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ABSTRACT

In four parts, this discussion describes characteristics of the thought of infants, preschool children, primary school students, and adolescents. Topics briefly addressed in part I, on the thought processes/capabilities of babies, concern sensorimotor thought without abstraction, the importance of physical exploration, the development of intentionality, learning about cause and effect and properties of objects, and the development of symbolic thought. Table 1 describes motor development in the first 3 years, and Table 2 delineates six stages in the development of object permanence. Discussion of the development of preschool children in part II focuses on combining and transferring information; reversing observations; egocentricity; animism and artificialism; intuition and sequential associations; cause and effect; classification; and applications (specifically concerning preschoolers' drawings, dreams, and concepts of death, as well as professional practice, preoperational thought in adults, and the transitional years). Table 3 illustrates conservation of liquid, number, matter, length, area, and volume. The development of the primary school student is described in part III in terms of the extension of conservation, seriation, classification, concepts of number and time, concrete thinking, verbal problems, hypothetical problems, proportions, combinatorial logic, and applications to primary school children's social concepts. Educational implications are also discussed. In part IV, adolescents are discussed with reference to the egocentric idealistic crisis; combinatorial logic; hypothetical deductive thinking; impression formation; use of symbols for symbols; and, very briefly, thought beyond formal thought. (RH)

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# Selected Papers

**Number 30**

## Unit for Child Studies

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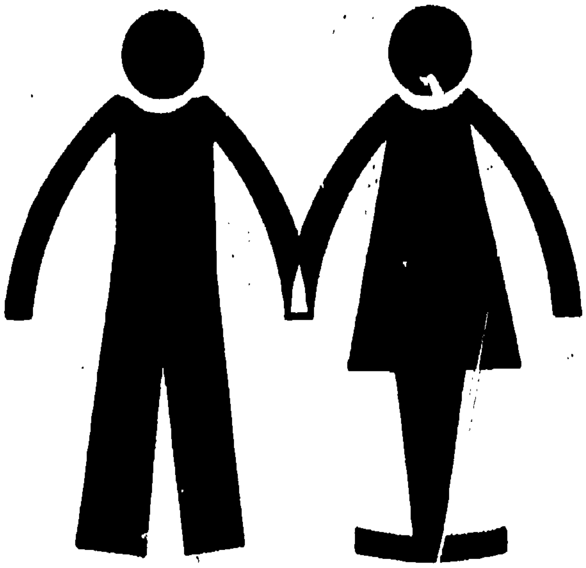

