have the impression that many of the activities in each program are plausible and valuable to do with children who missed them because they were assigned to a different reading group.

TEACHING AND LEARNING AT DELF COLLEGE

In the discussion of the reading curriculum thus far, we have (1) located the curriculum in the structure and content of the materials that are presented to the children, and (2) shown how the teacher mediates between the child and the text. In this section we want to look at the teaching/learning process in the context of Delf College and the children's prior learning histories. Clinically speaking, the children at Delf College are an enormously heterogeneous group. Yet they are alike in several important ways, quite apart from any diagnostic considerations. First, they are children who have failed to acquire the central skill that brings praise and success to their schoolmates. For several years they have sat in classrooms where their inability to read has been a public fact rehearsed five days a week.

Second, in so far as we are speaking of LD children, we are speaking of children who have a perfectly normal ability to profit from experience. *By definition,* clinically LD children have full scale IQ scores in the normal range. This accomplishment is a considerable feat, given that they have some subscale scores (such as digit span or coding) that are significantly sub-normal.

When we consider these two facts in terms of children's overall experience -- their participation in family life, friendships with age mates, sports, hobbies -- we can begin to get a glimmer of why such children rarely stand out when they are not in school. In so far as the difficulty makes itself manifest only when a child

is asked to interact with an alphabet, the child may be more competent than those around him, when not interacting with the alphabet.

But the situation in school is quite different. There are few routes of escape from the pain and frustration of repeated failure, especially when dealing with print and adults in the classroom. The route that many of these children choose is to avoid the task as much as possible. This requires them to change the basis of their interactions with adults, or to spend as little time around school tasks as possible.

Such children, whatever else we might want to say about them, are likely to be difficult to teach. Not only are they likely to have different ideas about what they are supposed to do in order to succeed in reading, they are also likely to have many routines for interacting with teachers while "not reading." Clinicians or educators might call some of these "not-reading" behaviors "having a short attention span," some might be called "emotional instability." (See McDermott, 1976).

These circumstances have led us to formulate concepts of the special requirements of teaching reading to children with a long history of failure in the enterprise.

The teacher as an adaptive expert

Now consider the situation facing the teacher of such children in a small reading group. If there is virtue in thinking of the teacher as a mediator between child and text there is also a necessity to think of the text as a mediator between the teacher and the child.[9] This view of the child-text-teacher interaction is essential in evaluating an interactive learning framework that preserves a plausible relationship between the structure of interaction presumed in the model and the structure of the reading activity. In the model, activities called comprehending and decoding are created in a system of interaction constrained "at the top" by top-down influences on the system. These top-down processes can be interpreted as the higher order goals of the system, its larger purposes and the knowledge that goes with those purposes. In the diagrams used to provide a schematic representation of interactive reading processes, the top-down processes are represented by an arrow, descending from the outside of the frame, like a bolt of lightening from heaven. In the actual settings where reading is acquired, a great deal of that top-down processing is provided by the teacher. The teacher is the guardian of the task. As the knowledgeable expert on reading and as the culture's representative in passing literate technology to its children, s/he must maintain reading as the task for the children until they can come to take it over for themselves.[10]

In our curriculum all of the teacher's behavior is supposed to embody the assumption that reading means "comprehending in a special way." S/he must maintain this assumption in interactions with the children while they are dealing in terms of their extremely varied understandings. S/he must also maintain that assumption despite the fact that while psychologists readily make a distinction between comprehending and decoding, there is no agreed-upon theory of how one understands connected text. No system of procedures and background knowledge (or, procedural and declarative knowledge, in current parlance) is known to be adequate at the level of sentence comprehension, let alone for higher units. While teacher manuals can specify a good deal of declarative knowledge about decoding ("When two vowels go walking the first does the talking"; The *a* says its name.") there is little guidance for the teaching of comprehension skills.

Our view of comprehension teaching/learning activities embodied in our three text-specific reading programs requires *the model of the teacher to be a model of an adaptive expert* (Hatano, 1982). An adaptive expert, by contrast to a routine expert is able to handle situations that vary considerably in the content and organization of their parts. Consider the situation: The teacher can understand the text in a way that the culture considers appropriate. The children cannot. The social interaction between the teacher and the children is like a pool of knowledge for interpreting the text. Just as one hopes that the teacher's interpretation will be made accessible to the children by virtue of the social interaction, so are the children's interpretations made accessible to the teacher. Publically accessible interpretations are desirable so that the teacher can "fix" the children's alternative interpretations; however, if the teacher is only operating as a routine expert, the children's alternative interpretations only act as "noise" in the system which may be sufficient to impair performance on the comprehension task.

With poor readers, like those at Delf College, the range of interpretations that group members offer is wide and the teacher must be able to reassemble his/her comprehension expertise in a variety of adverse circumstances. The process of reassembly is often as public as the alternative interpretations. During the teacher's repair work to self-correct, the children have an opportunity to see some of the strategies that a good reader relies on as well as to notice that the teacher denies or ignores strategies that the children are relying on. As a matter of principle, we encourage teachers to mutter aloud the basis of their comprehension (e.g., "Wait a minute, this *these* can't mean 'dark places' or else the sentence won't be really saying anything; you just don't go around saying 'dark places are dark places'"). Thus it is that teachers, by necessity adaptive experts who can adjust under the less-than-optimal conditions for reading aloud with a group of children, may be able to provide children with declarative knowledge about reading even though we do not have a well-developed body of declarative knowledge to provide to teachers. At the same time, they maintain the context where reading-to-comprehend is the goal of the common activity.[11]

[9]This latter relationship is especially easy for research psychologists to forget when they think about converting their theories of learning into a textbook designed to be relevant to teachers. It finds expression, for example, in the notion of a "teacher proof" curriculum, e.g, a curriculum where no matter how inept the teacher, the mere fact that the child has been brought in contact with the materials will suffice. We hear such rumblings again in connection with microcomputers.

[10]We also know that the grounds upon which the teacher maintains the task are very important. In so far as the task is imposed, not adopted, by the children, learning effectiveness is reduced. It is in the artful subversion of children into the task of reading that the master teacher excels.

[11]Not only do teachers provide knowledge about comprehension to the children, but by analyzing the teacher's behaviors and the folk accounts of her activities we may be able to contribute to the research community's attempts to develop a body of declarative knowledge about comprehension.

Successful maintenance of the reading task is, theoretically, the teacher's central function. When the children enter the task as she defines it (on behalf of the culture) their behavior is coordinated in a system that can be aligned theoretically, with interactive learning models.

For the model we have adopted, keeping the whole task together means that the children's interactions with teacher, text, and each other provide an appropriate mix of comprehension driven (top-down) and feature/letter/word recognition inputs to permit reading to occur. If the higher order parts of the task (parts that the child might be expected to master later as independent achievements) are made a part of the child's task, transfer problems will be minimized because the child obtains practice on "next steps in mastery" on every such occasion of reading.

Reading comprehension: What's the problem?

We can summarize our discussion of reading instruction for learning disabled children as follows: We begin by accepting a general interactive activation approach as a basis for understanding the reading process (McClelland & Rumelhart, 1981). Central to this approach is the notion that any given reading behavior must be understood to be constructed out of interactions among elements of the reading process. Applied to the areas we are concerned with, we can say that reading and understanding words or sentences requires interaction between analyses we call "decoding" and those we call "comprehension." "Understanding" is, theoretically, an emergent property of the interaction between person and print.

