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Studies of the effect of environmental stimulation on an individual's development in either general or specific ability conclude that some specific stimulation should be introduced at an early age while a child is still malleable. An intense, persistent, and regular tutorial approach within the family encourages the development of a special talent or ability and develops learning sets useful in the future. A child must learn the specialized symbolic language of the area in which he is being trained, such as in music or mathematics. Studies have shown that persons who excel in one field may show very little competence in others. General ability is present but concentration in the symbolic language and work production in one specific area is reflected in less learning in other areas. Similarly, if a family or school environment encourages young children to respond to certain stimulation which directs their energies and time in a particular way, these same children may do less well on IQ tests measuring general ability but very well on tests of specific abilities. How much training in certain symbolic languages and concepts is transferred to general cognitive functioning is as yet unknown. Environmental stimulation is a means of developing the greatest potential abilities in any individual. (MS)

The Effect of Early Stimulation:

The Problem of Focus in Developmental Stimulation

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Paper presented at a Symposium on Heredity and Environment at the annual meeting of the American Educational Research Association, New York, February 16, 1967.

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What is the human potential for unevenness in the development of complex cognitive abilities and to what extent can focused ability be induced through planned experience? In answering these questions we open the door that leads to the relations between general intelligence and specific abilities. We may also, in the process, find another, little traveled route to an attack on the problem of heredity and environment.

Psychologists have for some time decided that to pit biology and environmental forces, one against the other, is something of a pseudo problem, now generally restated in terms of an interactionist theory of development (Anastasi, 1958b; Hunt, 1961). This theory, asserts that original, genotypic tendencies, drawn from the pool of human potential, evolve through interaction with the sequence of stimulation the organism encounters in the course of development. Generally speaking, the evidence tends to show that the nature of the biological press is increasingly plastic as one moves up the evolutionary scale, the human species surpassing by a considerable degree its nearest surviving rivals, the apes (Hebb, 1949).

Yet this convenient and orderly restatement does not, somehow, erase the ancient question, just <u>how much can</u> experience modify the basic givens for any individual. To affirm that the final product of individual development at any moment in the life history is some complex function of the <u>accumulating history of the interactions</u> between two sources of development still leaves open the crucial question of limits:

That is, for any given level and form of innate structure, are there certain ideal combinations and sequences of experience which can maximize cognitive development. Is there a dynamic potential for each combination of genotypes, whose realization in development is proportional to some complex mathematical function of the history of the developmental stimulation encountered. In brief, to observe that development is not a linear function of the contributions of either hereditary or environmental forces, far from eliminating, simply makes more complex the problem of defining the cumulative effects of environmental stimulation. And, for our special problem of specialized abilities, we still need to know not only how much, but in what ways can developmental stimulation count.

In a recent series of papers, I have been attempting to formulate a set of basic principles relevant to environmental control of developmental learning (Fowler, 1966, 1967a). Developmental learning may be defined as the cumulative effects of learning over the course of development. As distinguished from education or learning a specific task, skill, or subject or from studying the general laws of learning across individuals, developmental learning is concerned with the process of how stimulation develops the individual longitudinally to pile up and transform the organization of his knowledge and abilities.

Many of the principles for optimizing environmental control over the developmental learning of cognitive processes can be regularly identified in the developmental ecology of precocious children (Fowler, 1962a, 1966, 1967a). Especially prominent in the life history of bright children are the earliness and continuing intensity, regularity and pervasiveness with which stimulation is pursued in a tutorial situation throughout childhood. The child, from his earliest months or years is surrounded by the systematic and devoted efforts of one or more members of a family, who value highly a life of what might be called high culture and intellectuality. Much of the stimulation is symbolic in form and centers on cognition. Often, the child is by design or as a by product of parent goals, limited in his peer relations to the active intellectual life of parent defined relations in the family circle or to a selected set of children.

