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Paradigms of Pretense

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In recent research on children's play a debate has arisen over differences between middle and lower class children. On the one hand it has been stated that lower class children are deficient in imaginative play and on the other that such a deficiency is an impossibility. In a recent symposium, the opposing points of view were presented by Dina Feitelson and Helen Schwartzman.[1] Feitelson, elaborated on the great difficulty that Kurdish Jewish children have in adapting to schooling. They do not engage in imaginative play and in consequence, she argued, have considerable difficulties with the symbolic materials of the everyday schoolroom as well as difficulties in intrinsic motivation and creativity. When given toys and play objects, they do not know how to play with them. Feitelson believes that if such children are to step into the modern world, they must gain greater acquaintance with imaginative activity, and has favored tutoring them in make-believe play. Along with other workers (Singer, 1973; Saltz, et al., 1974), she appears to have shown that academic benefits follow from modeling pretend play for children who seem to exhibit little of it themselves.

With the publication of *Transformations: The Anthropology of Children's Play* (1978), Helen Schwartzman issued a challenge to this way of thinking. She argued that while there are certainly differences across cultures and subcultures in kinds of play, there is no known culture without some examples of imaginative play. Labeling some children as deficient in such play, she argued, recapitulates the stereotypes and discriminations earlier associated with the notion that some children are deficient in the acquisition of language. Normally speaking, she suggested, children who are properly socialized in their own culture can no more be play deprived than they can be language deprived.

In this paper some attempt will be made to transcend these opposing viewpoints by suggesting that imaginative play may be considered in qualitative as well as quantitative terms. That is, there may be more than one variety of imaginative play.

[1]Presented at the Society for Cross Cultural Research, Annual Meeting, Philadelphia, February 22, 1980.

The Ethnocentricity of "Make-Believe"

It is clear from recent work on the history of play in western society (Cavallo, 1981; Sutton-Smith, in press) that the bulk of the material dealing with imaginative play, make-believe, or pretense within child psychology, operates within individualistic philosophical assumptions. It talks largely, but not entirely, of solitary individuals who achieve mastery, autonomy or creativity through their own playful actions. In recent comprehensive reviews of pretend literature (Sutton-Smith, 1979) one notes immediately the widespread assumption that it is possible to look at the behaviors of a solitary individual and specify their non-literalness, their pretense character. This is not an unusual habit of mind in western thought. Robert Fagen, in his new and most comprehensive book on *Animal Play Behavior* (1981) also believes he can take the individual case and characterize as play behavior, actions that he sees as combinatory, exaggerative, repetitive and variable. Bateson (1974) would have responded to both of these examples by insisting that prior to the recognition of these behaviors as play, the subjects themselves, as well as the observers, would have already taken a communicable stance upon what was to be play and what was not to be play. Whether this communication was mediated by the nursery school context, by the miniaturized objects called toys, by a smile face or by an exaggerated action, participants in the communication would require this cognizance, for any of the behaviors listed above to become play or pretense behaviors. Investigators often cite as a kind of mystery that observers can agree amongst themselves about where they are and what they are doing there. The argument to be presented here therefore is that imaginative play needs to be considered in the first place as a kind of communication.

Pretense as Communication

Here it seems the work of Ronald and Susanne Scollon on literacy is critical (1979, 1980, 1981). Let us begin with their contrast between their own two-year-old daughter at play, and the play of a two-year-old, Chipewyan boy playmate. What they appear to illustrate is that if their own daughter took, say, a toy spoon and pretended to play eating, the Chipewyan boy would take

the spoon and insist on giving it to his mother, because it is mothers who are responsible for such things. Their own child sees the spoon and feels free to pretend to do numbers of things with it. The Chipewyan sees the spoon and wishes only to pretend that it must fit into conventional role functions. Both are pretending. But one does it variably and the other conformatively

What the Scollons have to say about literacy in western society appears to underly what psychologists are usually saying about pretense. The Scollons write:

> We have only recently come to realize the degree to which the Western consciousness has been affected by widespread literacy. Since the Enlightenment in Europe, literacy has been highly valued as the hallmark of intelligence, it has assumed central importance as both the means of education and the ultimate goal of the schooling process. . . .From a historical perspective. . . .(we) trace the development of literacy as the decontextualization of language from the domain of speaking and its transformation into a unimodal visual display. . . .The pervasiveness of the literate orientation in Western Society has obscured for us the fact that literacy is the result of early and continual learning not something that develops in the natural course of maturation. Teachers of young children use a style of speaking that. . . .is instrumental in developing the literate orientation. By teaching children to pay attention to exact wording more than to contextualization cues in following instructions, this interactive style of teachers works towards developing skills in decontextualization which are necessary for literacy. (1979, p. 1)

They go on to suggest that there are two central aspects to this decontextualization. The first involves shifting the information structure towards a high degree of explicitness and the second involves fictionalizing both audience and author. The way in which children can be trained into this literary mode has been illustrated by the Ninio and Bruner (1978) case study which traces a child learning how to read a picture book. This is a neatly scaffolded arrangement whereby the parent points to a picture and calls off its name. If the child at nine months or so makes some noise, the mother then echoes with "Yes its a birdy." After a few months time the mother can ask, "What is it?" and the child will say "birdy." Weeks later, as soon as the picture is seen, the infant screams "birdy." Thus the child learns not to reach for or eat the picture book, but is rewarded for valuing pictures as referring to things not present. She learns representation. In a current case study of our own where we are tracing the steps a child goes through in learning how to make up her own story, there is similarly a clear pattern from being responsive to the parental story, to being participative and enacting the story roles, to finally telling the story oneself.[2] What happens in story-telling is not unlike the Bruner and Sherwood description of learning how to play Peek-a-boo games (1976), in which the child moves from a posture of passivity to one of active rule mastery as a result of a finely calibrated set of interactions contrived by the parent as the director of the game.

When a child can tell stories she can gain the kind of decontextualized control of language of which the Scollon's speak. It is not difficult to see that we also train children to play in this way. Instead of the narratives which subserve distancing in literacy, in play we substitute a curriculum of toys which subserve distancing in the ludic realm. This age-graded curriculum of toys which proceed from manipulation to representation increasingly gives the child a microcosmic control of the world totally distanced from the everyday world yet constantly referring to it. A typical modern toy situation is a child playing with a television modeled and advertised toy in front of the very program to which the toy refers. The television program for its part does its own secondary referring. Perhaps the highest level and most optimal outcome of this kind of decontextualized ludic training, may be found amongst those adolescents and adults who play the game of Dungeons and Dragons with their companions, where over a period of months and sometimes years, they jointly imagine and act within a fantasy world mediated entirely by words. Apart from rolling dice, no action need be taken even on the microcosmic level (Fine, in press).

Psychologists have for the greater part, unwittingly cast their ideas of play within this literary paradigm of communication. From Schiller to Erikson (1963) to Csikszentmihayli (1977), they discuss play as if it is a solitary affair between a player and his toys or his imaginings. Which means that when they say that the members of some other group don't play or are not imaginative, this is because they are thinking in terms of the literary ludic paradigm.

The Contextualized Imagination

Which leads us to the next question, whether there is some other kind of pretense which we need to understand if apparent deficiencies are to be truly appreciated for the kind of differences they may actually be. We return again to the Scollons, who point out that in preliterate societies, epics, folk narratives and longhouse speeches may last for days, be many thousands of lines in length, and yet, at the same time, be performances carried out with adaptivity and imaginative sensitivity to the audience and the current affairs of the group. There is imagination here they contend, but it is of a rhetorical or an oral kind in which there is interaction between the central performers and their groups. Having made such a broad contrast between a literate imagination and an oral one, however, we hasten to suggest that it is already known that there are varieties of each of these. This dichotomy greatly oversimplifies the known situation. It is presented here only as a corrective to encapsulation within the view that there is but one kind of pretense (Heath, in press, b).

We proceed now to explicate some of the contrasts between the two paradigms of pretense (the literary and the oral) as they occur in the American situation. We begin by contrasting the very earliest two-year-old stories told by a New York sample of middle-class white children (Sutton-Smith, 1981) with a sample of the very earliest two-year-old stories told by a sample of working class black children in the Piedmont Carolinas (Heath, in press, a). The contrast to be highlighted here is between the relatively impersonal character of the first two New York stories (#1-2) and the relatively personal character of the Piedmont stories (#3-6).

Stories

(1) The cat went on the cakies
The cat went on the car

[2]With Maryann Magee at Ancona Nursery School, Philadelphia, Pennsylvania.

The cookie was in my nose
The cookie went on the fireman's hat
The fireman's hat went on the bucket
The cookie went on the carousel
The cookie went on the puzzle
The cookie went on the doggie.

(2) The monkeys
They went up sky
They fall down
Choo choo train in the sky
The train fell down in the sky
I fell down in the sky in the water
I got on my boat and my legs hurt
Daddy fall down in the sky.

(3) Way
Far
Now
It's a church bell
Ringing
Dey singin'
singin'
You hear it
I hear it
Far
Now.

(4) Up (pointing high up)
Way up dere
All time up
Tony
Chugie got it (potato chips)
All up dere.

(5) Tessie May come
Come round here
Come dum
Da-dum, Da-dum
Da-dum.

(6) Track
Can't go to de track
Dat track
To dat train track
Big train on de track
Tony down by de track
Mama git' im
Track
Train track
He come back.

Whereas over 95% of the New York stories in this collection (about 500) are in the third person voice, this is true of only 30% (about 30) of the stories in Heath's collection. At first glance one might say that by and large her children (ages 2 to 12 years) do not tell fictional stories, they tell "true stories" about their own experience. The basis for their plots is nearly always a real experience, however, the details and even the outcome are exaggerated to such an extent that the story is ultimately anything but true to the facts. Here is an example of the tale of a twelve- year-old boy from Heath's Piedmont collection. It is in the personal voice but evolves its own fictional elements as it proceeds.

