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Toys and Infant Development: Biological, Psychological and Social Factors

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Abstract

Infants spend much of their waking time exploring toys and other objects. Although there is a great deal of research supporting the importance of object play for cognitive development, we tend to be casual about toy selection and use. The author's experience directing a toy research program for the Johnson & Johnson Baby Products Company showed how profoundly the physical features of objects affect the play opportunities they provide. This paper presents arguments for a more thoughtful approach to toy research, toy selection, and toy use.

Toys and Play: Do They Matter?

Infants spend much of their waking time exploring toys and other objects. This is generally accepted as a normal phase of childhood, and most parents feel that experience with toys makes a positive contribution to development.

Many students of cognitive development go even further, attributing to object playa crucial role in the growth of thought and understanding (DeVries and Kohlberg 1990; Gottfried 1984; Gottfried and Brown 1986; Piaget 1962; Uzgiris and Weizmann 1977; Yarrow, Rubinsteirt and Pedersen 1975).

In spite of this general faith in the educational importance of objects, there is little exact understanding of what children actually do with their toys (Sheridan 1977).

If the competencies children have are influenced by the quality, character, and timing of their early experiences, as many child development experts feel to be the case, then we should know more than we do about how objects influence those experiences (Gottfried 1984; Gottfried 1986; Hunt 1979; Uzgiris and Hunt 1987; Wachs and Gruen 1982).

In a pioneering investigation, Elardo, Bradley, and Caldwell studied 77 infants using an inventory of home stimulation variables (Elardo, Bradley and Caldwell 1975). They were looking for aspects of the home environment that correlate with Stanford-Binet IQ at 36 months. Three variables, measured at 6 months and at 12 months, correlated with later IQ. They were: "provision of appropriate play materials," "maternal involvement with child," and "organization of physical and temporal environment."

Gottfried (1986) reviewed a series of longitudinal studies designed to identify home environment variables that correlate with cognitive development. The two most potent and pervasive home environment variables correlating with cognitive development during infancy and the preschool years were: the availability of play materials, and the quality of maternal (parental) involvement. With advancing age, the relationships between play materials and parental involvement were found to influence cognitive development even more.

The toys that correlated with intellectual function were those toys that fit the interests and abilities of the infants and young children studied. They are referred to as "age appropriate," "responsive," and "providing feedback when manipulated." However, detailed descriptions of the physical features of toys that correlate with cognitive development are not provided.

During the 1970s and early 1980s, the Johnson & Johnson Baby Products Company supported a major research program on the design of child development toys for infants (Johnson & Johnson Baby Products Company 1981). The author served as Director of Research for this program. The research done for Johnson & Johnson demonstrated that the physical features of toys powerfully influence play duration, and the experiences an infant can have during a play episode (Chase, Williams and Fisher 1974; Williams 1989).

Since behavior is so powerfully constrained by the physical features of toys, it is time to move beyond a general understanding of the relationship between early toy use and cognitive development. We need a more detailed understanding of the structure of early experiences that influence cognitive growth, and the physical features of objects that support those experiences.

This paper has been written to encourage parents, teachers, and the research community to participate in this process.

Before we consider how to advance our understanding of toys, play, and cognitive development, let's pause for a brief survey of some milestones in the history of thought about toys and play.

Toys and Play: Historical Perspectives

Prior to the l8th century, toys and play were largely considered to be entertaining but unimportant preoccupations. In 17th century America, the "non-useful" character of play, whether practiced by child or adult, was considered a form of idleness that could easily shade into sinfulness. It was tolerated only in small doses (Brewer 1979).

The 18th century brought new ideas concerning human nature that cast toys and play in a different light (Brewer 1979; Mergen 1982). There was a growing sense that children came into the world eager to learn. Play became valued as a way of making learning more enjoyable, and toys became viewed as tools for play. These ideas have flourished ever since (Brewer 1979; Weber 1979).

From the mid-18th to the mid-19th century there was rapid growth in the number and kinds of play materials for children. Games often reinforced shared social values, with names such as "Right Roads and Wrong Ways." Along with the use of toys and games, parents were now encouraged to take their children to the circus, to the zoo, and to theaters and museums (Brewer 1979).