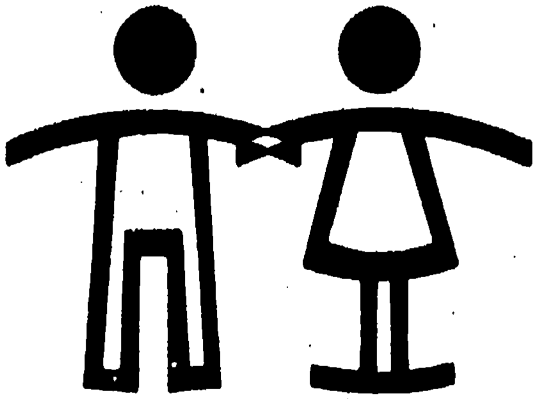

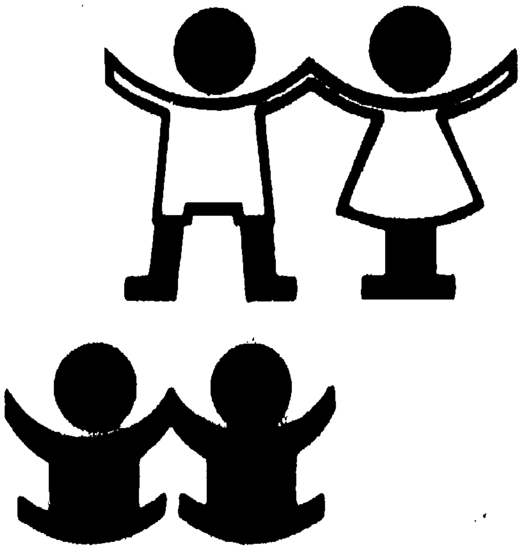

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**HOW CHILDREN THINK**

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# HOW CHILDREN THINK

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## INTRODUCTION

In many ways children think and perceive differently from adults. Their reasoning is frequently different. They have not yet had their minds channelled into the conventions of adult logic. But let us not underestimate children for they are working hard at making sense of their experiences. Too often children are used as extensions of the perspective and needs of adults. Most often adults design school curricula, administer drugs and medical treatment to children, design toys, run children's homes and generally exert power over children in family and society on the basis of what adults think children enjoy and need. Many well-meaning educational, medical, social welfare and family procedures with children exhibit ignorance and an unrecognised lack of empathy with how children think. Their task in interaction with children would be a great deal more rewarding if this were not the case.

The object of this paper is to delineate some of the differences between adult and childish thought and to underline that thought is constructed by the infant, preschooler child and adolescent out of his/her perceptions, actions, organising activities with objects, and interactions with others. I shall begin with the question How do babies think? and then move on to pre-schoolers, school-age children and adolescents. In each stage of development children undergo considerable changes in how they think and view the world.

## *DO BABIES THINK? HOW DO BABIES THINK?* *PART I*

As this topic has been discussed at length in a Unit for Child Studies paper (Phillips, 1982b), the main points will be summarised but briefly. Unfortunately, in our society, there is an assumption that everything begins at birth, so there is no substantial research on whether/how babies think before birth.

As a result of data collected by means of improved techniques in monitoring physiological changes, observing eye movements and a greater appreciation of the need to give babies optimal conditions before assessing them, notions about babies as learners and thinkers after birth have been considerably revised. Contrary to insufficiently tested beliefs and folklore that babies are passive, vacuous and disorganised, recent research indicates that babies are active learners and problem-solvers from the moment of birth.

### *Sensory Motor Thought Without Abstraction*

However, this cannot be defined in terms of adult logic and deduction. Present evidence suggests that if one could imagine oneself without abstract and logical thought processes in the head and thinking entirely by means of the senses of sight, touch, and smell, motor movements and physiological reaction such as fear, pain and pleasure, one might begin to comprehend how babies think. Another problem unfortunately, is that adults often egocentrically tend to believe that, unless someone can talk in the same way as they themselves do, and in the same language, then they lack any thinking processes whatever. Babies lack the talking output, and unless they are encouraged to communicate otherwise (Waterhouse, 1981) their output is often limited to incomprehensible crying.

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The observant adult, however, will see that their *intake* is considerable. All the time the baby is being pricked, watched or ignored, he/she is making observations. At first the newborn is nearsighted and spends about 5-10% of his/her time scanning anything in sight. By 2½ months this has increased to 35% of the time. This visual exploration stimulates the visual cortex and is, in part, the basis of thought. Lying flat in a pram with nothing but the mosquito net to look at can bore babies sufficiently to make them cry and this can occur frequently. Babies actively seek to practice things which promote physical and mental growth and need to see everyday things around them. Simple things such as lying under a tree where they can see the leaves moving in the wind, contributes to the bases of sensory thought.

At first, one can see babies closely watching areas of contrast such as the face and hairline, or chin and clothing boundaries, of persons attending to them. After a few weeks, focusing has developed sufficiently for them to concentrate on the eyes (Craig, 1979).

As early as 1½ months infants show a preference for looking at curved shapes. By two months they prefer to look at three dimensional figures rather than two dimensional ones. Infants also see colours by 2-4 months and by four months their colour vision is similar to that of adults (Haith & Campos, 1977).

These are but brief snippets of the marvellous perceptual learning process that babies undergo in the early months. It is believed that in these early weeks the baby's intelligence is centred largely on its perceptions. However, physical activity soon begins to play a part.