Principles of Developmental Learning

There are other principles which I have identified from my own and other experimental work and longitudinal projects on developmental learning (Fowler, 1965, 1966, 1967a). Among these are making an analysis of the dimensions of conceptual structures: sequencing and pacing the presentation of stimulus complexity; adapting symbolic stimulation to the sensori-motor and play-oriented developmental characteristics of infants and young children; individually tailoring programs by means of continuous psychocognitive diagnoses; defining cognitive learning tasks which are designed to generate effective cognitive styles; and setting up small group learning situations whose social psychological dimensions utilize both individually and group-oriented motivating systems.

Malleability of Development

It is clear from several classes of studies--including studies on early deprivation and social disadvantage, surveys on high ability children and experimental work with preschool children-that early childhood is a period of extreme malleability (Fowler, 1962a, 1966, 1967a, b & c; Hunt, 1961). We are only beginning to discover the range of developmental variability which may be brought under control by more precise and elaborate identification of the conditions and principles of developmental stimulation. One of the factors which appears to have retarded the evolution of scientific knowledge on these problems, is the global approach to both program design and measurement. Most of the nursery school training programs of earlier eras and many of the educational projects on preschool disadvantaged children today have failed to engage in systematic program analysis, to identify, differentiate and test relevant dimensions of stimulation (Fowler, 1966, 1967a, & c). Yet sometimes unimpressive cognitive gains of yesterday and today--modest or inconsequential IQ score shifts of 10 points or less in the course of a year's program, gains which have been known to largely melt away (e.g., Long, 1966; Weikart, 1964)--may additionally be accounted for on the basis of the highly slippery IQ measure. Among other problems, because of its lack of logical structure and its methodological bases, IQ tests are not only highly general but often actually measuring different functions at different age and developmental levels. Fortunately, more cognitively differentiated and logical measures are currently under development (Fowler, 1967c).

In many ways the most convincing evidence on the role of stimulation in the development of intelligence is to be found wherever stimulation programs have been focused on particular areas or dimensions of activity, and intelligence has been rooted and assessed in terms of specific abilities. In this way experimentation with varying amounts of precision and control have shown young children to be highly malleable to focused stimulation in such areas and skills as reading (Davidson, 1931; Fowler, 1962b, 1964, 1965a, 1967c; Moore, 1963; Terman, 1918), verbal language (Dawe, 1942; Fowler, 1962b, 1967b; Strayer, 1930) music, both singing (Jersild and Bienstock, 1931, 1934) and instrumental playing (Fowler, 1962a. 1967c; Maazel, 1950) graphic representation (Dubin, 1946) and motor skills (e.g., Hicks, 1930a & b; Hilgard, 1932; McGraw, 1935; Sherritt, 1922). In my own developmental stimulation projects, for example, it has proved repeatedly possible, employing many of the principles summarized above, to regularly induce fluent reading skills in three and four-year-old advantaged, middle class and some disadvantaged children (Fowler, 1967c). Other investigators appear to have had comparable success, although published reports are not yet fully available (e.g., Bereiter, 1965; Moore, 1963).

Relations Between General and Specific Abilities

One of the persistent sources of confusion in the field of intelligence has resulted from the failure to define the relations between specific abilities and general intelligence. Yet, a close analysis of many special area skills suggests a close parallel in cognitive complexity to the mental operations involved in the problem solving of IQ tests.

The abilities required in the complex task of reading, for example, are constructed with concepts seemingly equal in complexity to many skills required in tabks used to measure "g" or general intelligence, such as the Binet. Among salient ones in reading are the concept of reliable correspondence between visual and auditory patterns and its derivative, the concept of unit-for-unit correspondence (of oral and written words and phoneme-graphemes); the concept of sequencing from left-to-right (in English); and the complex coordinating of mental operations required in synthesizing graphic elements to derive and integrate meaning. It is hard to see how such concepts (which three year olds appear to acquire when they learn to read) are not equal in cognitive complexity and difficulty to such six and seven year old Binet tasks as identifying similarities and differences between simple pictures and words. In fact such processes appear to be similar in structure to aspects of the process of reading.

differing principally in the content of the structures involved, rather than in the complexity of relations and levels of abstraction involved.