The idea that children could be "improved" by providing the right experience at the right time was now gaining favor, and an abundance of children's books joined the parade of toys and games (Darton 1982; Jackson 1989; Summerfield 1985).

In the second half of the 19th century, Friedrich Froebel introduced the idea of special schools for very young children. This was the beginning of the kindergarten movement which gained widespread support in the United States (Froebel 1974; Shapiro 1983). Froebel recognized the importance of objects as tools for learning, and he designed his own system of learning materials as did Maria Montessori somewhat later (Montessori 1965). Many of the experiences in the Froebel and Montessori classrooms made use of their specially-designed play materials (Weber 1979).

Although classroom experiences for young children became more flexible and eclectic through the 20th century, the importance of toys and play remain central in

the theory and practice of early childhood education. And with new ideas about the experiences considered best for children, there was likely to be some accompanying change in play materials (Winsor 1973; Weber 1979).

When John Dewey argued that a child's own interests should govern play, he recommended that a real broom should be used instead of a play broom, and that it should be used to actually clean the classroom (Weber 1979).

The provision of supervised play experiences was carried to even younger groups. The nursery school followed the kindergarten, and the infant school has now arrived. Some public schools now admit children at age 4, and the idea of universal developmental daycare starting in infancy is growing rapidly.

The availability of play materials for very young children parallels these developments. Toys for the preschool child (3-5 years of age) became abundant in the 1940s and 1950s; toys for infants became plentiful through the 1960s and 1970s; and, in the 1980s, the needs of toddlers became recognized in toys designed especially for them.

Exploration and Play

Even a competently designed toy is first approached in a cautious way (Harlow 1963; Hutt 1979; Welker 1961). The earliest contacts with new objects are often slow, deliberate, and serious. Once an object becomes more familiar, actions become quicker, more confident, and more lighthearted. As mastery is achieved, playfulness and a willingness to share objects with others emerges. Corinne Hutt (1966; 1979) studied this progression and suggested that we use the term "exploration" for the early cautious behaviors, and “play” for the more confident and lighthearted behaviors that follow.

This distinction adds to our understanding of the importance of good toy design. If an object is too simple, too complex, or otherwise unappealing, then exploratory behaviors are not sustained. And, without sustained exploration, mastery cannot be achieved, and the self-confidence and receptivity to sharing that accompany mastery remain elusive.

There is another developmental issue that should be noted here as well. During much of the first year, the infant's attention tends to focus either on an object, or on a person (Eibl-Eibesfeldt 1989). As the infant matures, shared use of objects in play becomes both easier, and more rewarding. However, the generalization that independent exploration usually precedes shared use of objects remains valid through infancy and toddlerhood.

The Social Context

We have just noted that successful exploration of objects leads to social interaction and sharing. In this way, toys provide a framework for social experience. Opportunities for the growth of communication and social skills follow.

But there is yet another story to be told about social experience and the exploration of objects. That is the story of how children become explorers in the first place. If babies approach novelty with caution (as is true for all primates); how do they ever become the active and eager explorers that we associate with the idea of childhood itself?

To resolve this paradox we must look at the earliest social relationships. Understanding in this area has been aided by the study of animal behavior, particularly the behavior of monkeys and other primates (Harlow 1959; Harlow 1963). The animal studies make clear that infants deprived of normal parenting do not become active explorers. On the contrary, they avoid exploration (Bowlby 1969; Spitz 1965; Chase 1972; Dennis 1973). And if an infant monkey has the opportunity to develop a normal relationship with its mother, but is later deprived of access to her, there is immediate, active protest, followed by deepening despair. Studies with human infants show much the same thing (Bowlby 1969).

Successful attachment requires more than simple access to the mother. It is also important that the mother be sensitive to the baby's signals, particularly signals indicating discomfort, and respond to them in a timely and effective manner. When this is the case, attachment develops, and the infant shows interest in the surrounding environment (Ainsworth and Bell 1970).

As the infant matures, she leaves the mother more often, travels farther from her, and stays away longer (Rheingold and Eckerman 1970). However, backward glances are commonplace, and fear or discomfort are likely to prompt a hasty retreat. Mothers usually resist the earliest attempts of infants to separate and move out on their own. But they show increasing willingness to go along with the idea as the infant matures, and will eventually encourage the process, especially if the infant shows undue reluctance to explore on his own.