Ya' don't know me, but you will. I'm Terry Moore. Ya' might think I look sissy sittin' in dat class ackin' like I'm working, ya' know. But I'm de tough one around here, and I done been down to Mr. Brown's office mor'n you kin count. Ya' know, I'm de onliest one what can stand up to dat paddle of his. He burn me up. I'ma tell you 'bout dat (pause). One day I was walkin' down the hall, now you ain't 'posed to do dat, less'n you got a pass, and I ain't had no pass on my ass. And all of a sudden I hear somebody comin', and dere was a feelin' like my ass was caught for sure. And it was Mr. Brown, and he come roun' de cornah like he knowed I was dere. I took out runnin' (pause) now don't ever run 'less 'n ya' know you don't hafta stop. Dat was my mistake. It was good while it lasted. I run all the way down Main, but my feet 'n legs start hurtin' and then I got me a strain, but den a power like Spider Man, and I look back, and dis web fall all over Mr. Brown, and he struggle (pause), and he struggle (pause), and he struggle. 'n den dis big old roach come outta de walls of dem ol' building on Main, and that roach start eatin' his head (pause), his fingers (pause), 'n his toes (pause) 'n he holler, 'n he holler, 'n I come to de end of Main, and I stop to watch.

Hey Terry lis'n, hep me
Yea, I hep you, you gonna do what I say?
I do it, I do it. Just get me outta here.

I just hold my sides laughing, and him getting madder and madder. So after I had me a good laugh, I say,

You gonna burn dat paddle up?

He say,

You kin have it, you kin have it.

So I let 'im up, and call off dat roach and dat spider web, and we went back to school. But he didn't do what he say. He git me, 'n he took dat paddle to me, and toh me up (long pause). But somewhere out dere, old Spider Man, he know I'm takin' it for him, and he hep me out next time.

What begins here as a straight tale quickly moves into a tall tale. The intent is to deal apparently with the real context in which the listener lives and then convert that appearance into a novel performance. How does this come about? Heath gives some descriptions.

She says the parents of these children do not typically read them books or tell them stories. They tend not to talk directly to their children as is more customary in middle class homes. They tend rather to make statements about them, but in their presence, "Sumpin's the matter with that child." rather than "What's the matter?" Children were not excused from ongoing activities, in fact they shared more of the community activities and events than their middle class counterparts. Life more often took place in a crowd or a group. Frequent visitors to the community would tease the children, challenging them to particular feats or making statements of fact about the children.

You ever gonna learn to ride that tractor?
Can you lemme see you go, boy?
Your mama better come change your pants.
I betcha your moma don't know you got that.

Children were not expected to respond verbally, but to do what any command clearly addressed to them called for. Children were more talked at than with. They were expected to conform.

Accusatory questions were also used. The adult or older child asked a question which was known by all to be a statement of accusation; the addressee, if guilty, had only two appropriate responses. *One* of these was to bow the head, say nothing, and wait for the verbal diatribe which was sure to follow. More importantly for our present purposes, the other was to create a story or

word play which would so entertain the questioner that the infraction would be forgotten. In these responses, the child was allowed to shift roles, to step out of a submissive role, to exhibit behavior which for older children would be judged as "uppity." One mother exasperated with her son, 3 years - 9 months of age, said "What'd you do with that shoe? You want me to tie you up, put you on the railroad track?" The child responded:

> Railroad track
> Train all big 'n black
> On dat track, on dat track, on dat track.
> Ain't no way I can't get back
> Back from dat track,
> Back from dat train,
> Big 'n black, I be back.

All the listeners laughed uproariously at this response, and his mother forgot about the accusation. Older children could use these playful responses to other children or to certain low-status adults in the community, but they dared not to do so with high-status adults, either kin or non-kin. That this may be a general state of affairs amongst Blacks and not restricted to the Piedmont community is suggested by the very similar analysis of Roger Abrahams in *Talking Black* (1976, p. 71).

In this last example from Heath we begin to see how these young children as community members may, as time goes by, force their way into the center of focus if they can pull off an exemplary performance. In their own street play and games with other children they are doing this constantly as is well-documented by Bess Jones and Bess Hawes in *Step it Down* (1972).

In a recent paper Taylor and Ortony (1980) made a case for black children's excellence in metaphor (or signifying), in parody (or marking) and in mock insults (or sounding). The work of Mitchell-Kernan (1972) and Labov (1972) appears to document verbal group competencies which exceed those of comparably aged whites. This competence is put in folk terms by Roger Abrahams in his sympathetic work *Positively Black* (1970).

> They learn the importance of banter, the power of the taunt, the pleasure of playing with words. They develop vocabulary and other skills in active contest situations, for the purpose of winning a verbal game and gaining esteem from their group. (1970, p. 17).

> One of the aspects of lower class Negro life as an oral culture which is least understood by middle class society is the way in which everyday life is suffused with play. In an environment such as the ghettoes, gaming or the art of the put-on suffuses interpersonal relations. . . . the earnest regard for effective performance by those involved is self-evident. . . . (ibid, p. 27).

> With both Gregory and Muhammed Ali we see nearly all of the primary attributes of the man of words, the importance of inserting the performer in the midst of the performance, emphasized through the constant use of the first-person pronouns, the strong interaction between performer and audience, the identification of the performer with the item being performed, and most important the development of a performance technique in a contest atmosphere. (ibid, p. 39).

One wonders whether in oral cultures children are often members in the crowd observing the collective action, and then in their own play, imitating the star performances, and, if gifted, showing the kind of imaginative reconstructions which can catch their peers' attention and give them, temporarily at least, a cynosural or leader role. Does the relative ignoring of the child described by Heath, and also typical of at least some other oral cultures (Scollon and Scollon, 1979; Feitelson, 1959; Eifermann, 1972; Adams, 1980) lead to that very "dumbness" before adults, until such time as the occasional child can force him or herself to a position of commanding and rhetorical leadership? Is there no imagination in these children as so often has been asserted recently, or is the imagination of this rhetorical kind covertly waiting for expression? It has often been noted in make-believe training studies that children who appeared not to indulge in sociodrama, at first, quickly adopted it once the adult provided the eliciting model. Udwin of South Africa, in her factor-analysis of a variety of imaginative variables, found two major factors: a covert fantasy factor, and an expressive acting out factor (Udwin, 1979). She argued that her low-class children who at first appeared to be without imaginative play, in fact, only lacked the play techniques and skills to actualize their potential. They had the covert but not the expressive fantasy.

Again in some recent social class imaginative play and language contrasts, it has been found that while differences appeared within the classroom, the same differences were *not* found in outdoor play where the lower-class language behavior was as complex as that of their middle class peers (Tizard et al., 1976; Henninger, 1980).

Practical Implications

What has been said here does not argue with the observations of Feitelson over the problems that she has encountered with children from other cultures or from lower class strata when they are being assimilated into the literary paradigm of the schooling situation. It does suggest, however, that there is another tradition at stake, the oral or performance tradition. "In an oral tradition, performance is a mode of existence and realization that is partly constitutive of what the tradition is. . . . the tradition exists partly for the sake of the performance. . . . more often the performers of the Tradition are masters of adaptation to the situation." (Hymes, 1975, p. 15).

In terms of children's play it seems to imply that Piedmont children are more likely to show their talents in play that is of a collective rather than an individual character, that allows for individuals to take turns performing with the coordinated reactions of other members of the group and that deals with current events rather than fantasied ones. From Eifermann's work we know that the Arab children she studied were more playful when words were the center of their games or were used for ritual or humor, than when words were used only for functional purposes. For Jewish children by contrast, play was associated more with a functional than an intrinsic verbal usage (1972).

In Adam's study of the Basutho, moreover, the very media of artistic communication were regarded differently. If the medium involved sounds or involved movements which everyone could see and in which everyone could participate then the Basutho declared

the medium to be a playful one. But when the medium involved graphics or plastics, which were individually rendered, it was not said to be a playful medium (1980). In both the Chipewyan case and the Piedmont case, play proceeded more readily when it was based on the consensual realities of everyday life and proceeded at least initially in conformity with these. The literacy tradition deals rather with what is distant and not present, what is fancied by the individual rather than what is immediately apparent within the group's sensory experience.

Clearly we do not know as yet enough about all the differences that prevail across the oral or performance tradition, but the examples given in this article should suffice to clearly support the view that there is such a tradition. And that for those brought up largely, or to some extent, within that tradition it is easier to be playful and imaginative when the modes of that tradition are being called upon. It is harder to be imaginative when one is required to exercise that imagination within the limits of the newer or literacy tradition. We know that play is the most sensitive of behaviors and does not flourish unless it can take place in a relaxed setting where there is not too much novelty and where security can be taken for granted (Sutton-Smith, 1979, pp. 298-299). It is easily constrained by unusual requirements.

The educational implication of all of this is that if play is to be used as a means to the acquisition of academic symbolic masteries as is advocated by Feitelson, Singer, Smilansky and others, then some adaptation to culturally different kinds of play is in order. Schwartzman's view that everyone is basically imaginative (as they are basically linguistic) is well-taken, but it is only the beginning point because the imagination itself is multi-paradigmatic.

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". . . . the verbal component of behavior is determined in all fundamentals and essentials by objective-social factors. . . .Therefore nothing verbal in human behavior (inner and outer speech equally) can under any circumstances be reckoned to the account of the individual subject in isolation; the verbal is not his property but the property of his social group."

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The Role of Context in Cognitive Development*

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Introduction

The purpose of my work is to make a contribution, both theoretically and practically, within the area of cognitive development and cognitive psychology more generally. I will discuss the effects of manipulating concept-supporting and concept-distracting perceptual cues on performance in cognitive tasks -- an area which has been under-represented in work by Piaget and his colleagues.

I will seek to demonstrate two main empirical effects: 1) once the perceptual "dressing" of the standard tasks is made more digestible by the manipulation of perceptual cues, one reveals the capability of both low and middle-class socio-economic-status (SES) children to reason concrete-operationally well before the ages posited by Piaget or by investigators of cognitive functioning among low SES children; 2) by exposing these children to an effectively arranged sequence of perceptually varying tasks which lead up to standard Piagetian or Piaget-like tasks, young and low SES children will perform successfully also on the standard tasks well before the posited age range for such performance. This method of training is intended to serve as a model for accelerating cognitive functioning in general, whether at school, in everyday life or in vocational training.