Missing from existing cognitive science models of reading is an implementable account of how change in such systems occurs, although it is generally agreed that changes in "top-down" constraints are an obvious place to start looking. Our own special interest is in the way that the *social environment* can serve as a source of new top-down constraints, while at the same time providing "bottom-up" support that keeps the child in the theoretically appropriate set of interactions. Putting these elements together, we argue for a social organization of reading lessons that keeps the humanly meaningful goals of reading alive in the reading lesson so that comprehension and decoding are not separated from each other, e.g., that the "level" of decoding can interact with the "level" of comprehension so that the two can produce reading.

We believe that this is a useful line of reasoning as far as it goes. But without some way to implement these ideas we are left with very little more than an academic version of what every teacher strives for intuitively. Without special support, such as that provided in different ways by our three comprehension curricula, it is *very difficult* to maintain comprehension in the reading task if the child cannot interpret individual words. It really *is* difficult to comprehend if you can't decode. However, decoding in the absence of comprehension produces enormous difficulties for *both* decoding and comprehension, which become functionally isolated.

We get a strong sense of such difficulties where we compare the reading behaviors we observed in reading as the children played the computer games. Wherever possible, we got the children to try to interpret the print on the screen, some of which appeared time and again. Our videotapes of these sessions have a lot of reading out loud on them. We help the children pronounce words they do not read correctly. We act as if we believed that understanding would occur naturally *if only* we could get the kids to solve the problem of decoding, and then tackle comprehension and then specialize on functional reading. But our theory says that this isn't the way that reading works. Instead of concentrating on the sounding-out of individual words, the theory says that we ought to do something like the following: Suppose that a student signs on to the computer and gets the instruction "Put in disc 2 and hit return" and the child doesn't do it. We might ask the child what he thinks he might do to continue in the microcomputer game. Then we might ask if any of the print on the screen could verify his interpretation; or falsify it; or specify ambiguous or variable parts of it. Suppose that an initial conversation comes to the conclusion that the game wouldn't work with that disc. Subsequent reading would be a search of print on the screen to find out if any other disc was called for (verifying the interpretation of the situation) and if so, what disc was needed (specifying a variable.) Time and again, and "knowing better," we found ourselves under the control of the culture's knowledge that alphabetic print is difficult to learn and the cultures implicit task analysis (decode first). On these occasions, we generally end up with ample recorded evidence of the adult's ability to read, to decode and comprehend, and with evidence of a child being compliant or off-task or aggressive but not much evidence about the child's reading.

These experiences have also gotten us to consider the problem of teaching comprehension somewhat differently than we had previously. In future work we plan to study the factors that get us to descend to decoding outside the comprehension curricula. We have also begun to analyze the structure of teachers' manuals, where a good deal of the effort at comprehension training is now centered. The manual in a classroom attended by several of our Essa School children appeared to provide explicit training at an important comprehension subskill, "locate the main idea." This skill is part of the Illinois group's battery of trainable metacognitive skills where direct teaching has proven effective (Palincsar, 1982).

Unfortunately, the implementation of this idea in the manual adopts the notion that if a sub-skill can be taught then it can be taught and learned in isolation. Each paragraph in the exercise provided for the lesson concerns a different topic. Each requires a different strategy for extracting the main idea. Instead of providing maximum support for the child's discovery of a usable concept of "the main idea," the manual lacks relevant conceptual structure. The teacher, in attempting to teach children who have deficient decoding skills (thus requiring special support), is faced with an overwhelming problem of communication, because there is no such thing as a context-free rule for "locating the main idea."

When the teacher's communication with the children breaks down in this way, the children are very likely to lose a sense of the task. They are no longer participating in the same teaching/learning activity as the teacher. At this point the well-known issue of behavior problems arises.

The issue of discipline

There is one very marked characteristic of teaching and learning at Delf College, the theoretical importance of which we failed to appreciate when we began; the whole enterprise proceeds on a voluntary basis. This means not only that we compete for the children's time with other after school activities, but that when the children are disruptive, we can exert very little leverage through negative sanctions.

This fact of our research life was brought home to us very early in the enterprise. Once they got over their initial shyness of adults with unknown powers, the children did not follow our directions docily. There was a good deal of disruptive behavior: hitting, throwing small objects, running around, dancing on tables, except at those times when the children accepted the pedagogical tasks which we had arranged. These behavior problems were by no means peculiar to the children's behavior when they were at Delf College. Their various histories of failure had produced quite a variety of strategies for keeping reading and other education-related activities out of the contexts they inhabit. However, we faced new problems in this regard because there was no principal to send the children to, and no policeman to call in if the children failed to cooperate.

Casual visitors to Delf College, and several of the participant researchers had a common reaction to disruptive behavior: Get the kids to behave and then they can learn to read. We have come to adopt a position toward this common sense maxim that places it on a par with the idea of a teacher-proof curriculum; while it may make life easier in the institutional settings where reading is taught, it is not an appropriate goal for designing curriculum/teaching activities. The "control them, then teach them" approach has failed these particular children for a long time; in fact one of the many ways to describe the Delf College students is to say that they are students for whom that strategy is demonstrably inadequate. If it had worked, they would be succeeding in regular classrooms.

Another problem with attempting direct control was our limited authority. We could not compel the children to participate. So, instead of confronting disruptive behavior directly, Delf College teachers engage in a process of constant subversion of the children's disruptions, resorting to direct control only when physical damage is threatened. All other instances of bad, but not damaging behavior, were dealt with by a single principle: do not respond directly to bad behavior. Behave indirectly.[12]

We have adopted the notion of *appropriation* to describe the strategy of dealing with disruptive behavior. To say that a child is disruptive is to say that the goals organizing the child's behavior and the goals organizing the teacher's behavior are not the same. Instead of seeking to change the child's goals directly, as a means of bringing the child and adult tasks into line, appropriation builds from aspects of the child's goal-directed actions that can be fit in the activities associated with the teacher's actions. In effect, the teacher tries to coordinate with a part of the child's (disruptive) behavior in order to *appropriate* that bit for her own purposes.

So, for example, one teacher faced a problem with disruption in the form of a game in which sheets of paper (sometimes the sheet being written on) were wadded up and thrown across the table. This activity was appropriated by setting up a new activity; stockpiling paper wads for a paper fight after the reading lesson. In another case a teacher faced a problem from children doing a task parallel to reading, such as drawing a picture. Picture drawing was then incorporated in reading, with a rule attached; failure to be on task when a question is asked results in removal of the drawing task (Note that by this procedure, the child must hold herself responsible for the reading).

There are many difficulties associated with this approach to discipline, but given the constraints on our research setting, we are motivated to discuss its virtues. One virtue is the theoretical expectation that if we can be successful in subverting the children into our version of interesting activities, then their learning will be especially effective. In so far as they accept our goals, and we accept theirs, we are in a far stronger position to accelerate their reading, because control is exerted through activity, not through external constraint imposed by teacher or institutional authority. In so far as they do not accept our goals we are compelled to engage in an activity that might be thought of as psycho-educational therapy, simply to gain enough access to the child's system of understandings to make useful educational interaction possible. Delf College can be considered a combination of standard and non-standard instruction, organized so as to assist the child to marshal all the mental resources s/he can bring to the task of reading.

FROM COMPUTER TIME TO THE FIFTH DIMENSION

The second major arena of curriculum activity at Delf College centered on learning from microcomputers. At the start, our computer time facility consisted of three Apple II microcomputers, two computer aides, a part-time staff person, a small amount of software, and some of the goals and constraints essential for the proper plan to emerge. At the end of June, the Delf College Fifth Dimension housed a quite different computer facility embodying a far better motivated system of psycho-educational activities based heavily on microcomputers. This section presents a description of the development of the facility.