Exploration, Play and Learning

The quality of the infant's social interactions with caretakers is critical for the expression of exploratory behaviors. But, once these social requirements are met, exploration of the physical environment comes to occupy the overwhelming majority of the infant's waking time (White, Kaban, Shapiro and Attanucci 1977; Clarke-Stewart 1973).

Studies of infants from 12-33 months show that interactions with the physical environment account for approximately 80-90% of waking time. Social interactions account for approximately 10-20% of waking time (White, Kaban, Shapiro and Attanucci 1977). K. Allison Clarke-Stewart found that 9- to 18-month-old infants spent 46% of their waking time looking at and playing with physical objects, compared with 36% of their waking time interacting with mother (Clarke-Stewart 1973).

In addition to the enormous amounts of time that infants devote to exploration of the physical environment, investigators have been impressed by the seriousness

with which infants conduct their explorations (Uzgiris 1967; Hutt 1979; Gesell, Thompson and Amatruda 1976).

When Arnold Gesell conducted his pioneering studies on behavior development in infancy, he selected a series of objects in order to standardize environmental variables (Gesell, Thompson and Amatruda 1976). He notes: "it was not necessary to resort to artificial procedures in order to 'motivate' the infant and to make the materials exciting. They carry their own enticement, which is an extroverted way of saying that the infant has an ingrained propensity to exploit his physical environment" (Gesell, Thompson and Amatruda 1976).

We should note that these first two years of life, during which exploration of the physical environment occupies so much of the infant's time, and elicits such intense interest, is also the period during which the brain undergoes its most rapid growth (Dobbing 1973; Dobbing 1974; Magoun, Darling and Prost 1960).

During the first half of this century, biologists made observations supporting the idea that the development of neural structures depends upon "functional activation." Austin Riesen has reviewed the history of these investigations (Riesen 1961). In recent decades, more detailed ideas have emerged concerning the ways in which experience influences brain development (Diamond 1988; Gibson and Petersen 1991; Greenough 1986; Greenough 1987; Hahn, Jensen and Dudek 1979).

Gerald Edelman suggests that neural circuits are formed through a process of "Darwinian selection" (Edelman 1992). In a recent paper titled: "Real Brains and Artificial Intelligence," Reeke and Edelman write:

> *The essential requirement for learning, logic, and the other mental functions that are the usual subjects of AI (Artificial Intelligence) research is the prior ability to categorize objects and events based on sensory signals reaching the brain. The variety of sensory experiences is both vast and unique for each individual. The categories themselves are not present in the environment but must be constructed by each individual according to what is adaptive for its species and its own particular circumstances. The a priori specification of rules for categorization, applicable to all individuals and all contexts, is precluded by the complexity, variability, and unpredictability of the macroscopic world.* (Reeke and Edelman 1988).

Physical objects provide both occasions for experience, and constraints on experience. If the number and structure of brain circuits is significantly influenced by the number and structure of early experiences, then we should become more literate in our understanding of the experiences infants are capable of, and can learn from. A more detailed understanding of the ways in which objects influence behavior can lead to new tools for the study of brain behavior-relationships and new technologies to support the growth of intelligent behaviors.

Infants and Objects: A Child Development Perspective

In spite of the profusion of new toys for very young children (Toy Manufacturers of America 1991-92), most of the actual design is done by copying other work, or by guesswork (Chase 1984). For this reason, many objects designed for children fail to attract their interest, or fail to elicit and sustain a wide range of emerging behaviors.

Direct observations of the ways children actually use objects can take most of the guesswork out of toy design (Chase, Williams and Fisher 1974). Let's take as an example the Johnson & Johnson "Red Rings" toy which consists of two concentric flexible red rings attached by a strong vertical vinyl cord with a bell at one end and a small ring at the other (Figure 1). It was designed primarily to let babies practice handling skills (Johnson & Johnson Baby Products Company 1979).