From a theoretical standpoint, I intend my data to contribute to the crystallization of a model of cognitive development which integrates the "cognitive-change position" of Piaget and others, with the "perceptual-change position" of Odom and others (Odom, 1978). This model -- which could be called a "cognitive-perceptual position" -- has been emerging out of field work in "Creative Math and Science Teaching" with low SES children in Israel[1] (1976-81), in Venezuela[2] (1978-81), Costa Rica[3] (1981) and Brasil[4] (1981).

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[1]Project Petakh (PP), short for "development of thinking," created and directed by G. Carmi at the Department of Science Teaching at the Hebrew University, Jerusalem, and sponsored by the Israel Ministry of Education. This study involves 36 teachers in Jerusalem and with several replication groups elsewhere.

[2]Ciencia Creativa (CC), (Creative Science), directed and implemented by CENAMEC (Centro Nacional para le Mejoramiento de la Ensenanza de la Ciencia), with the author as principal investigator. This is an adaptation of PP.

[3]Ciencia Creativa (CC), directed and implemented by CEMEC (Centro para el Mejoramiento de la Ensensanza de la Ciencia of Costa Rica), with the author as principal investigator. This is an adaptation of PP.

[4]Ciencia Creativa (CC), pilot sponsored by CAPES, Ministry of Education, Brasil, with the author as the principal investigator. This is an adaptation of PP.

Background and Rationale. Odom (1978) distinguishes between two trends in the theoretical study of cognitive development -- the cognitive-change position (Piaget and Inhelder, 1969; Hagen and Hale, 1973; Kendler and Kendler, 1962) and the perceptual-change position (Odom, 1978; Gibson, 1969). To these one should add an independent, theoretically as yet uncommitted, growing body of findings on the cognitive capability of children, which is greater than hitherto assumed (summarized by Gelman, 1978; Donaldson, 1978) and growing reservations regarding some of Piaget's positions (summarized by Flavell, 1977).[5]

The *cognitive-change position* focuses on the evolution of cognitive structures through an assimilative-accommodative interaction with the environment. Questions of perceptual development per se play only a minor role in this position. Thus, no great importance is attached to the analysis or manipulation of perceptual components of cognitive tasks; their cognitive-logical structure is deemed all-important. This position is taken to imply that "once you know, you know forever," i.e., whatever the perceptual dressing of a logical structure may be, once the logical structure is acquired, a cognitive skill can handle all contexts.

The *perceptual-change position* stresses the importance of change in perceptual capacity with development. Perceptual sensitivity to relations, dimensions and categories, is supposed to increase with development and with increasing perceptual experience. It is assumed that "the greater the perceptual sensitivity to given information, the higher the probability of its being cognitively evaluated, regardless of the information's appropriateness for problem solution. . . . (i.e.) with increasing development, an increasing amount of both relevant and irrelevant information would be cognitively evaluated and either accepted or rejected for problem solution" (Odom, 1978, p. 117). It is further assumed that "dimensional salience be viewed as an estimate of perceptual sensitivity and that salience (determines) the order in which dimensions of a problem are processed. . . ." (Odom & Guzman, 1972, p. 272).

Later in this article, I shall propose a third position which integrates the above positions and, at the same time, points out their limitations. Here, the following general remarks can be made about them:

Horizontal decalage (i.e., the large temporal gaps in correct performance of similar cognitive tasks with different materials -- e.g., quantity conservation experiments with coins, sticks, clay or liquid) may be taken as an indication of the insufficiency of the *cognitive-change position* (Flavell, 1977; LCHC, in press; Odom, 1978). In addition, however, Piagetian stage theory employs too narrow and "adult" a definition of knowledge and reasoning. For example, Piaget claims:

> an act of sensori-motor intelligence leads only to practical satisfaction, i.e., to the success of action, and not to knowledge, as such. It does not aim at *explanation* or *classification*. . . . it links causality and classifies and takes notes of facts only in relation to a subjective goal which is foreign to the *pursuit of truth*. . . . (i.e.) in no way *reflective*. (Piaget, 1950, p. 121) (emphasis added).

[5]See, in particular, LCHC, "Culture and Intelligence," preprint March 1981. The author wishes to thank Dr. Michael Cole and his colleagues for making this paper available, and for their hospitality at the Laboratory of Comparative Human Cognition in May, 1981.

The definition of knowledge which is implicit here leads to a corresponding definition of criteria for cognitive development, of key evaluative cognitive tasks and of a theoretical structure for explaining how and why children at various age-levels fall short of such ultimate goals.

I do not define knowledge and criteria for measuring development in terms of some final goal. Rather, the basic yardstick is provided by a concept of "optimal change," which is assumed to govern optimal development at each interim step. A cognitive change is optimal when it is elicited by an external stimulus, or an experience, of "optimal novelty," i.e., which has the best balance between challenging *novelty* and success-guaranteeing *familiarity* and *potential for involvement.* This balance ensures maximum motivation to assimilate the novelty and to accommodate to it, while it ensures successful performances in the act elicited. This sets a criterion for *defining knowledge in terms of the effectiveness of interaction between the organism and environment* and not through some absolute structure of existing knowledge. Knowledge, in this framework, is defined *at any interim phase* by the type of phenomena the organism can assimilate and accommodate to, at that phase. This is a "state of the moment" definition, which, by integration of the past, automatically includes the whole past history of knowledge acquisition. When the development of an organism is optimal (i.e.,it passes through a sequence of optimal changes), it attains at each phase its optimal knowledge in that phase; it is this knowledge which the organism should measure up to, and this knowledge is the problem when the organism's development is less than optimal.

My approach attaches a measure to all potential stimuli i.e. on everything in the environment of the organism, according to their degree of effectiveness at eliciting a near-optimal change of the organisms. Such a measure (and its consequences) is foreign to Piaget's approach. However, foreign to the perceptual-change approach, is the notion that the degree of effectiveness interacts with change and development. Indeed, as to the *perceptual-change position,* my contention is that it neglects to include the crucial point of feedback between cognitive structure and perceptual sensitivity. In Odom's position, the two are developing side by side; in mine, the latest change in cognitive structure *changes* the capability of the child to overcome the next hurdle of nonfamiliarity and perceptual sensitivity. This is not at all the same as saying that perceptual sensitivity has increased: a simple increase would affect supporting and distracting cues *equally; my mechanism predicts that change would affect them oppositely.*

To bring out the limitations of the perceptual-change position -- which assumes separate and absolute development with age in perceptual sensitivity -- consider two concepts, A and B, such that one and the same dimension (color, say) is supporting a concept A and at the same time it is non-supporting and rather distracting to another concept, B. In Odom's position, perceptual development would entail a better understanding of A and a regression in the understanding of B. As it stands, this is an untenable model for development; one must invent a mechanism to insure that the parallel development in the cognitive structure is so coupled to perceptual changes as to compensate such regressions. This type of coupling mechanism is inherent in my position, in which both concepts A and B will develop in the positive direction.

My approach also automatically ensures that "knowledge" and all ensuing tasks and criteria for evaluation will be *culture and social-style dependent,* as the definition is dependent on the specific environment and tradition within which the development took place. This definition affords maximum respect to the intrinsic yardstick of each age and developmental level, and it gives us the general direction in which to proceed in adapting cognitive tasks to young children: by increasing familiarity, perceptual digestibility and by making them affectively meaningful.

Affective relevance is perhaps the main message of Margaret Donaldson's monograph (1978); she reviews a number of experiments recently carried out in England, which demonstrate many things children can do, contrary to the expectations of theory. The role of familiarity and perceptual digestibility, as well as language and other subtle factors, is also convincingly demonstrated by Rochel Gelman (1978).

My own experience in Israel and Latin America demonstrates that by increasing familiarity, perceptual digestibility and affective relevance in tasks, without compromising their cognitive or logical structure, the cognitive performance of disadvantaged children improves performance noticeably. They also handle various cognitive skills much earlier than expected for children from any socio-economic background. For example, research on the learning of such concepts as proportionality, density and symmetry demonstrates that a properly organized sequence of training exercises significantly improved performances of low SES children. The question arises whether this method would be similarly effective in the U.S; we must ask more generally, what the effects of cultural as well as SES variables are on the effectiveness of the method. My model seems to suggest that, with proper definition of criteria, the method should be equally effective, even though the course of development would be different for different populations defined in terms of culture or SES.

The Model

The Idea of Proconcepts. Recent research on middle-class preschoolers, as well as my own observations of disadvantaged children in kindergarten through ninth grade suggests that children's life experiences provide them at a very young age with some early sense of many concepts and of reasoning patterns which appear full-fledged only later, in concrete operational or formal operational stages. This early sense enables them to apply the concept and operate with it correctly in restricted domains of familiar phenomena whose perceptual distractors are of sufficiently low salience. Examples for such early concepts are numerous. For example, four-year-old children use *proportionality* correctly when they classify rectangles of different height-to-width ratios (Carmi, 1981), or when they point to the (unmarked) 3/4 level of an empty low and wide container, in which liquid from a 3/4 full, tall and narrow container is to be poured (whether or not their assumption of "equal degrees of fullness" is factually correct) (Craig, Love, & Olim, 1973, analyzed from the point of

view of proportionality in Carmi, 1981). I call these examples of early sense, *proconcepts:* these are concepts or cognitive schemata which the child is able to apply correctly within a restricted range of phenomena, but not beyond. I call this restricted range the child's "cognitive island(s)" for that concept.

Here the accent is on "correctly," as tested in contexts which are *cognitively* identical to the full-fledged customary tasks (e.g., Piaget's) and differ from the latter only by being *perceptually* more digestible. Thus, my "proconcept" is quite different from Piaget's "*pre*concept" which

> is not yet a logical concept (but) still partly something of a pattern of action and of sensori-motor assimilation. . . ." (Piaget, 1950, p. 128)

By contrast, a *pro*concept serves as a concept on all counts within its limited domain of applicability.