Computer time: Start-up

We planned to make the Apple II's principal components of a system in which we could accomplish two goals: (1) we could observe children engaging in a mixture of socio-cognitive activities for which we had interesting analyses; (2) we could engage in some training experiments that were well-motivated. The motivation had two sources. First, we knew that the video-game context is motivational for children; they might work to be in an environment which included computers. Second, Riel's (1982) research on a similar population of children motivated an argument that practice on some games transfers in predictable ways to classroom performance.

[12]There were occasions when physical damage was threatened severely. In only one case did we lose a child because of discipline problems; a child who threatened great physical harm to one of the staff and himself which we could not control. In a few cases we escorted children home.

The game tasks developed as programs for the Apple II by related LCHC research projects were primarily focused on arithmetic skills and concepts. In order to provide ourselves with some pre/post comparisons testing for transfer effects, we held these games out of our entering set of computer activities while we conducted extensive pretests (Petitto, 1982).

We were in a far less sure position when it came to computer-based games that involve reading. From a variety of sources we obtained educationally-oriented computer software that implicates reading. None of these programs had been worked with extensively by researchers; they were designed primarily for classroom use and normal readers. We started to adjust one program with permission of the publisher. We also had several interesting possibilities being developed by our LCHC colleagues involving writing (James Levin), reading (Peg Griffin), and short-term memory (Andrea Petitto). Software development takes time; assembling hardware to run these programs to their best advantage does too. When Delf College opened, the computer half of our curriculum was in a state of scholarly disarray.

There were two solutions for our problem of what to do during computer time and how to increase the literacy part of computer time activities. First, we investigated commercially available software and found several programs available for Apples that appeared to meet our needs. These programs provided interesting practice for children on tasks that seemed related to analyses of perceptual and cognitive development. And there were programs that required game players to be involved with processing a considerable amount of written text. The games originally considered were Hodge Podge, Odell Lake, Lemonade, Match Game and Mad Libs. Along with two of Riel's games, this gave us seven games for use in computer time; we felt this was not an interesting and extensive enough mix.

Other commercial games which staff members had found interesting and knew children had enjoyed were added, even though we had no theoretical claims about their usefulness in our research/training endeavor. Some of these games were almost direct copies of the games available in the video arcades that many of the children enjoyed. We were worried about arcade games on three grounds: (1) we could not avoid feeling the effect of the developing societal disapproval of video arcades, particularly when a local teacher visited and expressed disapproval of the frivolous proceedings; (2) we disliked the social mores of the arcade parlor that the games appeared to bring with them to Delf College: intense competition and sex-role differentiation; (3) we were worried that beginning with flashy arcade games would reduce our chances of successfully introducing the education/research games that we were busy developing and pretesting.

We decided to test this last concern: designating some games as flashy and some as not flashy, we split the children into two groups so that about half of them were to be able to play anything they wanted and the other half were allowed to use only the non-flashy games. After a month we gave up on this attempt: the practical problems of adults, unfamiliar with the hardware and the children, overwhelmed this mini-project. We also considered various systems of controlled access. But in the end we rejected all the straightforward control systems we considered. We were taking away too much and providing too little in return. Short of staff and facing a renewal progress report, we decided to bide for time and to make the best of it.

Phase One

In essence the computer time at Delf College grew topsy-like. The children's preferences and social relations were powerful forces determining who would use which program on which Apple. Sex differences and expertise differences were easy to note as the children worked during computer time. Our staff expanded: as our assessment component finished its first round, more adult interaction in the computer area was available. The original computer aide for each day was joined by two other staff members so that managing the equipment and supplies, and the children, and taking notes on the proceedings became less problematic. Soon, the children had more than two dozen games available to choose among. We added the printer and graphics tablet accessories to the basic Apple setups. With this variety and with our increased ability to note the children's activities, we were able to worry about how they were spending their time and whether their activities were sabotaging our goals.

Our observations and reflections returned mixed verdicts about this first phase of computer time at Delf College. On the one hand, interesting interaction patterns were being established. Children who worked very hard to avoid teaching interactions during the reading group time were willing to engage in them during computer time. One common pattern was for the teacher to insert herself into a group of children playing a very flashy game of Space Eggs or Snoogle (like Pac Man), to offer praise and encouragement, to name strategies that had been used, and to point out occasions when they might be or could have been used successfully. The children responded to this approach. They began calling for the teacher when she was out of range and busy. While we were having difficulty engaging the children in some learning tasks that we could relate closely to their learning abilities and disabilities, we were succeeding in participating in their learning on the arcade style games. Here the children showed perseverance, attentiveness, and a great deal of progress from trial to trial and from day to day.

Other patterns involved the children acting as teachers of their peers or adults. There was more than enough that a lot of people, including the adults, didn't know (See the section on spontaneous apprentices). The children asked each other to explain how to get a game started, to describe the procedures for playing a game, and to model and coach novices so they could learn advanced strategies. We were amazed to find that interactions that we would have characterized as good teaching and learning were said by the children to be instances of cheating or copying. Of course the beneficiary of the teaching/cheating never made the charge, but child observers did. We began to wonder what analyses of learning the children implicitly held -- teaching/learning strategies we thought of (modeling, verbal directions, hints, leading questions, metacognitive reminders) were treated as cheating, not teaching. Whatever their analysis of "fair" learning, it appeared to us to be one that would be very hard to learn with.

On the other hand, as we appraised computer time at Delf College, it was apparent that the full range of activities was not being exploited. Unless the adults were very good at controlling the group of children using the facility, the bigger children, the more practiced children, and the male children monopolized the facility and used the arcade-type games rather than the ones in which we were most interested. The computer time environment would not "organize itself" into a mix of activities that we could view as healthy. The most attractive games tended to remain attractive, even after a lot of use -- familiarity seemed not to breed contempt. The arcade-type games are cleverly constructed so that a novice views one goal that it is plausible to reach with some practice, and just as s/he reaches it, another goal comes into view that calls for a different kind of expertise and some more practice (see Malone, 1981; Newman & Petitto, 1982, for further discussion). There is always, it seems, an interesting *whole task* for the child to perform.

In a game called Space Eggs, for instance, the beginner sees: (1) a player gets points by shooting an egg and then shooting the creature that is hatched; (2) the player must avoid being attacked by the hatched creatures; (3) the player gets three different sized ships each with different gun characteristics, a new one provided when the old one is destroyed; (4) the points are carried on from ship to ship and a high score for the game is displayed in addition to the current player's current score. But, there are other characteristics to the game that emerge as one gets expert enough. If the player succeeds in hatching and shooting all the creatures (for 15 points each), the screen fills with new eggs that release different creatures when shot and that are worth more points. Each kind of egg and creature has a unique pattern that the player can react to in order to protect himself and clear the board to find out about a new kind of creature. A further characteristic of the game remained a mystery for quite some time: the player's ship has an opportunity to dock and get extra fire power if the player amasses a certain number of points on a certain ship on a certain creature.

Children who were expert at this game kept discovering new properties. The day finally came, however, when one child achieved to the degree that the computer had no further response to: all that happens is that the most complex pattern repeats itself. The child's response was simple: he stopped playing the game. During future days at computer time, he chose other games, going back to Space Eggs only rarely.

We learned a great deal from observing such sequences of discovery and interaction on arcade games. Quite apart from the pyrotechnic dynamic devices in such games, it appears crucial that upon entering the game there are obvious and achievable goals even for a novice, such as "shoot the eggs and get as many points as possible." *Not until (but always as soon as)* a certain level of skill has been reached do new and interesting goals present themselves. Once a new feature of the game is presented and becomes a goal of the child's activity, the reward structure of the previous stages is reorganized, so that in cases where the game permits, the child may bypass former goals (get as many points as possible per level) in the service of new goals that are higher in the game's goal hierarchy. This notion fits neatly with Leont'ev's writing on activity and goal formation. The games appear to be models of zones of proximal development.