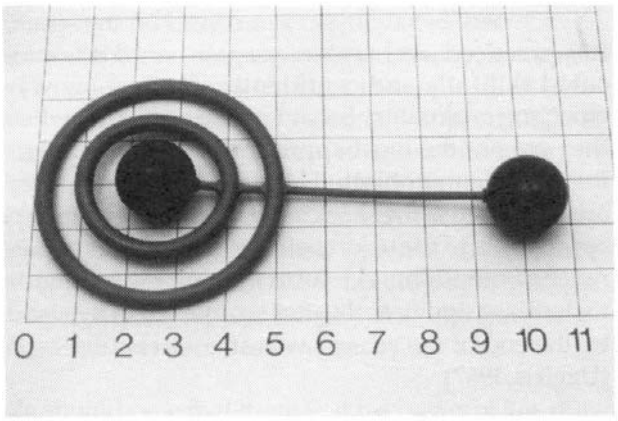


Figure 1. An advanced prototype of the Johnson & Johnson Red Rings toy for infants. The rigid plastic sphere on the far right was later replaced by a small, flexible red ring, similar to the two larger red rings on the left. The rigid blue sphere in the center of these rings contains a bell. The scale is in inches.

During the first six weeks, hands are fisted most of the time. By three months, the hands are open, and the arms are moving out into space. Babies now look for objects to explore, and they even handle their own hands and feet with great interest. But other objects soon become more interesting; particularly objects that have high-contrast visual features, that make sounds when handled, and permit exploration with eyes, hands, and mouth together (Chase, Fisher and Rubin 1984). By six months, the fingers are operating in a much more differentiated manner, and babies want to handle objects that let them tear, pull, push, crumple, squeeze, rub, slide, poke, twist, scrape, and fold (Uzgiris 1967).

We started the design program by inspecting the ring Arnold Gesell used to study behavior development in infancy (Gesell, Thompson and Amatruda 1976), A single, rigid, red ring, 4 1/4 inches in diameter, provides infants who can reach and grasp a great deal of opportunity for exploration. The shape of the object, and the bright red color, provide a large amount of high-contrast edge; a feature of physical objects that attracts visual attention. There is no "right" or "wrong" orientation of

the object in space. It is easily grasped no matter how it is presented (Figure 2), and once in a baby's hands, it can be explored by the hands alone, including transfer from one hand to the other, or by the hands and mouth together. Visual guidance may be used or not used, with little risk of dropping (Figures 3 and 4).

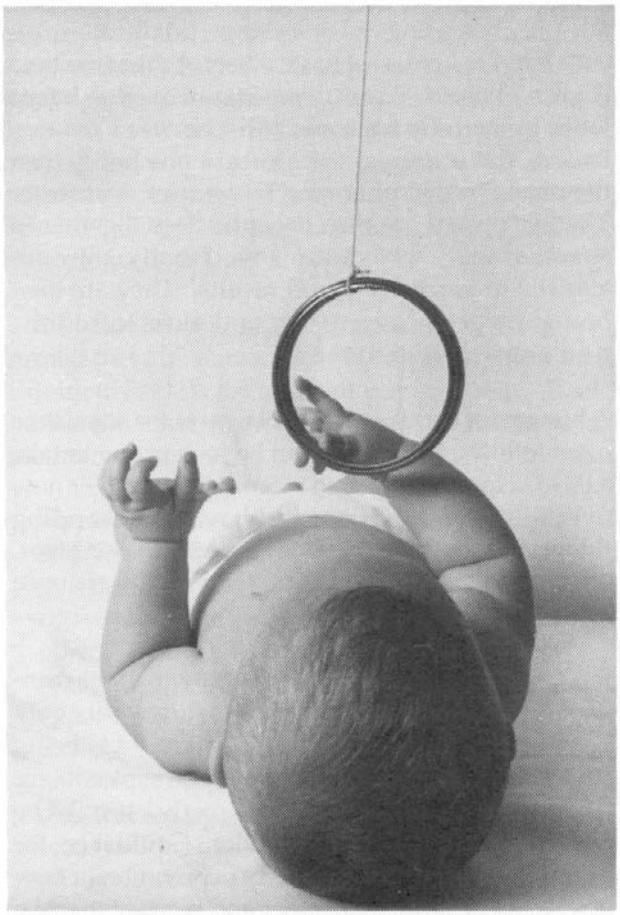


Figure 2. The 4-inch diameter wooden red ring developed by Arnold Gesell is here being suspended close to the body of an infant just beginning to reach and grasp.