More generally, I assume that the young child commands "pro-schemata." These are schemata of action in the Piaget sense (e.g., Flavell, 1963, p. 52) -- overt or internalized -- which usually appear full-fledged only at later stages. The young child applies these pro-schemata effectively in restricted domains of familiar experiences, e.g., s/he conserves number at four years, as long as the number is sufficiently small (see Gelman, 1972).

Such proconcepts and schemata may not appear, at first, to be on equal footing with the concepts and schemata which the (older) child is assumed to acquire. The latter are assumed to be content-independent schemata, of the "once you know, you know forever" type. My contention is, however, that there exists in human cognition no completely content independent concept or schema. Hence I assume that there exist no qualitative -- only quantitative -- differences between such concepts and proconcepts.

Cognitive Islands. Cognitive islands are the domains in which various proconcepts are operative, where a concept is represented in dimensional form. Such islands emerge as a result of the child's experience. As life brings the child into contact with a wider variety of examples, s/he gains an increasingly refined, interconnected and expanded sense of the concept in terms of the variables associated with it. The "islands" expand, interconnect: when the island is "everywhere," the child "knows" that in principle the variables associated with the concept may assume any value in the full range (i.e., zero to infinity). I consider Piaget's characterization of the object concept in its early stages to be an example of such cognitive islands: "but there still exist only images such as 'ball-under-the-armchair', 'doll-attached-to-the-hammock' etc. . . ." (Piaget, 1951, pp. 62-3).

The Gradual Acquisition of New Contents. As I have said, the proconcept is at first restricted to a narrow domain of objects and phenomena associated with the child's early experience. That domain serves as a baseline for the development of the corresponding concept in a wider range: it eventually links up with the context used in standard tests and finally results in a practically content-free handling of the concept by the child.

Together with the gradual widening of the range of applicability, there also occurs a gradual process of differentiation: from qualitative understanding, via gradative "more" or "less" comparisons, to semi-quantitative and finally to fully quantitative facility with the concept. In my Israeli work I teach "qualitative physics" in kindergarten and grade one, "gradative physics" in grades two and three, etc. Each such stratum of physics is a self-contained science, with its own phenomena, experiments, axioms, definitions, and theorems, and is in no way "less rigorous" a discipline than full-fledged quantitative physics.

The "qualitative-to-quantitative" hierarchy is here imported into cognitive psychology from the philosophy of the structure of knowledge, especially physics (Carnap, 1966). It seems that Piaget detected some portion of this within the child's behavior; albeit he takes it as a sign of immaturity:

> Piaget (e.g., 1970, p.52) believes that the younger child's centration tendency often takes the form of relying heavily on *order* or *ordinal* information in making quantitative judgements. If one of two identical pencils is slid ahead of the other, for example, it is apt to be judged as longer than the first (nonconservation of length). Ordinal relationships like "ahead of", "first", "X has passed Y", etc., are very salient for the pre-operational child and are often used inappropriately as the sole basis for quantitative comparison" (Flavell, 1977, p. 81).

This characterization makes it appear that there is something deficient about the younger child's reasoning; I treat this gradual transition from qualitative through gradative judgement toward an understanding of the full fine-structure of reality as an optimal path for effective development. This manner of thinking is best explained in terms of Piaget's concepts of assimilation, accommodation and equilibration. The analysis in perceptual terms is mine.

In order to *assimilate* new phenomena to his or her existing cognitive structures, the child must perceive their perceptual *similarity* to old, familiar phenomena, while the perceptual *differences* should not be too overwhelming. The young child's restriction to noticing almost only qualitative features of objects and events (as is the case in the "qualitative stage") serves as nature's protective measure against the usually prevalent dominance of highly salient differences (e.g., gradative or quantitative ones). Without such perceptual shielding, assimilation would be nearly impossible. A similar line of reasoning applies for *accommodation.* Since assimilation and accommodation together constitute the main mechanism for cognitive development, the latter would be seriously hampered without perceptual shielding.

Thus it seems that nature has provided the developing system with multiple layers of protective filters against overload in the perceptual input. These filters are shed off one by one as the system consolidates at consecutive levels (e.g., at the qualitative level). Once the system consolidates, there is minimum screening of familiar input (e.g., qualitative) *and* there is a dramatic increase in the screening of other (unfamiliar) input, i.e., there is minimum conflict. This is characteristic of *equilibration.* When development is *between* levels, on the other hand (in this case, between systems characterized as qualitative and gradative), the system is vulnerable to gradative input. Not yet having consolidated gradative structures, assimilation is difficult (being an assimilation to structures which are not yet consoli-

dated) and cannot catch up with accommodation. Thus the system is in disequilibrium.

In addition to the equilibration levels just discussed, additional ones occur when concepts or schemata start to intermingle as their cognitive islands begin to apply to common domains of phenomena. For example, grasping, sucking, and topological[6] visual perception overlap on the same group of objects, giving rise to the (topological) object schema.

Implications for Development and Learning. According to my proconcept paradigm, when a child is very young, almost all of the crucial thinking tools of the final stages of development "*pre-exist,*" in a rudimentary form and within limited contexts, in the form of proconcepts. Therefore within this model, "*development*" and "*learning*" are not being conceived of as "climbing up" a ladder of new cognitive schemata (see also Raven and Guerin, 1975; Beilin, 1971; Novak, 1977; Flavell, 1977; Brainerd, 1977, 1978; Deluca, 1978; and LCHC, in press for criticisms of the notion of "stages" in intellectual development). Rather, both spontaneous development and effective learning are conceived of as the gradual extension of the range of applicability of early pre-existing concepts.

A crucial point is to define what I mean by gradual extension of the range of a concept's applicability. By this I mean an extension over phenomena for which the perception of the concept in question (or, the application of the schema) becomes increasingly difficult, because of increasingly salient concept-non-relevant cues (see Odom and Guzman, 1972 for definition and discussion of salience). To make this idea explicite I define a parameter α by

$$\alpha = \frac{salience\ of\ distractors}{salience\ of\ supporters}$$

I also postulate that development proceeds by gradually extending the applicability of a concept or schema to phenomena with gradually increasing α. Thus at any given time "t", a given child, "k", *applies a given concept, "c", within a radius* α_{ktc} *in phenomena space, such that s/he is able to apply "c" to all phenomena whose* α *are at* $\alpha \leqslant \alpha_{ktc}$ but not beyond.

In this formal definition, "*distracting cues*" are the combination of all concept-relevant and concept-non-relevant cues which do not perceptually support the concept but rather elicit other concepts or schemata. Similarly, "*supporting cues*" are the combination of all concept-relevant and non-relevant cues which, perceptually, evoke the existing concept or schema. So, for instance, the color of the liquid in a conservation task may be non-relevant but supportive to the concept. The specific formula for *combining* the different dimensions of cues depends on the dimensions, on the age range, on the metric introduced, etc.

The *salience* of any cue may, in principle, be empirically defined and determined via the traditional salience tasks (see Odom and Guzman, 1972). In the present work, quantitative α-values are not relevant for the hypotheses tested, while the gradative α-comparisons required are obvious from the context.

[6]This is the first consolidated level of visual perception (Inhelder and Piaget, 1963). It closely corresponds to my "qualitative" level.

With the above definition of α_p, a "proconcept," is nothing but a concept whose radius of applicability α_p, by the child, is appreciably below the α_s of the standard test (Piaget's or other) for that concept.[7]

To demonstrate these ideas and, at the same time, to prepare the ground for the experiments proposed below, I now proceed to apply my concepts to the case of liquid conservation.

A Liquid Conservation Experiment

Piaget considered the concept of object-constancy (i.e., sameness of the object in spite of varying appearances of perspective, apparent size, etc.) to be as a precursor of the concept of conservation of a quanitity of matter (Flavell, 1963, p. 408). However, Piaget does not utilize this idea in his interpretation of the way children gradually acquire conservation, basing his conservation argument on the development of compensation (Flavell, 1963, pp. 245-9). To investigate the role played by object-constancy, I carried out the following experiment.

I hypothesized that children from about age one onwards gradually extend object-constancy from rigid objects to flexible ones like socks, shirts, etc., and from there to almost amorphous chunks of matter (pieces of mud, plasticine, etc.) and finally to a "chunk" of liquid; i.e., in addition to overcoming transformations of perspective and distance, the child also accommodates the concept to overcome transformations of deformation. I then hypothesized that object-constancy is the proconcept of conservation of liquid-quantity, i.e., younger children who do not conserve in Piaget's experiment, but possess object-constancy, will "conserve" whenever the "chunk-ness" of the water is sufficiently salient, relative to the distracting change of water level.

This was demonstrated in the following experiment (Carmi, 1979). Each of 111 middle-class children, 5 - 6 years of age, carried out three different versions of a liquid-conservation task (with suitable balancing of order and other factors).

1. *Standard Version.* Water is poured from a tall, narrow container into a short, wide container. Six of the 111 children conserved.

2. *Version 2.* Two identical, sealed and transparent boxes partly filled with water are presented to the child. One is then turned to a "lying down" position. Eighteen children conserved.

3. *Version 3.* The water is loosely contained in a transparent plastic bag which is transported from the tall, narrow container to the short, wide container. Thirty-six children conserved (of these, 16 conserved in version 2).

The order of the three versions was balanced, to eliminate any "learning" effect. The difference between the three conditions can be explained as resulting from variation in α. The distracting perceptual cue in all three versions was the change in water-level upon the transformation (a reduction in level from 15 cm. to 5

[7]This may be quantified through specifying the limiting percentages of success of both tests in the same population, e.g., $P\ \alpha_p \leqslant 25\%$, $P\ \alpha_s \geqslant 75\%$.

cm.). The cues supporting the proconcept (i.e., the constant "chunk of water") increased appreciably in salience from the standard version (#1) to version 3: in #1, the "chunk of water" broke up into "parts" which were reunited in another container; in #2, the water remained in the container, which, by its rigidity, underlines the variability of the water; in #3, the separate individuality of the body of water was accented by having its own wrapping (the plastic bag).