It was clear, however, that all the while that the arcade games were organizing admirable functional systems, they were also promoting a less admirable organization of computer time at Delf College. An essential organizational issue is the distribution of scarce resources -- in this case, the Apple microcomputers. The adults wanted some equitable distribution of computer access among the children and some variety among the programs used, with a bias toward the more carefully designed cognitive training games. The arcade games required massive amounts of practice -- hence, a hegemony on the Apples for these games. Further, the more expert players have the best chance of breaking through to another goal, providing the group with a redefinition of the game -- hence, a hegemony for the experts on the Apples. Turn-taking was basically in the service of competition among the experts; novices aspiring to master the game were content to cluster as an admiring audience picking up a turn at transition times when they were lucky. Children who were not motivated stayed away, were ridiculed away, were tricked away or, on occasions had an adult enter the struggle and wrest the resource, at least one Apple, away from the distribution system organized by the arcade games.

Phase two

We found that when adults were effective at countering the organizational power of arcade games, children could enjoy the commercial educational games and the games constructed at LCHC for research purposes. For example, Odell Lake is a game which uses an ecological chain and provides practice in seeing transitive relations among the items in an array. This game has some of the properties of Space Eggs; there are new goals to be discovered and practice can make better players. But the amount of text involved and the relatively less exciting payoff for the beginner's efforts make it the kind of game for which an adult helper comes in handy. An adult who introduces charts and writes down what is being discovered can keep the child in the game context long enough for the child to become accomplished and continue on his own. We had the same experience with several other games intended to have educational benefits; with adult mediation, they can be successful. Some of the children who professed dislike for microcomputers during computer time enjoyed these activities with the adults.

An obvious and, by March, plausible solution to computer time at Delf College was to increase the number of Apples and to increase the adult mediation. We added another Apple set-up and we added UCSD undergraduates for more adult help. When this happened, more educational activities started occurring during computer time. The undergraduates, furthermore, increased computer time outside of Delf College because they worked with the children on Apples at home or at the university on days that the children did not attend Delf College. The undergraduates learned ways to get the children to use the Apples for the more educational games.

Our solution at this point was to change control over the resources by expanding them a bit and by calling in

more capability for interactive, on-line adult control. Typically, there would be a cluster of children around two Apples organized by arcade games and a cluster of adults and children around two other Apples organized by adults and the research/educational games. We were not satisfied with this Maginot Line. We had some theoretically motivated and potentially interesting new software to introduce that we didn't want to "compromise" by identifying it strongly with the "adult side." A change was needed, but we wanted to be very systematic about the way we introduced that change.

The Fifth Dimension

Several considerations guided our choice of a new computer-based curriculum. Central was our desire to change the mix of computer activities. At the same time, we wanted to retain the good features of the interactions that resulted from the arcade games, especially the redistribution of expertise that gave children the opportunity to be experts *vis à vis* us and their peers, and the many opportunities for discussion of cognitive skills and strategic planning. Further, we wanted to avoid a situation in which the adults controlled access to the games by inventing a control system that the children experienced as intrinsic to the computer.

Here we were adopting Schelling's (1960) strategy of interaction; you can gain power in an interaction by giving it away. This was directly opposite our move in phase II, where we multiplied our power. By placing the decision-making power in the computer, we could move out of the role of control and nearer to the role of facilitators. We could work with the children helping them to succeed at their goals.

But we needed more than a computer controlled, restricted access arrangement to continue to motivate the children. We created a fictional world, "The Fifth Dimension," for the children to explore. The Fifth Dimension is composed of a conglomerate of popular music themes, which are coordinated and ruled over by a wizard who is never seen, but who issues orders by tape recorder in a deep and mysterious bass voice. We built a physical model of this world in the form of a 3' by 6' maze with 21 rooms in it, most with multiple doors, but only three with access from or to the outside. Like commercial computer games, the Fifth Dimension has a set of embedded goals where success at some nominal level is both demanded and generally accessible. It also has a series of higher order goals that allow the children to succeed while striving higher. Like Dungeons and Dragons, and other currently fashionable role playing adventure games, the Fifth Dimension has a chance component to it, along with various escape clauses that permit the children some added measure of control over their fate. The Wizard gives children and adults somewhat equal control by providing each with typewritten copies of the rules and procedures, including a procedure to ask for clarification of unusual situations.

After a great deal of shuffling about, we selected a beginning set of 22 computer games and 4 non-computer activities that children would be required to deal with when they entered the rooms in the Fifth Dimension. (Some rooms included a choice of activities.) Of the computer games, we classified 7 as arcade games and the remainder as education or research-relevant.

The Fifth Dimension proved a big success. By and large, the children adapted quickly to the change in computer time. They were taken to a local store to purchase small metal unicorns or beasts or knights on horseback to represent them in the game. They also came to the university to help decorate the Fifth Dimension maze with bright designs inside and out. They knew that their metal token could mark their progress through the rooms.

When the children entered the classroom on the day that the Fifth Dimension arrived, they found that they could not log onto the computer until they had entered into the game, and they met up with the goal of helping their tokens to escape the Fifth Dimension by one of the possible exits. If successful, their characters were "transformed," and the children could return to the store to purchase new characters to re-enter the maze. Within a week or so all of the children were spending their computer time in the Fifth Dimension. The first student to achieve the goal of transforming a character was a girl who had, until this time, refused to deal with computers at all.

According to the wizard, a child whose repeatedly transformed character manages to visit all the rooms in the Fifth Dimension also gets a special testimonial t-shirt. No child has yet achieved this goal, but some are close.

Although some of the children grumbled about restricted access to arcade games, this grumbling did not carry the day. Instead, the children began to find a great variety of games interesting. In some cases, when the rules gave a choice for a child to enter a room that s/he knew included an arcade game or another room that provided a more education-like game, the child chose to forego the opportunity to play the arcade game in order to achieve goals appropriate to the Fifth Dimension, like getting to an exit.

Several factors seemed to be involved in the success of the Fifth Dimension environment as a setting for the computer games. Every activity in the Fifth Dimension has three pre-set levels of achievement which controlled movement to a new room and the award of tokens instrumental to some freedom in choosing rooms. For each activity, levels always included at least one that was easily achievable and one that was very hard. Consequently, from the perspective of the game-world, arcade games and educational games did not differ much in difficulty; all had goals that were very hard and very easy, and all demanded skill to gain freedom of movement.

It was also important that in the Fifth Dimension the children tended to work alone, although we had a provision for joint ventures into a new room. From various comments made by the children as they made their choices in games in the Fifth Dimension we began to realize how the previous social arrangements had formed a part of the attractiveness of the arcade games. Those waiting to play the next round formed an audience and with it competitive comparisons. In the Fifth Dimension students were all busy "surviving" in addition to monitoring the success of others. As a consequence, the competitive spirit diminished and the arcade games lost relative attractiveness. The children's acceptance of the goals of the Fifth Dimension reordered the reinforcing value of the alternative activities.

A very important factor in the Fifth Dimension, felt

strongly by adults, was the mediation of control by the Wizard's rules. At times, we sabotaged our own efforts in thought or in deed. We chafed against a system that provided a particularly wonderful reward for a game that was "fun anyhow" and that provided a miserly reward for a game we particularly wanted a child to play and worried that he might reject. We managed to prevent ourselves from tampering with the Wizard's levels and consequences. However, we were more likely to slip and take control back from the Wizard when a *child* chafed under the constraints. It was always a mistake and it never worked; when we had the sense to relinquish on-line control and consult the Wizard's rules with the upset child, we would always find an acceptable escape clause that kept the child in the context.