By adding more parts, and using flexible materials, we greatly expanded the number of ways the object could be explored, and the visual, tactile, and auditory consequences of these explorations (Johnson & Johnson 1979). Now it could be twisted, bent and stretched. Examined by one hand alone, or by two together. And exploration with the mouth could be added without interrupting exploration with eyes and hands (Figure 3). Any change of position changed the configuration of the object and invited additional explorations of relationships between parts (Figure 4).

After each change in parts and materials, we made more observations of how infants actually used the object. We listed the behaviors observed, and the frequency with which each behavior occurred during a 30-minute test session. As

new features were added, the length of time an infant explored the object increased from a range of 5 to 10 minutes to 20 to 30 minutes.

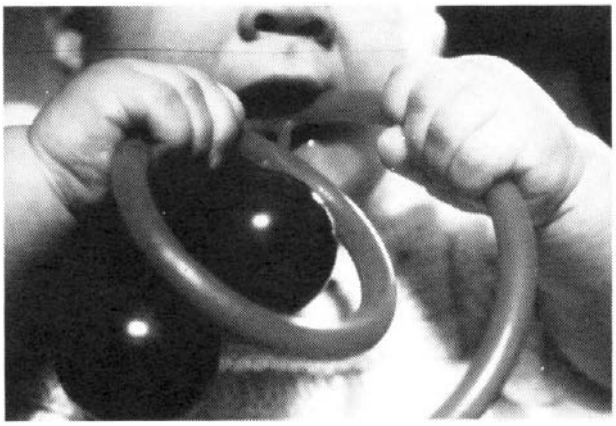


Figure 3. The Johnson & Johnson Red Rings fills the space defined by mouth, hands, and eyes. It can be explored by one or both hands, with or without visual guidance and mouth exploration can be added without interrupting handling.

Objects, Experience and Learning

The behaviors that infants use to explore objects unfold in predictable patterns through the first year of life. Uzgiris made home observations on the behavior of 84 infants (Uzgiris 1967). The sample was about equally divided between boys and girls. She found that a majority of infants demonstrated mouthing by 2 months; visual inspection by 3 months; hitting by 4 months; shaking by 5 months; examining by turning, poking, and manipulation of object surfaces by 6 months; tearing, pulling, crumpling, squeezing, rubbing, sliding, pushing and so forth (clustered in ways appropriate to the object being explored) by 7 months; dropping by 8 months; and throwing by 9 months. Gesell observed the orderly, sequential development of an even larger repertoire of exploratory behaviors (Gesell 1972; 1974; Gesell, Thompson and Amatruda 1976).

As each new behavior pattern comes on the scene, it is practiced over and over again, until it is executed skillfully and confidently. At first, newly-emerging exploratory behaviors are used even when they are not the most appropriate ways of exploring a particular object. However, over time, they are used increasingly selectively, and in groupings appropriate to the object being explored. The occurrence of mouthing as a form of exploration begins to decrease significantly after six months of age, and by the end of the second year it is rarely observed (Uzgiris 1967).

During the first nine months of life, when the basic repertoire of behaviors used to explore objects is being consolidated, infants need objects that vary in their physical characteristics. Materials that produce sights and sounds in response to the infant's explorations are particularly interesting.

Figure 4. Red Rings is a floppy, multi-part object system. Any change in the position of a part produces a new configuration of the system as a whole. In this way, the object remains novel, and invites continuing exploration of parts and their relationships.

Between 6-9 months, the two hands begin to operate with increasing independence, finally allowing each hand to hold a separate object at the same time (Chase, Fisher and Rubin 1984; Figure 5). The infant looks quizzically back and forth between the two hands, first staring at the object in one hand, then the object in the other, and so on back and forth. The two objects are then brought close together in space; at first, very cautiously. Finally, they are allowed to touch. A sound results. They are then brought together repeatedly and more forcefully, resulting in louder sounds.

A hunger for handling many objects at the same time often follows, and babies can be seen trying to take a third, a fourth, and even more objects in their now overfilled hands. Of course they start dropping things, but they will then store

objects in their laps, or on nearby surfaces, so that their hands are once again free to grasp something new.