Generally, we consider all conservation experiments as differing from each other only in the medium employed (coins, sticks, clay, water) and in the ratio $\propto$ of perceptual cues, *but not in cognitive content.* "Horizontal decalage" i.e., the relative delay in the acquisition a logical schema embodied in different materials -- is consistently explainable in my model: the child's general concept of conservation develops from cases of low $\propto$ (number, length) to cases of high $\propto$ (substance, liquid). Indeed, the cues supporting conservation are more salient (lower $\propto$) in the former than in the latter cases; the gradual acquisition along this sequence is thus no more than the "overcoming" of gradually increasing $\propto$'s. (See also Odom, 1978, for a convincing exposition of a closely related view on horizontal decalage. However, his view differs from mine in the underlying developmental mechanism assumed.)

Piaget's view on the mechanism of acquisition is entirely different (Flavell, 1963, pp. 245-9): a gradually accelerated shift of attention between the "height" and "width" of the substance, with a final interrelating of the two. It thus calls into play an additional schema (compensation) which, according to Bruner (1966) is more advanced than conservation itself. According to Piaget's equilibration model (c.f. e.g., Flavell, 1977, pp. 241-3), when the child notices that the height decreases and the width increases upon transformation, a conflict arises which requires "equilibration": the two realizations lead to opposing conclusions as to which container has "more" liquid. The equilibration is achieved, according to Piaget, when the child relates height and width in a compensatory way.

However, a little reflection shows that this conclusion is circular. As long as the child does not conserve, or at least as long as s/he does not apply object-constancy to the transformed "chunk" of water, the two heights do *not* associate in his or her mind with one and the same notion of quantity. For all s/he is concerned, the chunks "after" and "before" may be two unrelated objects, and the two different heights may just be two unconnected perceptual cues which give rise to no conflict. However, if a proconcept of object-constancy exists in his or her mind, it may point to the fact that "more" (in height) and "less" (in height) apply to the same chunk (before and after transformation), which leads to the necessary conflict. This example demonstrates the crucial role played by a pre-existing proconcept in a theory of development if it is to be self-contained.

The process which I assumed for conservation is assumed to hold generally. The actual capability of the child to apply any (existing) proconcept or schema to a new phenomenon is assumed to depend crucially on the relative salience of the distracting and supporting cues, i.e., on the ratio $\propto$ = salience of distractors/salience of supporters. If the supporters predominate ($\propto$ small), the child will grasp the phenomenon in light of the proconcept (which accommodates to the new content). If the distractors predominate ($\propto$ too large), s/he will not understand the phenomenon or s/he will understand it in the light of older conceptions. "Familiarity" is an independent factor which generally decreases $\propto$.[8]

The Process of Learning and Development

I now add another basic assumption: when a child has *overcome on his or her own* the distractors in a new situation and has extended the realm of the proconcept or proschema to the latter, this in itself will constitute an *intrinsic reinforcement for the proconcept, enabling it to overcome even stronger distractors.* Thus, the event of "discovery" (explaining a new phenomenon or acting on it) acts as a "hurdle overcome," which in itself "reinforces the proconcept." The proconcept is then more likely to overcome additional and higher hurdles. The hurdle serves as a challenge and thus provides its part in creating the developmental thrust. The other part resides in the developing concept or schema which (with Piaget) "craves" cognitive "aliments" (Flavell, 1963, p. 77). The main point is, however, that the *propellant and thrust for future development is thus contained in the cognitive event of the present.*

The Self-Propelling Sequence. From the assumptions made, a very important corollary follows: by placing before the child a sequence of "hurdles," whose $\propto$ increases in just such a way that the child is able to overcome one after having been sufficiently reinforced by the previous one -- the child could, in principle, move on his or her own, non-stop, towards the (practically) content-free stage of handling the concept.

This assumption dictates the notion of the "self-propelling sequence": this is a "hurdle track" -- i.e., a sequence of new phenomena with ever-increasing distractors and discrepant content, along which the child can move *on his or her own,* in an optimal way, so as to extend the application of the proconcept step by step, after a characteristic "digestion time interval" at each step. What is crucial here is *optimal discrepancy* or *optimal novelty* i.e., that the degree of discrepancy from step to step is not too large to be overcome, yet not too small to gain appreciable reinforcement and progress. The digestion time is needed in order to consolidate the new cognitive acquisition. This is done by testing out and verifying the latter on a number of similar yet somewhat different cases. I assume that the details of this verification process are similar to the process described earlier for the consolidation of the "macro"-levels (qualitative to quantitative), except that now everything is repeated on a "micro"-level.

Paradigm of the Controlled Distractors. When looked at in this way, distractors turn from a "nuisance" to an essential component of cognitive development, which serves both to anchor a concept in concrete reality and to provide the propellant for its further development. One may indeed go so far as to say that there is no meaningful learning which is not a training in the autonomous overcoming of such distracting hurdles. This paradigm combines essential points of the paradigms of

[8]In the present work, familiarity is held constant over the range which is manipulated and hence, to simplify the presentation, was omitted in the definition of $\propto$.

Bruner, Gagne, Ausubel, and the developmentalists (Lawson, 1979) and bridges over them, if the following assumption is added: *The optimal steps which a child is able to make successfully along the acquisition-sequence of a given concept, increase steadily in size.* That is, not only do the "hurdles" keep increasing, but the increments between them keep increasing (see Figure 1), so that the hurdle tops form a concave curve.

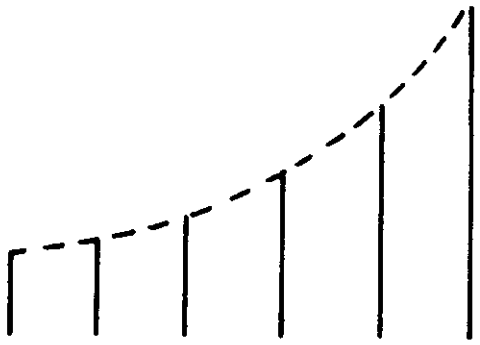

Figure 1. A "hurdle-track" with increasing increments.

The above assumption was suggested by the observation, probably shared by many practicing educators, that when a concept is explained by examples, the first examples have to be very similar to each other, but gradually their discrepancy may be increased in. bigger jumps, i.e., the "hurdles" may become higher in an accelerating fashion.[9] This assumption leads to the practically content-free stage of the concept.

Stages of the Developing Concept. With the above assumption, one will sooner or later reach a stage where the next hurdle is so far away that, for all practical purposes, one may consider the field from there onwards *practically content-free.* This can be considered the stage of formal application of the concept. I believe that absolutely content-free concepts do not exist.[10] Hence, "formal thinking" is achieved when the relevant concepts are *practically* content-free. The rigorous application of this assumption would require a quantitative definition of α which, as mentioned, can be given via traditional salience tasks (Odom and Guzman, 1972).

It may seem from the model described thus far as if Piaget's notion of discrete stages is being challenged by a model which is continuous throughout. This is only partly true, as *stages seem to be derivable in a natural way from my continuous model.* Furthermore, it seems that this can be done in a rather culture dependent way.

It may seem from the earlier discussion that concepts and schemata are thought to develop independently of each other. However, their eventual clustering into global structures is a necessary corollary of the assumptions made. This is so because, as the range of applicability of each concept expands over increasing territories of phenomena, different concepts by necessity overlap to an increasing degree. As they do, a phenomenon faced by the child mediates interaction between the various (pro)concepts which "meet" at that phenomenon. Thus, for example, the proconcepts of "object-constancy" and of "compensation" meet on transformations of length, substance and liquid quantity, to interact and form a "conservation" schema. Hence, compound schemata will appear one by one in a stage-like fashion, whenever additional overlapping occurs.

Such overlapping occurs on a small scale from early infancy and gives rise to "routine-hierarchies," in which schemata are composed of sub- and sub-sub-routines (e.g., walking). Later on, when representational schemata overlap on a grand scale, concrete operational and formal operational structures arise. An interesting (and hitherto unexplored) combination of cognitive islands results in quantitative schemata which break down into gradative sub-schemata which break down further into qualitative sub-sub-schemata. However, the model of discrete stages now no longer needs to be postulated per se but could thus be the outcome of an underlying continuous process of expanding ranges of applicability of concepts.[11] Neo-Piagetian concepts such as executive schema, M-space, etc., can be accommodated by the model in a natural way.

Cultural Differences in Development

The proconcept model seems to account in a natural way (at least in principle) for the possibility of cultural differences in cognitive development. Clearly, the timing of overlap between expanding concepts or schemata -- and, therefore, also the timing of super-schemata and stages -- depends rather sensitively on the relative rate of expansion of each concept separately. Figure 2 presents two different clusters which result from two different rates of expansions of the same concepts A, B, C, D. Clearly, these rates of expansion are culture-dependent varying even within one and the same culture, accounting for social- and education-dependent differences, and hence their overlapping may occur at different times in different cultures.

For example, it seems that linguistic differences in the use of the terms related to the notions "more" and "less" in Hebrew, English, Spanish and Portuguese throw interesting light on differential performances on some Piaget-like tasks. In Hebrew, the equivalent of "higher" or "heavier" is "more high," or "more heavy," whereas, in both Hebrew and English, a separate form, like "more" is used for describing a larger a quantity of liquid. This linguistic difference might well create a difference in the rate of expansion of the two concepts "higher" and "more" in the two cultures.

In fact, I found evidence of culture/language specific distraction in a study of children in Israel compared to English speaking children. The Israeli children make a

[9]This is probably related to the statement by Piaget (1954, p. 953-4): "The more the schemata are differentiated, the smaller the gap between the new and the familiar becomes" i.e., one may take larger and larger steps to keep the latter gap the same.

[10]The development of science bears ample witness to this statement. For example, the concept of absolutely flowing Newtonian time is valid only within the context of Newtonian physics, i.e., up to the next hurdle (the Michelson-Morley and other experiments) which brought about the Einsteinian concept of time.

[11]This is much the same way as the quantum theory of discrete jumps in physics is explainable as an outcome of underlying continuous phenomena in the "sub-quantum level."