Our rewards for following the rules were high. We saw children whose temper tantrums had succeeded in getting them out of educational activities come back under the control of the Fifth Dimension so quickly that errant tears dropped on the keyboard while the microcomputers were booting up a new estimation arithmetic game or an interactive text writing program; the children were too busy to wipe the tears away. We had the pleasure of collaborating with children on hard tasks whose achievements *they* had accepted as a goal and who no longer viewed us as someone to wheedle or bully into making the hard work go away.

By the close of school, the new computer curriculum was in full swing. Every child had explored many games, and many had put in hours of practice on educational games, including several of the specially designed LCHC games. From the standpoint of research, and with the Wizard's collaboration, the flexible framework of the Fifth Dimension can continue to evolve with the developing skills of the students. We are currently revising this educational/gaming environment in preparation for a more refined assessment of its usefulness.

Some Issues Concerning Fact and Theory

Earlier in this essay we described the strategy whereby we could coordinate to construct an interdisciplinary research project on learning disabled children. True to our original strategy we have described our experiences pretty much in terms of the entering strands of research. Underlying this strategy were a set of research goals that we believed could be profitably pursued if we made common cause. *Theoretically*, this common cause was to create an environment in which our disparate techniques and languages could speak to each other. Could we move from creating an interdisciplinary project to creating an inter-discipline?

Remembering that the rewards for such an enterprise will certainly be found in the doing if they are to be found anywhere, we have spent a good deal of time seeking ways to extend the parts of our data base for which we can give principled accounts. As we note elsewhere, we are guided in this effort by Alexander Luria's attempts to create a "romantic science," in which general laws derived from laboratory research would have to confront the "living facts" that they were supposed to explain. The system that Luria created, part "experimental," part "clinical", was designed to produce data adequate to the phenomena being analyzed. In current parlance, it was insufficient to settle for a nice share of the variance; what was needed was an approach adequate to the real decision making requirements of the individual. His books on a person with a remarkable memory and another with a severe brain injury illustrate his enterprise. Recognizing the difficulties of forsaking the controlled circumstances of the laboratory, he characterizes his ideal as follows:

> Truly scientific observation avoids such dangers. Scientific observation is not merely pure description of separate facts. Its main goal is to view an event from as many perspectives as possible. The eye of science does not probe "a thing," an event isolated from other things or events. Its real object is to see and understand the way a thing or event relates to other things and events. (Luria, 1978, p. 177)

The difficulty of Luria's advice is that we have no agreed-upon set of criteria for adequate description of many events that our experience suggests are linked in theoretically important ways. In so far as we are serious about getting the events that characterize our individual strands to relate to each other, we need to find "inter-methods" to go along with our inter-discipline.

In the following two sections we describe two events that struck us as significantly related to our overall theoretical concerns, but for which we had neither prearranged methods of analysis nor any video taped record that we could use to check with. Instead, the data are our records and field notes, interpreted using the framework we have been describing here. It is our hope that in their present state they will prove useful as hints about the living facts of learning among learning disabled children.

NOTHING SUCCEEDS LIKE SUCCESS

Its an old adage. Nothing succeeds like success. In the following remarks we describe the process that the adage summarizes using an example from the cognitive training strand of our research. Our task, as part of our efforts to assess the contribution of metacognitive processing to problems among learning disabled (LD) children, was to administer a memory testing and training procedure. The testing aspect consisted in finding out how many of 16 color photographs a child could recall. The training aspect consisted of showing the children a videotape on which a girl about their age demonstrated seven different ways of remembering pictures just like they were being asked to remember.

We included this work because recent psychological research and theory has placed special emphasis on the teaching of thinking skills to school children somewhat separate from the usual curricular goals of teaching reading and arithmetic. The idea that schools should teach children to think, not just fill them with facts, is the background assumption that underlies these efforts. So, one reason to teach children strategies for remembering is that they are academically useful so the children can use them in varied academic tasks. Our orienting question in this regard was: will the skills that we teach them in this training task transfer to the classroom? (There were plenty of grounds for scepticism, but some evidence for hope too.) A second reason was quite specific to the population of children we were working with; we suspected strongly that the kind of learning handicapped child labeled "specific learning disabled" would *not* be disabled when it came to strategic planning abilities. That would help to specify better what we meant by the "specific" part of the phrase

specific learning disability.

We are still collecting the last few bits of data on the current study, but a few things are clear already. First, given the small group with which we are working, and the mixture of experiences we are giving them, we will not be able to say much about the transfer to classroom work of the strategies we taught them or got them to use.

Second, we can say fairly confidently that, as a group, these children *do* engage in strategic remembering behavior. They look away and rehearse to themselves, they concentrate on pictures they forgot earlier. However, until they have seen the model child regroup the items and systematically rehearse them in taxonomic categories they are unlikely to do so. Once they have watched the model rehearse items by category and declare that it is terrific, they avidly regroup the items, rehearse them, and remember them. Some, but not all of the children, used the same strategy when retested a month later. All of the children proved capable of learning all sixteen items on one or two tries. Instead of reporting these performance data in detail, We want to report a repeated dynamic within the test-train-retest cycle that relates to the way that success is a cause of success.

First we have to consider the situation that the child finds herself in at the beginning of the test/lesson. She is sitting at a computer playing a game that excites her. She doesn't know the experimenter well, but when asked, she comes along. The experimenter is one of the group of adults who control her life in school, although she is not in school, she is new to Delf College and she is in a schoolroom. As they walk across the yard, experimenter and child chat about little things in common. The computer games are a good topic, but the experimenter retreats to "what did you do this weekend" if their experience is no more closely connected.

When they enter the room where the training is taking place they sit down at a table, behind which sits a large television screen. A shallow cardboard box containing a few scattered papers is sitting on the table. As they sit down, the experimenter picks up the cardboard box, revealing 16 color drawings of common objects; 4 vehicles, 4 fruits, 4 toys, 4 kinds of clothing.

"Here's what we are going to do," He says. "There are 16 pictures here. I want you to study them for awhile so that you can remember them all when I cover them up." He puts the box back on top of the pictures.

"I don't know how tough this is for you. All the kids remember some, but not many can remember all of them. Once you have a chance to figure out how it goes for you, we'll watch a girl about your age trying to do the same thing. After we see how she does, I'll give you a new set of pictures to remember." With that, the experimenter uncovers the pictures and the child starts to look them over.

A lot of different things can happen at this point. Sometimes a child is uncertain of what a picture is named, and has the temerity to ask. Although they are told that they can do anything they want to help them remember (It's not true; one boy asked if he could hold pictures in his hand, which we overruled on the grounds that it would not be real remembering if he looked at them). Few children touch the cards. But almost everyone displays signs of "trying to remember." Some close their eyes and mumble to themselves. Some scan a row and look away for a few seconds as if trying to "fix" the row in their memories.

After a time, sometimes no more than 15-20 seconds, the child says "O.K.," or the experimenter senses that the child is done "trying to remember" and asks if she is done. Each child is allowed to study the array as long as she likes, but no one takes more than two minutes.

As he covers the array and picks up his notebook, the experimenter says, "O.K., tell me all the things you saw." At this point, as before, almost anything can happen as the children start recalling. Some rattle off the items on the first row, pause, pause longer, recall a couple of items from different lines, an odd item or two, and stop. Others recall at a steady pace, but with no seeming pattern to the way that items are named; they are neither grouped by any identifiable category, nor can we discern any spatial order to their recall. A few seem to mix spatial and categorical units in their recall.