*The Importance of Physical Exploration*

Thought and understanding also grow out of physical activity and exploration. This depends greatly on the stage of motor development.

Table 1 gives a rough indication of some developments in motor activities which enable the child to explore objects with greater dexterity. For example, once babies can lift their heads at about three months, they can obviously see and learn much more. At first they are largely interested in learning about their bodies. For example, when a baby at 3-4 months accidentally waves his/her hand before his/her eyes, he/she spends time studying it (Church, 1966). At this time they may also discover their feet, althought, if these are heavily bundled (Stone et al., 1973), it might not be until about six months of age.

After four or five months of age babies show pleasure in handling and exploring objects because motor development and perceptual development are now sufficiently co-ordinated for them to be able to reach out for objects. If infants are given very little to look at, grasp, or reach for, and if their hands are tucked under a blanket or into sleeves, then their visually guided reach will occur later than if they had been permitted more opportunity to move their limbs and see everyday things (Fein, 1978).

The visually guided reach enables exploration of the shape, contour and surface of objects with hands and fingers, which gives the infants, after many repetitions, a "motor" record of the object. This registers sense patterns in the cortex and is basic to the development of thought.

By nine months infants' motor development has advanced sufficiently for them to bring objects to their mouths and explore them with their lips and tongues. The environment should be made safe so that babies can add to their sensory-motor concepts through this new avenue. Punishing the infant who has not yet grasped the dangers of indiscriminate sucking may eventually inhibit him/her and

*TABLE 1*

*MOTOR DEVELOPMENT IN THE FIRST 3 YEARS*

During the first 3 years of life, babies' primitive sensorimotor systems become elaborated and co-ordinated. Both the gross (large) motor system, which governs movement of the head, torso, legs, and arms, and the fine (manual) motor system, which governs the smaller movements of eyes, hands, and fingers, come to be under the infant's own control. This motor development enables advances in cognitive development.

1 MONTH

At 1 month of age, babies cannot yet hold up their heads. They turn their heads if their cheeks are touched, can follow a horizontal movement of a ball, and can grasp a finger placed in their hands.

3 MONTHS

At about 3 months of age, babies large motor systems have developed so that they can hold up their heads when they are lifted to a sitting position and can lift their heads and upper chests when placed in a prone position. Their eyes can follow the vertical movement of a ball, and they can look at their own hands and clasp and unclasp them. At this point, babies may bring an object grasped in their hands to their mouths, but they cannot yet co-ordinatre the movement of eyes and hands.

6 MONTHS

By the time they are 6 months old, babies have achieved a greater degree of gross muscle control. They can sit straight when they are supported and can kick strongly and grasp their own legs. Their fine motor systems have matured to the point where they can grasp objects with both hands, move them to their mouths, and suck on them.

9 MONTHS

At 9 months, babies can sit by themselves, pull themselves to a standing position, and begin to crawl. They can hold small objects and strings between thumb and forefinger (although they cannot yet deliberately release them).

12 MONTHS

At 1 year, babies can crawl, and some can walk by themselves. They can put pegs in a pegboard and manipulate toys in a variety of ways without immediately putting them in their mouths; they can use everyday objects such as combs, for their appropriate purposes; they also are learning to retrieve hidden objects.

18 MONTHS

By around 18 months, babies learn to walk up and down stairs with help, to push and pull wheeled toys, to walk while carrying a toy, to build towers with blocks, and to enjoy looking at picture books when the pages are turned for them.

*Table continues over*

*Table 1 continued*

2 - 3 YEARS

At 2 years, babies hold pencils and scribble, turn the pages of a book one by one, build tall towers with blocks, and drink while standing up. By the age of 3, they can walk up and down stairs while carrying a large toy.