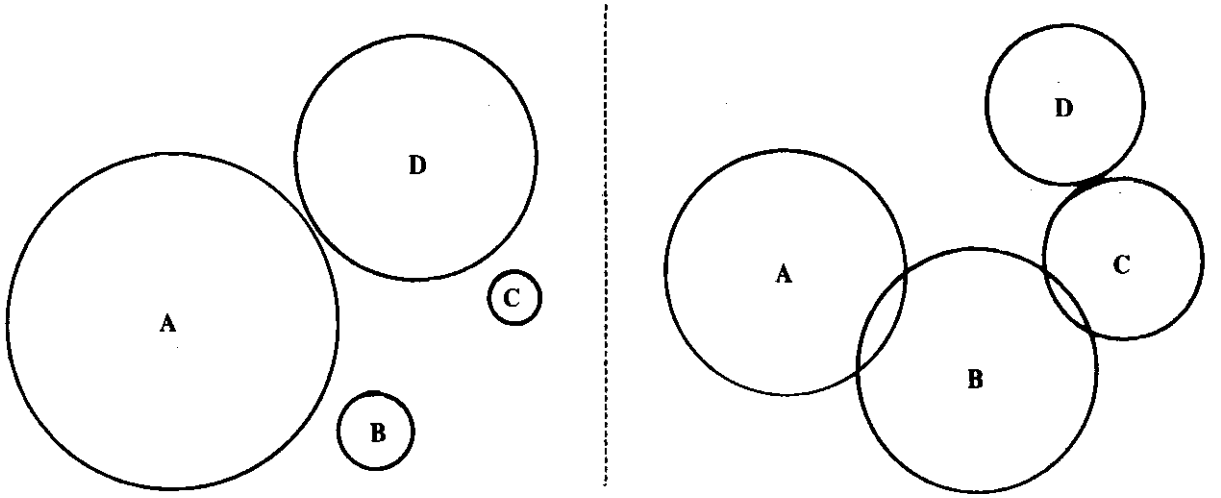

Figure 2. Two different clusters which result from two different rates of expansion of the same concepts A, B, C, D.

characteristic error when shown a picture of two children arranged on a see-saw such that one child stays up in the air. When the observing children are asked "Which of the two is 'more heavy'?" many point to the child who is "more up." It is as if, among the two cues competing for the title "more," the *distractor* (height) is more salient than the *supporter* of the concept in question, (weight). These children appear to fail to integrate the two questions into a co-existing schema ("one child is more high, but the other is more heavy"). It should be emphasized that the same children judge correctly, about a much smaller balance beam, that the lower object is the heavier. In that case the distractor is less salient (smaller). A pilot study with English-speaking children did not show this effect, although they performed similarly to the Israeli children on other tests. For the English-speaking children, the language does not provide a separate form, "more," to serve as a distractor in the see-saw context. The α value is higher for the Israeli than for the English-speaking children.

Such cross-cultural comparisons should serve as a first stage in exploring environmentally determined differences in cognitive development. This research would prepare the ground for the exploration of socio-economically determined differences in cognitive development *within the same culture,* i.e., of disadvantaged vs. middle-class children.

The Special Implications of the Model for Disadvantaged Children. In my practice in Project Petakh, my model has served as a powerful practical guideline in designing concept training sequences. I hypothesize that the success of this tool is due to the particular relevance of my basic paradigm to disadvantaged children. Pro-concepts exist very early in disadvantaged children; in my belief, as early as in middle-class children. Therefore, we do not have to "write" concepts and behavioral skill-routines on a "tabula rasa"; but the major battle in learning and in cognitive development is to overcome the myriads of distracting perceptual cues in new concrete contexts, against which the disadvantaged child has to pit the proconcepts, which are his or her cognitive weapons. In some circumstances, the early proconcepts are too weak to do the job unassisted. My strategy is, therefore, to lead the child through a structured sequence of concrete situations, each of which s/he is just able to overcome unassisted, with nothing more than the intrinsic reinforcement and additional boost which the previous conquest has given his or her proconcept.

My training program is not inconsistent with prevalent views on the major cognitive difficulty of the disadvantaged child (Frankenstein, 1964; Bresnahan & Shapiro, 1972; Odom, 1967). These describe the child as unable to disengage from the perceptual dimensions so as to focus on the concept- or rule-relevant cues. Being at the indiscriminate mercy of all cues, the child holds rigidly to a few primitive overlearned concepts, even if s/he receives reinforcement on these only in a fraction of cases. This view is in accord with the cognitive-perceptual position I have argued to be relevant for development of any child. To this, however, I would add that there is no reinforcement so compelling as the "clicking" of a proconcept with a new situation. This can be seen as internal control, in terms of Rotter's (1966) formulation of *external* control vs. *internal* control. We can say that *external* control exists when a reinforcement is perceived by the subject as following his/her own action, but since it is not entirely contingent upon his/her action, it is usually perceived as the result of luck, chance, fate. It is treated as under the control of powerful others, or as the unpredictable outcome of the great complexities surrounding him, while *internal* control is at play when people respond to an event as contingent upon their own behavior, or their own characteristics. The "clicking" of a proconcept is available as an internal control mechanism promoting development. However, external control also comes into play in my view of development and it is here that the disadvantaged child's disadvantage accumulates.

The powerful others and unpredictable outcomes of external control are familiar to the disadvantaged child in view of his or her placement in socio-economic contexts whose random and inconsequent reinforcement

history towards him or her from birth allows the child to consider the world as "capricious, magic and chaotic" (Frankenstein, 1964). This is a *failure-schedule* for the disadvantaged child. Indeed, the analysis of differential responses of lower and upper middle-class children to different reinforcement schedules (Bresnahan & Shapiro, 1972) makes it clear that consistent and continuous success in conceptualization is much more constructive, while inconsistent success is much more destructive to disadvantaged children than to middle-class children. The view of development proposed here makes clear the extra disadvantage unless intervention training of a specific type occurs. In everyday life, concept-relevant situations are encountered by all children at *random* and the crucial parameter

$$\alpha = \frac{\textit{salience of distractors}}{\textit{salience of supporters}}$$

assumes in succession arbitrarily fluctuating values as the child encounters different phenomena during the day. Since, according to my model, at any given stage of control over the concept, the child can accommodate the concept only to situations having an α-value not greater than some limit α_{max}, *everyday life presents a typical random-sequence schedule.* It naturally follows then, that it is not sufficient for disadvantaged children simply to encounter concept-relevant situations in everyday life. Everyday life does not present them with the reinforcement schedule that allows them to develop effective internal control, the "clicking" of the proconcept. However, if experiences are structured so as to insure continuous success (i.e., along a sequence with appropriate α_1, α_2, α_3), not only will disadvantaged children learn the concept; but they will gradually begin to expect success, with concomitant consequences regarding intellectual venturing and self-image.

Summary

The shift of attention towards proconcepts, the validation of the early existence of major concepts and cognitive skills, the explicit discovery in each case, as well as the utilization in training processes through an optimal change of α, support my main claim for novelty in the program. Theoretically, I propose a synthesis of two hitherto separate approaches to cognitive development -- the "cognitive-change position" and the "perceptual-change position" (Odom, 1978). I propose a model which takes account of the perceptual input as an additional dimension to cognitive processing, yet is closely and causally intertwined with the latter. My model is a continuous model from which Piaget's stage-like structures should, in principle, be derivable without further assumptions as a result of sudden overlaps of continuously changing regions. Piaget's experiments are seen as isolated points, each on another continuous dimension along which a "salience"-parameter α changes. This model leaves ample room for cultural, social and other differences in cognitive development, especially in the attainment of stage-like behavioral criteria. The model also indicates the theoretic tools for explaining and predicting such differences.

Thus its major significance should be seen in its potential to provide a theoretical basis as well as practical tools for examining and accelerating cognitive and conceptual development, especially for disadvantaged children.

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The Effect of Conceptual Point of View on Understanding*

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It is now a widely shared idea that people do not always behave the same in everyday-life contexts and in laboratory experimental situations. This creates the need to study more realistic contexts directly. In previous studies of understanding and problem solving, subjects were most typically asked to work alone. In more realistic situations, however, people often learn and problem-solve in the company of another person. To study how people interact in problem solving-like situations is, in this sense, an important step toward developing models of natural processes of understanding.

Allowing dialogue between subjects provides chances to observe more naturalistic behavior as well as it helps to eliminate the awkwardness of the thinking aloud procedure. Though such data are usually harder to analyze, analysis is still possible if there is a theoretical guidance for where and what to look at. In this article, I am going to show that researchers can get insights into thinking and learning from a fairly simple analysis on protocol data taken from an interactive setting.

* * * * * * * * *

I asked several pairs of people to figure out how a sewing machine works while I videotaped and recorded the conversations. In the first sessions, they were not allowed to examine a sewing machine, but they could construct drawings and frameworks. The task was extremely difficult, even though at least one person in each pair always started with the belief that they knew the machine fairly well. Moreover, during the conversations, a number of points of "understanding" were reached, only to be later proven wrong. One important aspect of their performance was the location of the conceptual point in space from which the speaker appeared to be viewing the machine. This conceptual point of view (C-POV) was reflected in their use of language. The C-POV appeared to be stable during points of "understanding" and to shift frequently when they were in a non-understanding stage. In this paper I provide a framework for understanding a physical device and connect my observations to the framework. Changes in C-POV can be regarded as a mechanism to promote the process of understanding.

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Observation

The sewing machine stitch problem. To understand my points you will need to understand the sewing machine. Consider how a sewing machine makes its stitches. There are two different threads in a sewing machine: an upper one and a lower one. A stitch is made by pulling the upper thread through the material by means of the needle, then looping the upper thread entirely around the lower thread. This, however, creates a topological puzzle, because for this to happen, the upper thread has to go around the free end of the lower thread, and how this can be done is not obvious. The answer lies in the bobbin upon which the lower thread is wound. It is so constructed and connected to the sewing machine that the upper thread can go around the whole bobbin (in other words, the bobbin itself serves as a free end). This explains the operation of the sewing machine. When my subjects first recognized the function of the upper thread getting looped around the bottom thread by means of the bobbin, they felt that they understood the machine. They were in what I call "a stage of understanding."