At this point the experimenter encourage the child, first by testifying that they did a pretty good job, and second by urging them to take a second look, to study the items again, and to try to recall all 16. As they began to study, several of the children asked if they had to remember all of the items, not just those they missed before. "Yes," was the reply, "The idea is to remember them all at once." Several of the children displayed further knowledge of study time allotment strategies by overtly rehearsing the items they had failed to recall *in addition* to the time they spent on the previously remembered items. In several cases, these specially studied items were first named when the child again recalled the array.

After a third trial, "just to see if you can get them all" we put the cards away, and pick up a small stack of glossy photographs. The experimenter goes over to the television and turn it on. He explains our training tape. "There's this girl named Janet who we taped on television. We asked her to do the same kind of remembering that you just did." As the tape reaches the appropriate point, the sound is turned up and we see and hear Janet talking about her activity. She is seated at a table which we see from two angles. Half of the screen shows her face-to-face with us, seated at a table on which are a dozen cards like the ones with which we had been working. The experimenter stops the tape and point out the cards on the table, the overhead view of the cards on the right half of the screen, and the first glossy photograph, which pictures the array that Janet is looking at. When he thinks that the child understands that she is looking at the same pictures that Janet is, they proceed with the tape.

Janet goes through seven memorizing-recall cycles with seven sets of pictures, all of which can be divided into four categories of three items each, and all of which are laid out in a neat 3 x 4 array. On the first trial she says that she will look at each item very carefully so that she can remember well. When she is done, she looks up. The experimenter stops the tape and ask two questions: "Do you think that (looking hard at each item) is a good way to remember?" "How many do you think she can remember that way?"

Again the children's reactions were quite variable. As the tape began, the children didn't know what to

expect, and they still didn't after watching a demonstration of one set of recall activity. Almost every child said "Yes, that's a good way to remember," even if they had engaged in more elaborate study strategies themselves during the pretest. The question, "How many do you think she can remember that way?" evoked a variety of estimates. Some guessed a specific number. Others simply said "Alot" or "All."

The tape was started again. Some of the children fidgeted and looked away, but most glanced at the new photograph in their hand, and listened as Janet said that she didn't do very well, she only remembered three pictures. This time Janet decided to name each picture while she looked hard at it. Most children again agreed that this was a good way to remember. They more or less maintained their estimates of her success. Again Janet reported that she wasn't doing too well. Next she was going to look quickly at the pictures so that she wouldn't forget them. At this point, virtually all of the children declared that Janet was making a mistake; quick glances are not a good way to remember.

For most of the children, this negative evaluation of Janet was a turning point in what happened in the experiment. They began to "tune in" to her more carefully. Some even began a dialogue with the T.V. set, or with the experimenter about the set, commenting on what Janet was doing. This active involvement cropped up most clearly toward the end of the series, when Janet was grouping pictures according to semantic category and laying them out along each row. As Janet mused out loud about the array a number of the children mused in advance of her. (Janet is a bit of a slowpolk at this point in the proceedings).

Not unexpectedly, the children who seemed most in command of the recall task before we started the tape appeared least involved with Janet and her problems. Unfortunately, a couple of children who did not do well initially also failed to show much involvement with what she was doing.

Janet's last routine has her categorizing the pictures by row and then naming them repetitively row by row. All of the children got a pretty good idea of what she is doing, and all figured that this time she would get them all. In part these judgements come from their recognition of the fail-safe power of what Janet does, in part it comes from their experience with television. Several children told us that television programs have happy endings, so they knew she would get them all. Doubts aside, it is safe to say that all of the children were influenced by the videotape. They learned from it.

Part of what they learned was that it was alright to pick the cards up and move them around, revealing an interesting interpretation of what it must have meant to them when they were told at the start of the session that they could do anything they wanted to remember the cards. It substantiated our feeling that a lot of the children were interacting with the experimenter on a formal basis, "minding their p's and q's," remembering to keep hands off things that the teacher is working with unless he tells you it is alright. This time, Janet had shown them what to do, so they did it. A few even hesitated, and asked if it was alright to do what Janet had done. "Sure," they were told, "Do whatever you need to do so you can remember them all." They rearranged the cards so that they produced four rows of categorically grouped items. Very few spoke aloud as Janet had done, but they studied by scanning rows of the matrix, sometimes whispering to themselves, sometimes looking away. In general they studied longer than they had on the first series. When they were ready, the array was covered and they began to recall.

It worked. Like Janet, they could now recall them all. They would "read" off a row, pause, and run through the items on a second row, a third and a fourth. Sometimes they would hesitate after completing a category/row, scrunch up their faces, and rattle off another. Some didn't read the array in a very systematic way. But their recall was excellent.

We wanted to allow for three trials on this phase of the study to compare with the three trials given as a pre-test. A confident, perfect recall on the first try gave us some problems; We needed a way to motivate a second try. In these cases, if a child simply glanced at the pictures, We asked if they could really remember them without any more study. More often than not, we were assured that all was in order, and it was. The children had mastered that task. It looked and felt tough the first time around, they watched it done on television, and they did it.

The experimenter was as pleased as the children. He shook hands in congratulations. He enjoyed being there to congratulate them simply because they were so pleased to feel like they deserved congratulations and they got it. The excitement even followed the kids out of the room. They would run up to their teacher of the moment, asking if the teacher wanted to know all of the pictures that they had just seen. "Sure" was always teacher's reply; as likely as not the 4 x 4 matrix came back as the students' reply.

SPONTANEOUS APPRENTICES

A few years ago George Miller wrote a monograph about a group of children in an experimental preschool, in which he likened the children's language acquisition processes to apprenticeship. His thoughtful title, *Spontaneous Apprentices*, also mirrors the extent to which he believed that he and his colleagues were co-apprentices in the process of learning. The general principles underlying Miller's broader effort came to mind recently in our work with learning handicapped children.

In this section, we want to relate an anecdote about a spontaneous apprenticeship involving adults and children, teacher/researchers and subjects. This anecdote illustrates several principles discussed in previous sections. When our failure to implement a lesson began to threaten the viability of a reading group, we spontaneously joined into the lesson WITH the children. In so doing, we made our activity, *educational activity*, available to the children as a way of interacting with printed material. In order to enter with us into the activity (which the children wanted to do, since they were getting all this help from adults who also needed help) the children had to engage in the actions which we consider essential to good reading, especially actions which have comprehension as a goal. These interactions were all subordinated to a pretty well-coordinated system such that this "failed lesson" engendered a great deal of educational activity.

The information gained from this session then became directly relevant to the planning of a next lesson. This next lesson was organized so that essential

parts of the support work that had been provided by adults was taken over by a social object, a specially constructed version of the text, which allowed a single teacher to carry out functions previously requiring three adults.

The children-apprentices gained an unusually large dose of theoretically guided practice in learning to read. The researcher-apprentices gained a good deal of insight into the interactional dynamics that allow students to engage in appropriate practice; the researchers, in short, arrived at a stronger theory of the processes involved in reading as well as a stronger theory of the specific organization of those processes appropriate to the education of children who find it difficult to learn to read.

The anecdote

Learning on short notice that she could not be present to teach one day, the teacher-researcher, Peg Griffin, set up a lesson that could be run by Cole. A few passages of text taken from material that the students had been reading the previous lesson was cut into strips. Each strip contained a sentence or a sentence fragment, typed in bold print. The children were given an envelope with the entire story cut into 23 strips. The text from which the story had been created was nearby in case the children felt that they needed to refer to it. Glue sticks in hand, interpersonal issues organized into abeyance, the children began the task of reconstructing the text from the sentence fragments.