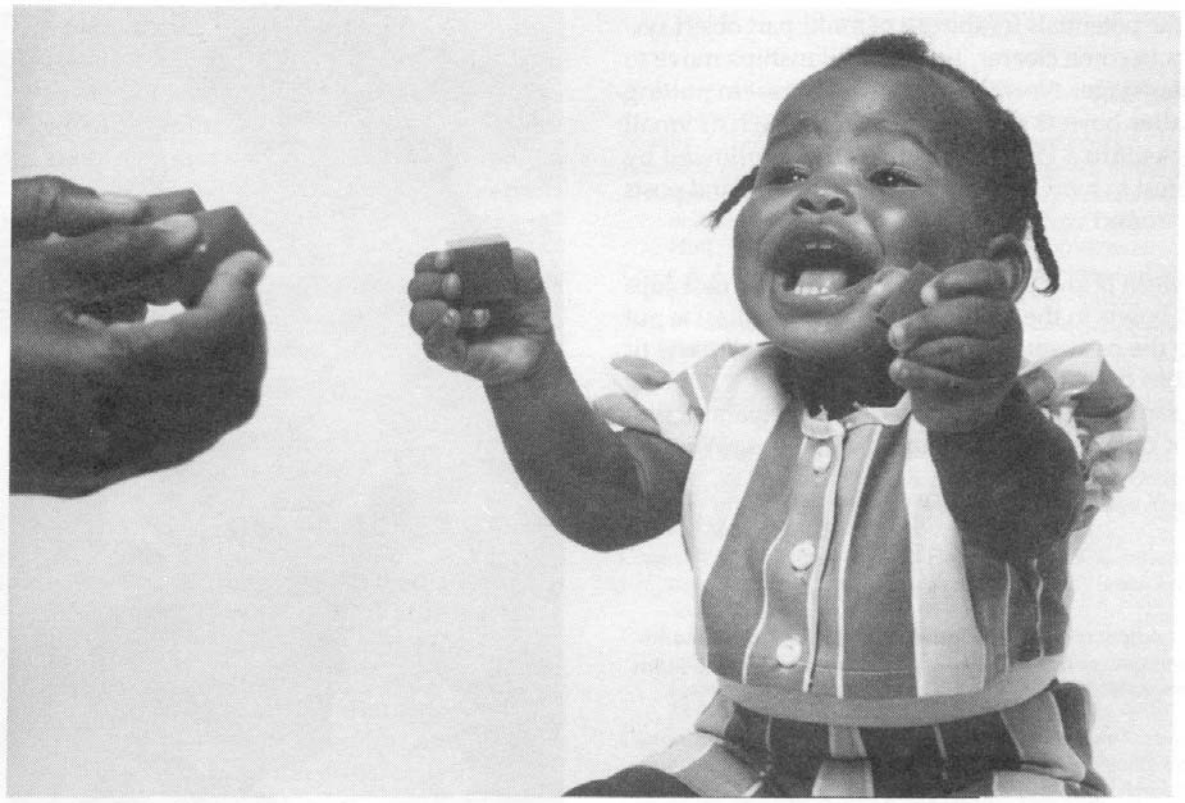


Figure 5. Between six and nine months, the two hands operate with increasing independence, finally allowing each hand to hold a separate object at the same time. This is a threshold event for the exploration of relationships between objects.

It is exciting to watch this steady growth in the complexity of exploratory maneuvers. But, we are only seeing the tip of the iceberg. For a mind is being stretched by the consequences of these explorations. Cognitive growth is not seen directly. It must be inferred from observable behavior. Could it be, for example, that the cautious early exploration of how objects can be brought together and touched to make a sound might be the birth of the idea: "more than one"? This could be a threshold event for the exploration of relationships, classifications, sets, systems, series, and so on.

As the potentials for the use of multi-part object systems become clearer, fitting relationships move to center stage. Now there is great interest in putting smaller objects inside larger ones, such as small blocks into a cup (Figure 6). This is followed by interest in more challenging fits such as round posts into round wells.

Between 12 and 24 months, infants learn to nest cups and bowls in the correct order. The smallest is put into the next smallest, and so on, until all parts fit within the largest of the series (Figure 7). During the same span of time, infants learn to separate classes of objects that have similar features. Wooden rods are placed

together; clay balls are put in another group; and plastic bowls go in a third group (Sinclair, Stambak, Lezine and Rayna 1989).