If this is so, it would seem very possible to develop other graded stimulation programs, built with the substance and specific content now employed in varying types of intelligence test tasks. Exposed to such programs, children could then be systematically developed to higher levels of cognitive competence---on those corresponding type tasks of an intelligence scale---equivalent to the competence now often easily developed in three year olds in reading. Of course, it should be pointed out that reading is an area which is structurally very near to oral language, an area to which the modal child is heavily exposed from his earliest months of life.

McGraw's (1935) classical developmental learning study of complex motor abilities in Johnny and Jimmy affords an even more dramatic illustration of the long overlooked complexity of cognitive operations involved in specific skills (Fowler, 1967b). Like many empirically based investigators, McGraw developed little in the way of a conceptual framework on the nature and organization of cognitive processes. She tended to limit herself to empirical descriptions of specific behavioral skills, failing to consider the mental dimensions which might be involved. Actually, the ascendence of behaviorism after Binet long delayed the analysis of both general intelligence and specific skills in terms of the cognitive mediational operations entailed.

The value of McGraw's study lies less in its definitiveness---the twins were fraternal---than as a demonstration of the potential for developmental stimulus control over complex cognitive motor mediation at so early an age.

It will be recalled that a systematic developmental stimulation program, continued daily from birth, produced high competence in a variety of complex motor skills in the trained twin prior to the age of 22 months, years before the age when (and if) such skills are usually acquired. The motor tasks encompassed such complex activities as tricycle riding, swimming, diving, jumping, climbing, roller skating, and stacking boxes in seriation.

The Shifting Role of Cognitive Mediation

It seems evident that motor skills are mentally governed abilities, compounded of an intricate pattern and sequence of spatial concepts and movements. In many ways, motor skills parallel language processes, despite the fact that it has long been taken for granted that language processes, unlike motor processes, are closely linked to thought and cognition. As with language processes, it is in the learning that the active and complex, cognitive mediational processes of analyzing, structuring and sequencing dimensions and relations are most obviously involved. Tricycle riding or roller skating, for example, each entail the discrimination, organization and coordinated timing and sequencing of stimulus components of several distinct spatial movement patterns, pairs of which must be learned as complicated reciprocal functions. Moreover, parallel to the relations between reading and speech, the structure of these processe finds roots in the earlier mastery of the skills of crawling and walking. And, again like language skills, once complex motor skills, become well-mastered, they seem to involve much non-cognitive automaticity. This appears to be similar to what is called "automatic sequential" activities on the Illinois Test of Psycholinguistic Abilities.

In this regard, it is also interesting that cognitive deficiency often shows up better on certain visual-motor performance tasks than on verbal tasks of the Wechsler scales (Littell, 1960; Wechsler, 1958). Apparently, the former tasks demand more active problem solving with newer content and dimensions than the verbal scales.

Uneveness in Cognitive Ability: Summary of Evidence

The extent to which high cognitive competence can be developed in the same individual area, much beyond the competence he acquires in other areas is revealed in a variety of sources. McGraw's trained twin, for example, so advanced at age two in certain complex abilities in the motor sphere, attained no more than average levels on verbally loaded IQ tests, so often equated with general intelligence (McGraw, 1935). The acquisition of reading skill by the three year olds in Davidson's study on early reading, on the other hand, as might be expected from the obvious verbal links, was paralleled with significant mean Binet IQ gains (Davidson, 1931).