Twenty minutes had been alloted for this activity, but it didn't take long to figure out that twenty minutes was not going to be enough time. After a few minutes of struggle, things weren't going too well. Little reading was occurring. Some of the children were playing layout artist; they were busy arranging strips of paper in a newspaper format but paying no attention to their semantic content. Some of the children had pasted a single phrase or sentence on their sheet of paper, but the remaining paper strips lay in jumbled heaps around the table. Some time was spent in trying to regularize each child's stock of phrase strips, but by the time one child got organized, another was dropping out of the process in confusion and its ensuing state, boredom. The noise level was slowly rising.

Cole, seeing that things were going poorly, reached for the original text from which the phrases had been drawn. As he did so, Brown and Campione, who were present in the capacity of observers, could see that the lesson was in imminent danger of collapse. Uninvited, but welcome, they moved up to the table. They elbowed their way in between distracted children, and started to puzzle over the tangle of paper and print, talking aloud to themselves, asking questions.

Cole began to read the story slowly, commenting from time to time on the relationship between what he was reading and the phrases with which the children were working. He found some important landmarks (for example, that a discussion of "difference machines" precedes discussion of "analytic machines") which he pointed out to the group. Brown and Campione played cooperating chorus. They emphasized the significance of benchmark phrases, suggesting that one of the strips clearly came last.

Everyone set to work again. For awhile, several of the children worked with Cole, Brown and Campione in an attempt to come up with "at least one good story to show to Ms. Griffin." Progress was made, so that after 20 minutes or so of discussion, trial and error work, and lots of phrases saved from a gluey grave, parts of the story could be found on a few sheets of paper. But time was up, so the adults called a halt to the work with the promise that the kids would all get another chance.

The entire interaction was unusual for what we might call its affective tone. At the outset, the children agreed that the task was dumb and uninteresting. Computers buzzed and beckoned them from across the room. However, something about the task was engaging. The goal was clear enough, but it looked very tough to achieve. Once failure loomed the children started seriously to reject the task. The critical juncture occurred when Cole picked up the text, visibly intent on success in the face of adversity, and Brown and Campione moved in to help. It was clear that the adults did not know precisely what to do, but also that they were willing (and apparently happy) to tackle the job. As the adults began to chat with each other about possible sentence/phrase combinations, the children started to chime in with suggestions. There were enough plausible suggestions and confusion, so that everyone felt a part of the activity. Expertise was not clearcut, but *everyone was reading.* Almost all of the children read strips of various kinds repeatedly, and none of the adults could piece all the strips where they belonged. Adults and children had entered into a task together, and together they accepted and worked toward a goal. When time was up, everyone was satisfied that a real piece of work had been done, even though we "failed" in the narrow sense. The triumph consisted in getting a differentiation of the senses of failure.

The followup

The following day, Ms. Griffin repeated the lesson with another group of children. Forwarned, she prepared sheets on which some of the strips had been pasted ahead of time, so that the task of arranging all the strips was greatly simplified. Now it was necessary only to arrange the MISSING strips. Several milestones in the text were placed on the sheets as an additional aide to finding the missing pieces.

In these circumstances, Ms. Griffin could handle the task alone with the children; social resources for engendering educational activity had been converted into static, written resources. This conversion of "social" into "cognitive" resources was manifested in the way in which the interactions between Ms. Griffin and the children were structured. All of the children worked like beavers on their own story "puzzles." Ms. Griffin moved from one child to the next, responding to calls for help. She "failed" only in the sense that the children's requests for assistance in carrying out *their* task were coming faster and more furiously than she could cope with smoothly. With the appropriate structuring of the story-making task, these children took over the activity so thoroughly that Ms. Griffin became coach instead of a guide. She cheered their suggestions, wrinkled her nose at strange combinations which threatened to stick to the paper in strange places, and generally did her best to indicate her pleasure at being able to participate in the children's activity.

Some interpretive remarks

With these anecdotes in hand, we can return to the

idea of spontaneous apprentices with which we began. We find the notion of apprenticeship helpful in thinking about the changes in the children's behavior that were produced by our two different versions of a "writing" assignment. In each case it appeared that the children shifted from a situation where there was a teacher and students to one in which the students "got into" the task, taking it as their own, and thereby engaging in precisely the kind of learning activity we were seeking to engender. This shift coincides with an ability on the children's part to engage in interactions with the adults in which a division of labor had been arranged. Each party to the interaction, adult and child, contributed *to the utmost of their abilities given the constraints provided by the text and the entering skills of all the parties.* Adults were no longer "holding out" on the children; they were contributing at their highest level of understanding. They *displayed* this understanding and the work it entailed. The children could see that understanding consisted in more than the final product; it could be seen, too, in useful actions that presupposed the overall goal ("Let's read these darn slips of paper and figure out what the story must be"). In moving from a system controlled by a "known answer machine" to one controlled by a "knows something about how to find the answer" person, we had recreated an essential feature of natural environments for language acquisition (á la George Miller) and an equally natural environment for learning-to-read-as-a-problem-solving-tool.

The notion of "spontaneous" is frought with philosophical problems, but it captures an important feature of the interactions we have described. There were no plans ahead of time to have Cole teach a lesson that was too difficult; there were no plans for Brown and Campione to move into the center of the lesson to help out; Griffin could not foresee her role as consultant/kibbitzer once the reading task had been more fully structured. These roles grew "spontaneously" in the interaction. "Spontaneous" in this case means that interactional dynamics made the form of interaction seem natural and necessary, "given the conditions." The conditions were the foundation necessary to keep the children in the interaction in the absence of strong negative sanctions. Either we made the activity into something that the children would make their own, or we failed. In making the repairs necessary to keep the children in the interaction, we hit upon a system that got them to enter into it in the way that V. V. Davydov[13] calls educational activity. Vasilie Vasilich likes to say that educational activity will never be found in a school. He is almost right.

From Practice Back To Theory

It would be possible to continue this account with descriptions of other aspects of this project; we have slighted those strands of the work focused on an understanding of the relevance of cognitive testing and disabilities and home/community life to our understanding of learning disabilities. However, the specifics of running a multifaceted project like this one constantly threaten to inundate us with arcane knowledge that is difficult to keep well-woven into the tapestry of the overall scheme. So, we want instead to use the remaining space to step back and get an overview of the project as a whole.

An interim summing up

We began this study of learning disabled children because we saw a unique opportunity to address some central issues of psychology, sociology, linguistics and education. We were particularly impressed by the theoretical importance of the fact that some children seem to be *selectively* handicapped. We felt that if we could understand the nature of this selectivity (the "specific" in specific learning disability) we would thereby better understand such questions as: the relation between cognitive and metacognitive behavior, the relation between social interaction and cognition, the organization of effective learning environments.

For the first year of the project we sought to work within the given institutional framework of the school, gathering observations of children from many different contexts, and seeking likely ways to combine our different kinds of data and theory. Our goal was to build up a special kind of longitudinal case history; a portrait of an individual child constructed out of the separate strands of observation collected over a year period. In simple language, we wanted to get to know the children very well using all the techniques at our disposal. This goal could not be achieved within the institutional constraints of the site schools.

In retrospect, we can see that by creating Delf College as an environment intended to apply the best that our research knowledge could give to educational practice, we simultaneously took responsibility for the children. These added responsibilities and the opportunities for research that go with them, shaped the special character of the project.

The major new research element introduced by Delf College was the curriculum, especially the reading curriculum. We are satisfied that the reading curriculum research has provided ample justification for its supporting theory. It was gratifying to observe improvement for children in all of the reading groups related specifically to the behaviors taught in the individual curricula. It would be more gratifying still to have been able to report that the 30 hours of added reading instruction we provided had produced across the board results. As a result of our experience thus far, we are very interested in moving toward a single, integrated reading curriculum that combines elements of all four curricula.