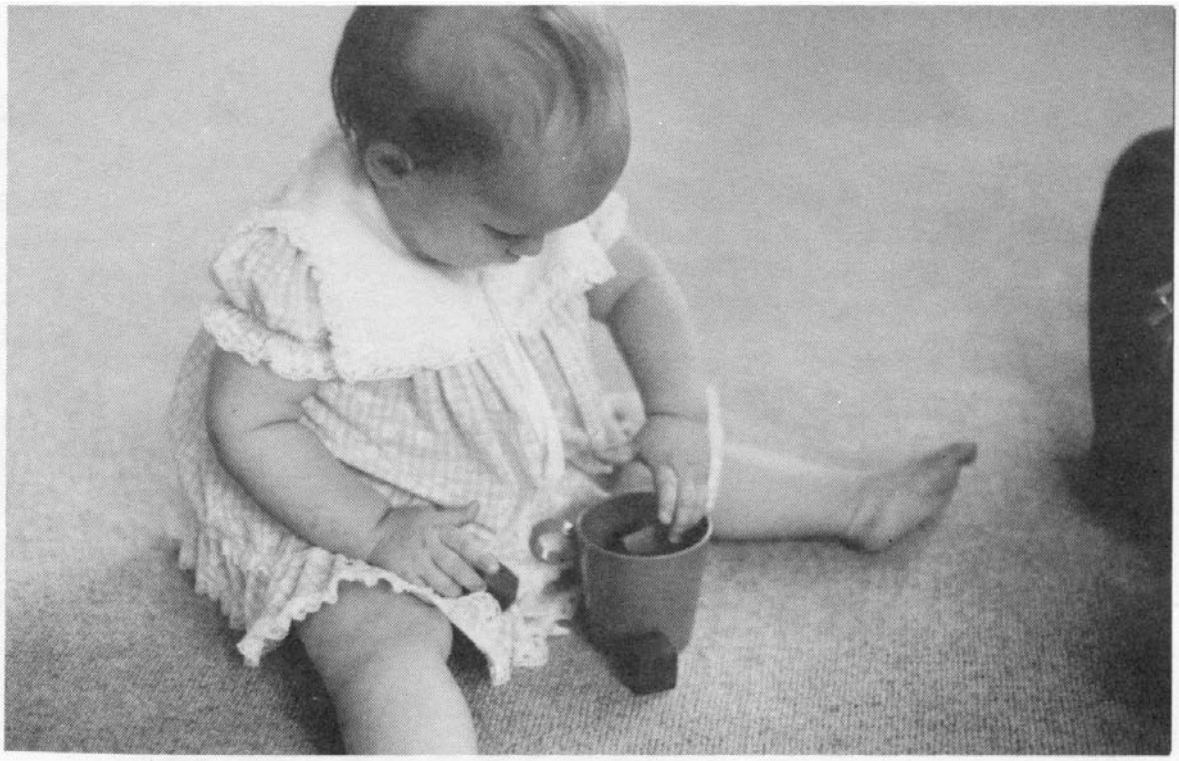


Figure 6. Between nine and twelve months infants show interest in putting all members of a set of small objects inside a larger object. Here we see an infant placing one inch wooden cubes inside a plastic cup.