There are still some problems, however. How can a bobbin serve as a free end when it is attached to the body of the machine? The statement "the upper thread can go around the whole bobbin" is a puzzle; to solve this puzzle you need further understanding. When my subjects realized this, they moved from a stage of understanding to what I call "a stage of non-understanding." Now the question is what is the difference between these two stages.

Point of view coding. The linguistic forms used by a speaker reveal from where the speaker states the scene (Fillmore, 1974; Kuno and Kaburaki, 1977). In the case of describing the movement of a part of a sewing machine, four such points of view can be distinguished.

First, the machine can be viewed from a distance, from the position of the "bird's eye." Alternatively, the machine can be viewed close-up. This gives two more possible points of view: either from above or from below (which also means inside the machine). Finally, the observer can pretend to be the part itself. Note that these are all *conceptual* points of view (C-POV); the observer does not need to move in physical position. These different C-POVs are reflected in the language that I recorded, as shown in Table 1.

Table 1

C-POV	*Example statement*
1. Bird's eye view	The needle moves up and down.
2. Top outside view	The needle goes down.
3. Inside bottom view	The needle comes down.
4. Empathized view	I come down.

Point of view shift and stages of understanding. Table 2 shows person A at the stage of understanding that the upper thread goes around the whole bobbin. Table 3 shows A describing the same situation, but this time from a state of confusion (non-understanding). In the Tables, the numbers on the right indicate A's C-POV.

Table 2. Understanding stage

Protocol	*C-POV*
A: right it's got to go around the whole bobbin	3
that's why	
B: oh right	
yeah	
A: so as this comes down	3
B: okay it's caught by this little thing here	
A: and	
goes over the whole bobbin	3
B: yanks it around	
A: and goes back up	3
B: and then	
goes back up	

Table 3. Non-understanding stage

Protocol	*C-POV*
A: so we come along here	4
----	
turn around	4
grabs this	4
(pause)	
now	
this is unfortunately a little too long	
because it got to go behind and	3
pause)	
I'm not	
not quite clear	
it carries this down below	2→3
part of it slips in front	3
like that	3

These examples illustrate one of my points; when people in this task are confused, they tend to shift C-POV reasonably frequently.

A Framework for Understanding the Role of Point of View

A framework: Function-mechanism hierarchy. There are different levels at which a question can be answered. Each level will have a different specification of the function and the mechanisms. There will be a dovetailing of function and mechanism: the function at one level requiring the mechanisms of the next to explain it. To see this, consider how a sewing machine accomplishes its function (the "zero" level function) of making stitches. One answer is that it has a mechanism (a "level 1" mechanism) that has as its function the intertwining of the two pieces of thread. For some purposes, the explanation at this level would be satisfactory. But this level of answer does not explain "intertwine." How does this get done? To explain this, we need another level. The function of "intertwining" is accomplished by a mechanism that makes the upper thread go around the bottom thread. Again, this is a satisfactory answer for some purposes, but it doesn't explain the mechanism by which the function "going around" gets done. To do that, we must introduce a new level, which in turn will have its unexplained function.

Table 4 shows one possible function-mechanism hierarchy for how a stitch is made on a sewing machine.

Table 4
A function-mechanism hierarchy for how a stitch is made on a sewing machine.

LEVEL	
0: Func:	A stitch is made.
1: Mech:	Two pieces of thread intertwine.
1: Func:	Intertwine.
2: Mech:	Upper thread goes around bottom thread.
2: Func:	Going around.
3: Mech:	The upper thread gets looped around the whole bobbin (on which the bottom thread is wound).
3: Func:	Getting looped around.
4: Mech:	The needle pushes the upper thread and leaves a loop behind. The loop goes around the whole bobbin holder which is only so attached to the machine that a single thickness of thread can pass behind it.

I propose that the process of understanding follows the function-mechanism hierarchy as a framework. One notices a function of the device and then starts to look for mechanisms to accomplish that function. When the mechanism is determined, the understanding proceeds, moving one level down in the hierarchy. Then, the explanation of mechanisms itself is decomposed to create a new statement of a function, and the whole process repeats itself.

C-POV shift in relation to the framework

In the above framework, "the understanding stage" can be defined as "Function statement at level (n) being accompanied with Mechanism statement at level (n+1)." When the accompanying mechanism statement is absent, then one is in the "non-understanding stage."

The C-POV shifts were counted at the stages of "understanding" and "non-understanding" at each level of the above function-mechanism hierarchy. Table 5 summarizes the number of those C-POV shifts I have observed in two pairs of subjects who all worked on the sewing machine stitch problem. The number in the table indicates percentage scores calculated by dividing the number of observed shifts by the maximum possible number for each occasion. The pattern of "less shifts with understanding, more shifts with non-understanding" is subtle, but consistent.

Table 5. Summary of C-POV shifts.

	Pair 1		*Pair 2*	
	Person A	Person B	Person A	Person B
Level 1				
Understanding	0.0	0.0	---	---
Non-understanding	37.5	75.5	---	---
Level 2				
Understanding	---	---	25.0	---
Non-understanding	42.9	27.3	---	45.0
Level 3				
Understanding	19.0	9.8	20.7	0.0
Non-understanding	21.2	23.8	25.9	27.3
Level 4				
Understanding	14.3	14.3	6.3	12.5

Shifts in C-POV appear to occur at the point where a functional statement is reached, but its mechanism is not yet available. This suggests that C-POV shifting has something to do with the search for submechanisms hidden in a functional statement.

Conclusion

To understand a mechanical device means to be able to explain its function in terms of relationships among its submechanisms. When people can do this, they feel that they understand the device, and can explain it from one stable point of view. After spending some time on this explanation, however, they can go a step further to promote their understanding by focusing upon one of the mechanisms of the explanation, seeing it as serving a subfunction. At this stage, the further detailed mechanism to accomplish that new function may not yet be known, which creates a sense of non-understanding. Here, one tries to see the submechanisms of that function by looking at the function from various points of view, and this shifting will sometimes be reflected in the language used to describe the phenomenon.

I do not want to claim that this is the only role for shifting one's point of view. However, in the current context of attempting to discover deeper levels of understanding of a physical device, the shifts in C-POV appear to reflect shifts in conceptual views of the problem.

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"Consciousness is co-knowledge."

L.S. Vygotsky

"It should be noted, too, that
the Russian word obuchenie
does not admit to a direct English translation.
It means both teaching and learning,
both sides of the two-way process, and
is therefore well suited
to a dialectical view of a phenomenon made up of
mutually interpenetrating opposites.
Its frequent conventional translation
simply as 'learning'
therefore renders much Russian work in
English translation wholly meaningless,
particularly the intense Soviet interest
in the relationship between obuchenie *and development.*
It should be recalled that the verb 'to develop'
is transitive as well as intransitive,
and that the dialectical viewpoint will therefore
include a different view of the concept of 'development'.
Not only do children develop,
but we adults develop them.
On balance, Soviet developmental
psychology is a psychology
of teaching and teaching difficulties,
as much as ours is one
of learning and learning difficulties." (pp. 169-170)

Andrew Sutton, In J. Brine, M. Perrie, and Andrew Sutton, (Eds.), *Home, School and Leisure in the Soviet Union,* University of Birmingham, 1980. [Reprinted by Permission]

"All systems leak."

Edward Sapir

Changing Collective Representations for Number in Oksapmin Communities*

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In a previous issue of the *Newsletter*, I described some aspects of traditional numeration among the Oksapmin (Saxe, 1979). The purpose of the present report is to summarize recent research with the Oksapmin that offers some insight into the way in which novel collective forms of knowledge emerge in the social history of a cultural group. In particular, the concern of the present report is the way in which novel forms of number representation are emerging among the Oksapmin as a function of their participation in new Western-styled social institutions, economic exchange with currency and enrollment in a community school. Before summarizing the research, it will be useful to review briefly some general characteristics of the Oksapmin community and the indigenous body counting system. (Rich and extensive descriptions of the community are contained in two doctoral dissertations that are in preparation [Guilford[1]; Moylan[2]]).

There are between 6000-8000 speakers of the Oksapmin language who live in two remote valleys in the highlands of the West Sepik Province of Papua New Guinea. The traditional economy of the Oksapmin is subsistence based: people cultivate root crops (taro and sweet potato) and hunt for small game with bow and arrow. The Oksapmin counting system differs markedly from the Western, as do the systems of other Papua New Guinea groups (Lancy, 1978; Saxe, 1979). To count as Oksapmin's do, one begins with the thumb on one hand and enumerates 27 places around the upper periphery of the body, ending on the little finger of the opposite hand. If one needs to count further, one can continue back up to the wrist of the second hand and progress back upward on the body. Thus, the potential problems for arithmetic computation when one thinks in the terms of such a counting system are many. How does one consider adding, for example the nose to the shoulder, or subtracting a shoulder from the ear? Although in traditional life such questions are virtually non-existent, these questions are now becoming important ones.

Participation in Economic Exchange with Currency: An Occasion for Arithmetic Reasoning

The introduction of Western-styled currency presented a new approach to the exchange of goods for the Oksapmin, since traditionally, Oksapmins traded goods directly (e.g., bows for salt, axes for bows). Perhaps the only analog to currency in traditional life were shells traded from the coast. Shells were (and still are) considered valuable in and of themselves and probably were the traded items furthest removed from practical utility. They were used as a medium of exchange for some local goods, but not all.

The history of currency in the Oksapmin community is short but complex. There have been three Western currencies used, but only the first and third (the current kina) have left a lasting impression. The first wave of currency was in the form of Australian shillings and pounds (20 shillings = 1 pound) and was brought by the early missionaries and patrol officers to the region, starting about 1961. Since 1966, currency has taken other forms in Papua New Guinea. In 1966, the Australian dollar was instituted (100 cents = 1 dollar), and in 1975, before the country became independent, Papua New Guinea issued its own currency in the form of kina and toea (100 toea = 1 kina, 200 toea = one 2 kina note). Many Oksapmin people, particularly individuals beyond their twenties, translate kina and toea (current national currency) into pounds and shillings (the first currency system). On this basis, people call one 10 toea coin, one shilling (a twenty toea coin is called two shillings) and one two kina note, one pound. Many people count kina and toea as their pound and shilling equivalents.