Despite shortages of hardware, software, and personnel, the computer- based curriculum made great strides. Our initial distress that arcade games would thwart good education changed when we realized that despite characteristics we disapproved of, the games had a good deal to teach us and the children. By entering with the children into game playing, we allowed the games to redistribute expertise in the educational setting. Consequently, we found many opportunities to engage the children in talk about learning and problem solving strategies, while observing their maneuvering with computers and each other. When personnel and machinery became available, we created an alternative computer-based curriculum embedded in a fantasy world. Reordering of goals and activities promoted by this change brought more children into the computer activities and

[13]For an example of Davydov's thinking translated into English see V.V. Davydov, & V.P. Andronov, 1981).

brought all the children in repeated contact with games which we believe have specific cognitive consequences.

In parallel with these curriculum activities, we carried out a variety of individual testing/training activities such as those described in the "Nothing succeeds like success" section of this newsletter, and spent a great deal of time getting to know the children at home and in the community.

Delf College as a Model System

While it is our hope that individual strands of this project will prove useful both for the development of theory in the domains they represent and the practical benefits that might accrue, our overarching goal extends beyond these separate aspects of the project. As recounted earlier, we came together in the belief that a properly constructed investigation of learning handicaps could serve as an arena within which to confront basic issues of social science. How does Delf College relate to that larger goal? Some candidate achievements in this category might be the following:

1. Our research has provided evidence for the Interactive Learning Framework, including the central role of guided social interaction as a principle element. It has proven possible, as we hoped, to conduct a comprehension-based reading curriculum composed in part of specially organized text material and in part of special organizing teacher strategies.
2. We have obtained ample support for the functional systems analysis of the dependence of goal structures on activity. The computer curriculum provided an especially rich source of evidence. So, for example, we discovered that as children go further and further into some games, the goals that had organized their behavior changed; content to gobble up points at the early stages of Pac Man, a child starts to ignore point-gathering moves in order to clear the board to gain access to amusing "time out" routines. A different example is illustrated by the success of the Fifth Dimension; acceptance of the goals of that fantasy world significantly reordered the choice among games of various kinds, allowing us to introduce games of our choosing. There are also interesting non-computer examples, one is to be found in the anecdote about spontaneous apprentices, where the children entered willingly and actively into a broken lesson, helping adults to repair it; the subordination of decoding to the goal of comprehension in the Berkeley reading curriculum is another.
3. We have illustrated the usefulness of the analysis by synthesis interpretation of learning interactions, and established, in preliminary fashion, connections between this approach and the conceptions provided by Soviet scholars and our colleagues in CHIP. As indicated earlier, the key point of departure for us is the explicit recognition that multiple and differing analyses of a task occur in educational settings. It is crucial that the fate of theoretically important individual analyses not be collapsed into the notion that only the child comes away changed, or that changes in the child are uniform. It is our belief that when combined with an interactive learning/ teaching framework, analysis by synthesis provides a powerful way to unite instantiations of the theory at different levels of analysis given by the different discipline-based analyses that go into this project.
4. We have provided new data on the role that metacognitive processing plays in shaping the nature of learning handicaps. From a great variety of sources comes evidence suggesting that LD children cannot be characterized as deficient in metacognitive abilities in any general sense. To be sure, they may not give evidence of such abilities when reading, and explicit tuition in the relevance of particular text-processing strategies may prove beneficial. Work by Brown and Campione at Illinois as well as scholars elsewhere is pursuing this promising line. However, from our cognitive testing and a variety of observations of the children in an equal variety of settings, we know that they suffer no *general* metacognitive deficits. This conclusion is supported directly by our observation in the metamemory training study, where virtually all of the children displayed overt, relevant cognitive strategies of an appropriate kind. Converging evidence comes from the children's ability to acquire and use reciprocal questioning strategies as part of their reading activity.

Still at issue is the important question of transfer. Follow-up studies testing transfer of training in a controlled way are an important item for our fall agenda. But recalling that we are working with children who by and large have normal tested intelligence, we see no reason to expect that transfer will be a problem of the kind it is, for example, with the mentally retarded. A final example especially relevant to our population of children is the evidence that a good deal of the behavior that is ordinarily taken as indicative of a specific learning disability (short attention span, for example) is not a cause, but a consequence, of the children's prior frustrations with school-based tasks. Here our multiple observations in varied settings is of great importance. We have collected repeated examples of children who manifest LD-like behaviors when reading, but not in other settings. One child, who was extremely mobile and fidgety during reading sat for more than an hour, patiently sorting through baseball cards with a UCSD student. This same child, when playing arcade games, or jockeying with the other children and teachers, demonstrated a tenacity that was intimidating.

The children displayed for us over and over again their belief that it was cheating to use information from someone else when attempting to learn an activity where performance is socially evaluated. They displayed great skill in treating us as if we were deficient versions of the proper way to teach, an interpretation which validated their attempts to avoid the task of reading. The disentangling of "primary" and "secondary" symptoms, e.g., those intrinsic to the child as learner and those which arise because of the child's need to hide her difficulties and maintain her social status represents one of the major challenges in the diagnosis and remediation of these children's difficulties.

It will not have escaped notice that the underlying strategy of this project is difficult to fit into the classical experimental mold that underpins a good deal of contemporary psychological research. Nor have we relied on clinical and medical concepts to explain our manifestly behavioral data, despite the fact that we are working in an area where such interpretations abound. On the other hand, we have not mounted a typical clinical research design either. Instead, we have created a research strategy which brings experimental and clinical practice together in a single system with many interacting parts. Our evidence for the nature of the system and the components that comprise it comes less from standard uses of standard instruments and designs than from multiple contrasts across time and settings, motivated by an interactive model of learning, whose workings are described in the previous pages.

This kind of project has an important historical precursor in the work of Alexander R. Luria, one of the very few cognitive scientists who succeeded in making

important contributions to *both* basic psychological analysis of general human functioning *and* important contributions to the design of therapeutic programs of training for the handicapped. As our work has progressed, we have more and more self-consciously modeled ourselves on Luria's example.

Luria sought all of his life to create a unified theory of mind which did not "split living reality into its elementary components nor to represent the wealth of life's concrete events in abstract models that lose the properties of the phenomena themselves." (1978, p. 174). We, like Luria, recognize the need to be responsible for individual cases in so far as we take seriously the notion that diagnosis is supposed to be linked firmly to remediation. While using the ideas of Luria and other scholars to shape a model system for the diagnosis and remediation of learning handicaps, we are trying to understand the unique problems that this syndrome entails.

It is very useful to have a well worked out system like Luria's to use as a tool; but, by the principles of the system, we know that we cannot carry the details of his methods over to the problems confronting us in their details. Rather, we have had to consider both the similarities and differences that shape our treatment of learning handicapped children when contrasted with Luria's studies of brain lesions. The similarities are striking: we are dealing with information processing deficits associated theoretically with aspects of brain function; our subject/patients are people of normal intelligence who have the possibility of using intact functions to mediate activities that cannot be organized normally. The differences are also important: questions of brain locus are far more problematic in the case of learning handicapped children, so much so that there are few cases that promise explanation in terms of localized perturbations of brain function. Even more significant, we believe, is the fact that Luria's patients, being adults who had undergone a long process of socialization, accepted the tasks he presented them and entered with him, as doctor, into a prescribed program of treatment. Consequently, he could make rather strong claims that they were working on the task that he was analyzing. We do not have that luxury; for us a central difficulty is to discover the task that the child is working on to inform our efforts to induce him to discover and adopt the tasks that we present.

In future work, we will continue to pursue these analogues while constructing a project in the spirit of Luria's notion of romantic science. We hope that this report will stimulate our colleagues to comment on the enterprise, and suggest ways in which we can extend and clarify our ideas.

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