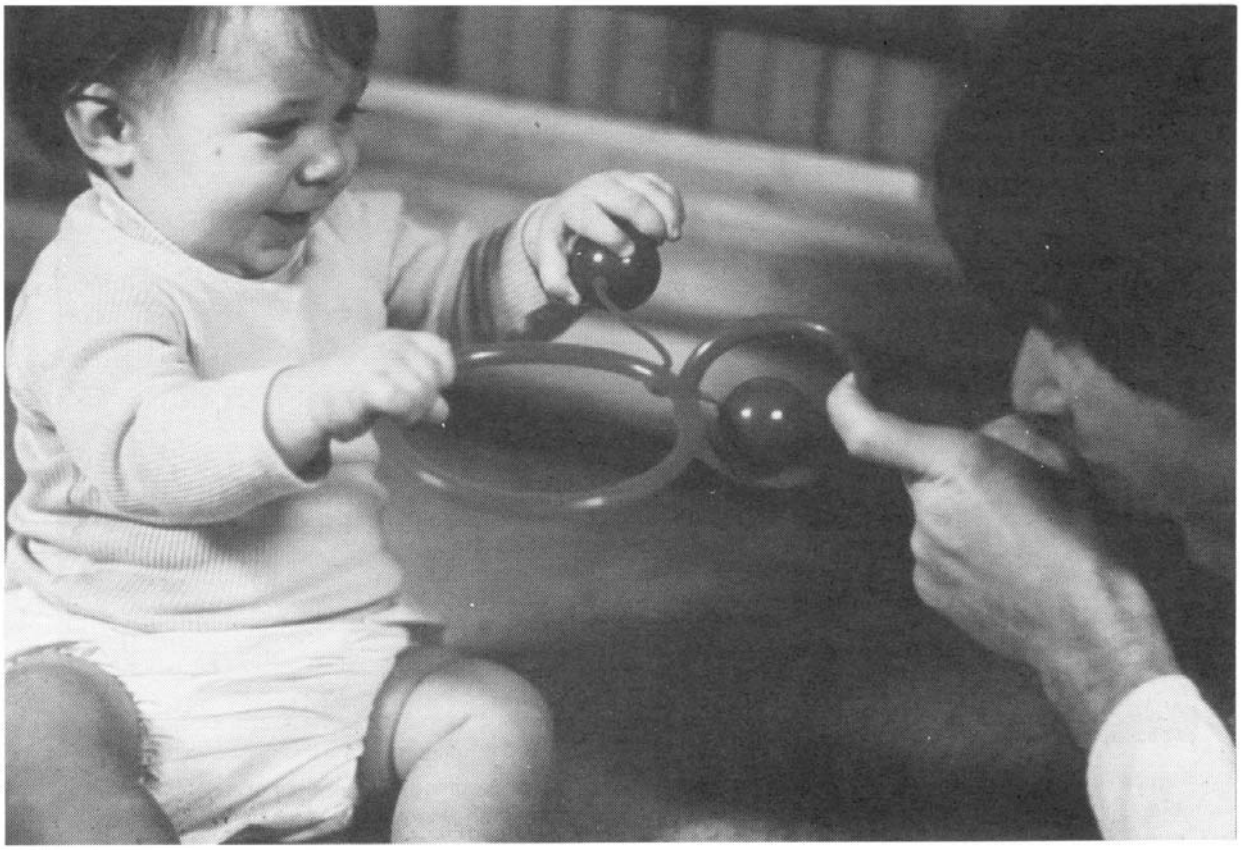
Figure 7. Between twelve and twenty four months, infants learn to nest cups and bowls in the correct order.

By 18-24 months, simple puzzles are of interest. By 24-30 months, more complex fits dominate. Children are now interested in the many ways parts can be related, and the simplest construction toys are appreciated. The ways in which parts fit together is far more interesting than what the constructed objects look like, or what they can do.

Experience now becomes even more dependent on the characteristics of object systems available for exploration. These object systems must be thoughtfully designed if they are to support a rapidly growing repertoire of cognitive behaviors.

Some have feared that toys might displace people in the affection of children. There is little to fear, at least for the very young, for toys don't have much interest for children who are deprived of nourishing and trustworthy social relationships. As for children who experience the comfort and encouragement that such relationships provide, toys become potent vehicles for enlarging their social, communicative, and cognitive capabilities (Chase, Fisher and Rubin 1984; Fagen 1982; Kaban 1979; Miller-Schwarze 1978; Oppenheim 1987; Smith 1984; Sutton-Smith 1986, Uzgiris 1977; White 1990; Figure 8).

Figure 8. Once an object has become familiar to an infant through independent exploration, it can become a focus for social play. This infant is enjoying a game of "tug-of war" with a member of our research team.



Summary and Conclusions

Nineteenth and twentieth century thought about toys and play show increasing respect for the contributions they make to children's development. And behavioral research has confirmed that children spend most of their waking time exploring objects in the early years of life. This is also the time of most rapid brain growth, and theories of brain development suggest that the structure of early experience influences brain development, including the shaping of functional neuronal circuits.

A picture begins to emerge from these facts. Exploration and play with objects in the earliest years of life can now be seen as a possible foundation for the growth of intellectual skills, like classification, that are necessary for all later cognitive development, much the way that early exposure to language provides the essential foundation for the growth of communicative skills. These possibilities recommend a more serious approach toward the design, selection, and use of toys.

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