One consequence of the introduction of currency is that people have adapted the indigenous numeration system in order to communicate about currency (Moylan[2]). Using the adapted system, an individual can count considerably larger quantities than one could using the standard indigenous system. Using the adapted system, an individual can count considerably larger quantities than one could using the standard indigenous system. Using the adapted system, an individual counts shillings up to the inner elbow on the other side of the body (20) and calls it one round or, one pound. If the individual needs to continue the count, he begins again at the thumb of the first hand and then verbally records each round. Similarly, an individual may count two kina notes and thus count forty kina (20 two kina notes = 40 kina) as one round. The adapted system, then, has a base structure that reflects the base structure of the early Australian currency system but nevertheless is an outgrowth of the standard indigenous system. It is important to point out that Oksapmin use this system flexibly. There are many ways of expressing the same value either through combinations of the traditional and the adapted system or using only one system. The individuals who use the adapted system with the most regularity are those who engage in frequent economic transactions involving currency.

The trade store is a recent development in the

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[1]Guilford, V. Doctoral Dissertation, in preparation. The Graduate Center of the City University of New York.

[2]Moylan, T. Doctoral Dissertation, in preparation. The Graduate Center of the City University of New York.

Oksapmin community and is a place in which economic exchange with currency occurs frequently. Trade stores have emerged in recent years partially as a result of Oksapmin men returning with currency (about 200 kina) from two year stints of labor on copra or tea plantations. Some of these men buy quantities of bags of rice and tinned fish to sell to people in their hamlets. The first such trade stores were started in 1972 and by 1980 there were more than one hundred in the subdistrict.

As an inherent part of the interactions which occur at the trade store, customer and owner pose arithmetic problems to one another. From the customer's perspective, the trade store owner sells goods for a specified price, and the customer must offer the currency which is required for the purchase. From the trade store owner's perspective the customer has a certain amount of money, and the trade store owner must evaluate whether the customer has presented the appropriate amount and/or how much change the customer should receive. In fact, transactions such as those which occur in trade stores can be successfully negotiated in any number of ways, owner and customer contributing in different degrees to the completion of the economic exchange. For example, one possibility is for the trade store owner to complete the entire transaction, and select the appropriate amount of currency from the customer. Another would be for the customer to request a commodity and over pay, then receive change from the trade store owner. A third would be for the customer to calculate the exact amount and determine the change. The style of transaction, of course, would be dependent upon, among other factors, the owner and customer's relative competencies at producing arithmetic calculations. Regardless, the trade store presents a social context, an inherent aspect of which is arithmetic computation, a context which is very new to Oksapmin life.

To determine the way in which the use of currency in economic transactions is influencing the way people employ mathematical concepts, adults who had different levels of experience with the money-economy were asked to solve arithmetic problems. These included trade store owners, men who had returned from a work period at a plantation, and groups of young and old adults who had little experience of economic exchange that involved currency.

An analysis of people's strategies to solve the arithmetic problems revealed some dramatic differences across the four groups. People who had little experience with economic exchange involving currency (young and older adults) did not differentiate body parts from body-parts-as-numerical-symbols in solving the arithmetic problems whereas the plantation goers and the trade store owners did make this differentiation. Thus, to subtract 9 from 16, a traditional person would typically enumerate the corresponding series of body parts as an answer (e.g., shoulder (10), neck (11), ear (13), nose (14), eye-on-the-other-side (15), and ear-on-the-other-side (16). In contrast, people who had regular experience with economic exchange would differentiate between body-parts-as-body-parts and body-parts-as-numerical-symbols in their solution procedure by calling one body part by the name of another body part. For instance, to solve the same problem a typical strategy would be to enumerate the shoulder (10) to the ear-on-the-other-side (16), using the terms thumb (1), index finger (2), middle finger (3) Thus, these people would achieve a precise numerical representation ("forearm" or seven) for the product of the subtraction.

The use of currency presents one context in which people must adapt old ways of thinking and reasoning about number to new types of problems. There are other contexts in the Oksapmin community which also are giving rise to the development of new forms of arithmetic thought.

Going to the Community School:
Another Occasion for Arithmetical Reasoning

A very different social institution from the trade store which has also been introduced since contact is the community school. At school, Oksapmin children participate in a wide range of activities -- from formal school lessons to the building and maintenance of the school grounds. The teachers do not know the Oksapmin language, nor the Oksapmin numeration system.

Just as in the trade store, arithmetic problems are posed to individuals (in this case children and adolescents) in the school setting. Although there is formal instruction in how to solve arithmetic, it would be natural for children to create ways of using their existing knowledge about number -- their indigenous counting system -- to attempt to solve the Western-styled problems. Two types of studies were conducted to explore this possibility. In the first type, children were observed in their classrooms as they took an arithmetic test, and two coders noted whether or not individual children showed signs of pointing around their bodies as they took the test (i.e., used the indigenous numeration system). In the second type, children were individually interviewed about their strategies for solving arithmetic problems.

An analysis of children's performance on the arithmetic test showed that many children used the conventional body part system to help them solve the arithmetic problems, however, the frequency with which children used their bodies to solve the task differed over grade level. While a majority of the children in Grade 2 used their bodies to help them solve the arithmetic problems, by Grade 6, only 10% of the class used their bodies. In order to find out the nature of the body part strategies children used to solve the problems, children from all grade levels were interviewed individually about how they solved a variety of arithmetic problems. In addition, a group of non-schooled adolescents were interviewed in order to determine whether the children's invention of the body part strategies was due to the school experience.

In the initial interview, children were presented with four arithmetic problems, one by one (5-3, 3+5, 14+7, and 16-7). If children used an overt body part counting strategy, the nature of the strategy was recorded, and if they did not, they were asked to explain how they arrived at their answer and probed about whether they could use their bodies to help them solve the problems. In addition, if children were successful at solving these problems with body strategies, they were given additional, more difficult problems which extended beyond the standard 27 body parts (e.g., 41-6, 34+12, etc.)

The results of the interviews revealed a wide range

of body strategies to solve the problems, and, as was the case in the study on the influence of currency, some of the strategies were much more adequate than others. "Inadequate" body part strategies were considered those which did not incorporate a "stop rule." These strategies were similar to the ones used by adults who had little experience with economic exchange with currency. In these strategies, children successively iterated body parts while trying to solve the problem and did not use the procedure of calling one body part by the name of another body part in their solution procedure. "Adequate" body part strategies were considered those which incorporated a "stop rule," a procedure whereby the children could determine when the correct sum was achieved in an addition or subtraction problem while counting on their bodies. Typically these strategies took a similar form to that of the adults who had experience with economic exchange with currency. For example, to add 14+7, a child would begin with the nose (14), call the eye the thumb (15=1), and continue this procedure around the upper periphery of the body until stopping at the forearm-of-the-other-side (21), since it would be called the forearm (7). With the more difficult problems, children had to know how to count in English, and it was only at Grade 6 that children regularly used an adequate body strategy to solve these problems. For instance, to add 34+12, the child would say that he had the larger of the two numbers, 34. The child would then count the thumb as "35," the index finger as "36," and continue counting up the upper periphery of the body to the ear (12), which was counted as "46," the correct answer. A similar procedure was invoked to solve subtraction problems involving large numbers.

Concluding Remarks

An inherent property of many types of social interactions is that problems are posed interpersonally. This property is an essential feature of the interactions that occur about numerical problems in the Oksapmin trade stores and community schools. In order to achieve adequate solutions to these problems, Oksapmin individuals are constructing more specialized means of numerical representation from their traditional system, a system that is already a part of their enumerative activities. Those solutions that are generalizable and effective across a variety of numerical problems are becoming sociohistorical adaptations in the sociogenesis of knowledge in the Oksapmin community. Though the studies discussed are limited to interactions in a single cultural group and about a single cognitive domain, it is likely that this mechanism -- the creation of new instrumentalities to solve problems that arise in social interaction -- is one that has considerable generality both in the ontogenesis and in the sociogenesis of knowledge systems across cultural contexts.

References

Lancy, D.F. (Ed.) The indigenous mathematics project. *Papua New Guinea Journal of Education,* 1978, *14.*

Saxe, G.B. A comparative analysis of the acquisition of numeration: Studies from Papua New Guinea. *The Quarterly Newsletter of the Laboratory of Comparative Human Cognition,* 1979, *1*(3), 37-43.

ANNOTATED BIBLIOGRAPHIES

Papert, Seymour. *Mindstorms: Children, Computers, and Powerful Ideas.* Basic Books, 1980.

This book traces Seymour Papert's intellectual passage from an Alpine village near Geneva, as a disciple of Piaget, to Technology Square, at M.I.T.'s Artificial Intelligence Laboratory, where he has become a prime philosophical force for using computers in education. His story is a powerful illustration of the mix of disciplines constituting current cognitive science. He describes his own interests as "thinking simultaneously about how children *do* and how computers *might* think."

Papert and his co-workers have developed computer environments to help children control their own learning in computer-based settings. Central to this development is a computer language called LOGO. But LOGO stands for more than just another language - LOGO is a research enterprise, LOGO is a moral crusade turning its back to BASIC and other vulgar computer languages, LOGO is "a philosophy of eduction."

An important contribution of the LOGO project is the notion of "microworlds," simulated worlds supported by a computer within which learners can explore, acquiring rich intuitive knowledge of a particular knowledge domain. For those who worry about oversimplification, he points to the prevelance of oversimplification in all theory - the trick is to pick the right stuff to keep.

Perhaps the most powerful idea is captured in the title of chapter 6: "Powerful ideas in mind-sized bites." "Mind-sized bites," a phrase attributed to a 7th grader named Robert, paints a portrait of the power of procedures, permitting the hierarchical organization of knowledge.

Mindstorms lays out a developmental history of LOGO. Papert takes an activist position, advocating the use of computers as the most promising way to bring about the cultural changes necessary to lead to modifications in the way children learn. Here he specifies enough of the philosophical underpinings and the political implications of a radical view of computers and children to make this book must reading for anyone concerned about the future of education.

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