Profile analysis of intra-individual, ability test patterns often reveals wide discrepancies between areas and types of competence, aside from variations due to emotional problems and anxiety (Anastasi, 1958; Wechster, 1958). On the other hand, the consistently low correlations found between competence in musical, graphic art and mechanical skills, on one side, and verbal and general intellectual abilities, on the other, is a fertile ground for study (Anastasi, 1958a; Wilson, 1953). In Termans (1925) original study of bright children, for example, the average IQ of ten children with high musical ability was 122 with a range from 95 to 139. One particularly intriguing source of evidence, where the phenomenon of high intra-individual variation in ability is sometimes most evident is among child[illegible] of precocious ability, occasionally reaching the extreme of the "idiot savant" (Anastasi, 1958a; Lindsley, 1965).

In her historical analysis of 300 "geniuses," defined principally by their intellectual contribution and eminence, Cox (1926) found "intensity of a single interest" to be at the upper limits of her rating scale on the 100 most outstanding historical figures. While many high ability children and adults are broadly developed in their abilities and interests, it would appear that concentration of ability is as much the rule as generalization of ability across areas (Anastasi, 1958a; Cox, 1926; Miles, 1954). High specialization of ability is most frequent in the fields of music, mathematics, art and athletics (Anastasi, 1958a; Barlow, 1951; Cox, 1926; Dolbear, 1912; Fowler, 1962a, 1967c; Pressey, 1955; Scripture, 1891). The great musicians, including composers (where both creativity and cognitive complexity are high) of the stature of Mozart were relatively undeveloped in other spheres of ability. The early and continued brilliance of figures such as Gauss and Ampere in mathematics, compared to their intellective ability in other areas is also striking. Descartes, who could develop "the calculus" played chess---but played it poorly. Superior athletes and dancers are also usually relatively unskilled in other areas.

"Idiot-savants" have long been known for their phenomenal calculating feats, such as mentally multiplying 10 or more digit numbers, or the ability to learn entire musical scores on a single hearing (Anastasi, 1958; Fowler, 1962a; Mitchell, 1907). The imbalance between these high skill developments and sometimes extremely limited abilities in other areas has been variously attributed to brain damage and/or emotional disturbance, combined with highly focused training and motivating circumstances. Much is made of the inflated role of memory and a lack of generalized and abstracting, problem-solving processed (Scheerer, Rothman, V. Goldstein, 1954;

Anastasi and Levee, 1960). Even in such instances, however, both the developmental evidence and the tremendous uneveness in levels of intellective complexity among ability areas indicate that, while organic deficit may be involved in some instances, developmental stimulation has played an extraordinary role as well (Anastasi and Levee, 1960). Moreover, the selective, abstractive and organizational properties of the graphic artistic work of an otherwise retarded individual such as Yamashita, suggests focused cognitive development that is beyond the role of rote memory factors alone (Lindsley, 1965).

The Etiology of Focused Ability

The phenomenon of intra-individual variability in intellect is in fact so common that it is surprising how little it has been investigated. Yet, there are implications in the phenomenon, which have much relevance to problems of developmental stimulation in education and child-rearing, as well as to the nature and origins of ability itself. Aside from the obvious role of such inherited physiological factors as auditory structures for musical potential and body structures for athletic potential, there appear to be a number of developmental learning circumstances which can lead to the acquisition of concentrated ability. Of these, perhaps the most powerful is stimulation concentrated in a given area, such as music or mathematics. Moreover, virtually all of the principles and arrangements we have defined earlier, facilitative of developmental learning of high, <u>general</u> ability, apply with equal force to the developmental learning of specialized abilities. Thus, the earliness, intensity, persistence, regularity, family concentration, tutorial approach, and the presence of dominant family intellectual-cultural value orientations all apply. The principle difference is to be found in the fact that attention is heavily centered in one type of ability.

The evidence also points to an important reinforcing role that a variety of supplementary factors may serve in producing superior, specialized abilities. Among these are the presence of a milieu and culture, beyond the familial, capable of furnishing an environment generally stimulating in the given field. Such a milieu would also provide an abundance of culturally valued and successful social role models as well as make available to the child adequately reinforced social learning roles. Such a set of conditions has, historically, been found in the field of music in the cities, towns and communities of German culture, leading to whole Bach and Mozart families of musicians, generating large pools of talent from which the Bach or the Mozart could evolve. Closely allied with these background factors is the propensity of parents to label as special talent the first bit of interest or skill observed in early childhood. Energies are then systematically addressed to educating the child in the skill, as with Mozart, leading to something of a self-fulfilling prophesy (Cox, 1926). On the other hand, parental decision to concentrate does not always wait upon evidence of even preliminary competence, but is based on deliberate attempts to "manufacture" genius (Cox, 1926; Engelmann and Engelmann, 1966).

Possibly one of the least considered yet noteworthy factors tending to generate special ability, arises from the nature of the areas in which focused cognitive ability most often occurs. Music, mathematics and graphic art are all forms of mental activity and knowledge, largely composed of relatively independent symbol systems. Mechanical and athletic abilities, which consist of complex organizations and coordinated sequences of body movements with tools in space, appear to be similarly isolable. They are also quite unrelated to and independent of the verbal language systems upon which so much of general knowledge and problem solving are based. Yet, the intricacy of concepts and levels of abstraction required are every bit as great in these areas, certainly in mathematics and music, as the cognitions generated within the framework of verbal language systems. It would thus appear that concepts and abstract cognitive processes may be at least partly intrinsic to or embedded in the particular symbol systems from which they emerge. Such a state of affairs would, to the extent true, define the limitations of the range of the concept of general intelligence. The role which specialized language learning appears to play in the development of superior ability -- especially of a focused nature -- would lend support to the points of view of Luria (1961) and Vygotsky (1962).

In the end, of course, the essential consideration underlying this entire question is not _can_ superior ability become highly focused through specialized developmental stimulation. Far more significant is whether superior specialized competence can be developed _only_ at the cost of cognitive competence in other areas. While it is evident that competence has not necessarily been confined to one or even two areas -- witness the classic renaissance man, Leonardo da Vinci -- there are considerations which suggest that _some_ concentration of developmental stimulation may not only be desirable, but that some focused stimulation should commence very early in childhood.

There are first the advantages which psychocognitive investment in a defined area or type of symbol system may produce in the form of focused interest and more efficient cognitive learning sets and styles. Aside from the apparently large and permanent advantage shown by the early focal trained musical and mathematical geniuses, there is ~~much~~ experimental evidence on the utility of early established learning sets for facilitating later learning in related problems (Harlow, 1949; Harlow et. al, 1952; 1960, Reese, 1963).

At a more complex level, there are also careful follow-up, experimental investigations of McGraw (1939), Burtt (1941), and Durkin (1964) which indicate a persistent advantage accruing from early focused stimulation in the motor, verbal memory and reading domains, respectively. These studies did not, however, investigate developmental stimulation and learning in other, unrelated areas.

Another obvious factor relates to time and energy distribution. Stimulation for one type of activity reduces proportionately the total time-emergy availability of the learner for alternate activities. If, as some evidence suggests, the great superiority of figures like Mozart, Heifitz, Gauss and Picasso are more than coincidentally the product of highly intensive and focused developmental stimulation from early childhood, (as well as of genotypic factors) it may be necessary to reduce the time-energy proportion devoted to acquiring knowledge in other areas accordingly, in order to generate such refined genius.

There is, after all, a difference between levels of mastery of a subject varying as a function of the depth and range of familiarity with the myriad of specific elements, relations, concepts and network and hierarchy of principles involved, as Gagne's (1965) model suggests. At the uppermost levels, where creativity as opposed to competence per se is maximal, it is perhaps not enough even to be steeped in a field; one must almost "live" the field. Contrary to Piaget, it may well be that one of the highest and most complex forms of conceptualizing may involve firm anchorage in the idiosyncratic language and themes of a field. The root, as yet developmentally almost untouched question, is how much transfer can occur from concepts acquired through developmental stimulation in one language system to cognitive functioning in other quite distinct symbol domains.

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