Some of these developments may seem quite simple, but for a child, learning to drink wh[illegible]g up or to go up and down stairs while carrying a toy involves [illegible] the large and fine motor systems. A child just learning to r[illegible] r to walk has to concentrate completely on that one activi[illegible]egins to be automatic. For instance, a simple activity such as pi[illegible] bottle and bringing it to the mouth - an activity that babies have ample time to practice, requires the coordination of three separate acts: looking, grasping, and sucking. Eye, hand, arm, and mouth have to work together before a baby can actually pick up the bottle and bring it to the mouth. Most other activities such as building with blocks, involve the same sort of combination and integration of simple acts into complex behaviours.

REFERENCE:

Fein, G.C. *Child Development.* Englewood Cliffs, NJ: Prentice Hall, 1978.

N.B. These ages are very rough indications only. Babies vary enormously.

make him/her anxious about exploration and learning.

Infants at this stage do not yet understand the adult functions of objects but turn them round, pound them and throw them. In this way they discover their physical properties. The problem is, adults often project their own intentions into infants and see the pounding and throwing behaviour as destructive and rejecting rather than exploratory. An infant discovering that the eyes can be pulled off a teddy bear is gaining valuable information. If adults cannot stand it they will need to compromise realistically between the infant's need to explore and their own inclinations when they choose a toy.

Being able to stand at nine months enables the infant to see the coffee table from the top as well as the bottom and his/her motor-perceptual concept of it becomes more accurate. The development of the fine pincer movement between thumb and forefinger means he/she can now explore small objects such as grass, dead insects and cigarette butts. Obviously, the infant does not yet understand hygiene and again it is the caretaker's task to provide a safe enough environment for the infant to increase his/her sensory motor conceptual repertoire rather than to learn that his/her curiosity arouses anger. Learning to walk gives much more scope for registering motor and perceptual information about objects as one can pursue a ball or learn about pushing, pulling, opening and shutting gates and so on. In this way motor-perceptual concepts are extended.

Between 12 and 26 months the child becomes interested in putting things in rows, and in towers, and exploring many similar organisational possibilities with objects. This is the beginning of the motor record of bringing things together and placing them apart whi[illegible] the basis for the later symbolic understanding of adding and subtr[illegible] of words such as "and" or "separate".

Thus, infant intelligence is of a sensory motor nature and is involved with learning about having hands, legs, fingers and toes, the shape and texture of objects and, eventually, about how they may be organised. The sensory motor concepts of the infant have not yet evolved into substantial thought, the abstractions of conventional logic and the psychological manipulations of adulthood.

In fact, it would seem that babies have to learn to intend or plan. Thus, the parent of a two-day-old or a two-month-old who argues that his/her infant is trying to be boss has a problem and needs help in understanding his/her own anxiety and the nature of adult projections. If a young baby cries, it is because it is uncomfortable, hungry, over-fed, over-tired, bored, or having difficulty in adjusting to the necessity of breathing and keeping his/her temperature stable. Cuddling or wrapping firmly or swaddling often helps to diminish bodily discomfort in babies in their early adjustment to life outside the womb.

*The Accident of Intention*

Similarly, intention has to be learnt and in infants appears to develop through a series of accidental and random activities. The infant accidentally waves his/her hands in front of his/her eyes, or accidentally places his/her fingers in his/her mouth, or makes a noise with a rattle. Having done it once accidentally, the infant's curiosity may be aroused and he/she endeavours to repeat the event but it takes practice to perfect the process. So intention is practised through the increasing accumulation of such interactions with bodily parts and physical objects. Psychological intention and manipulation begins much later and is not well established until adolescence (Phillips, 1983a, 1983c).

*The Proliferation of Objects*

As indicated, the early learning of infants is devoted to exploring the texture, shape and appearance of objects. At first, for the infant, the world probably appears to contain an undue proliferation of objects (Bower, 1971). The same feeding bottle, rattle, or spoon, looks like a different object from other angles. Infants have to learn that objects remain the same despite the change in angle. It is also believed that they have to learn that objects still exist even though hidden from sight (Piaget, 1951). The first indication that this is beginning to be understood is between four to eight months. When an object falls from their crib babies may, by then, lean over and look for it rather than simply stare at the point from which it disappeared.

Around 8-12 months babies will search for an object when they see it hidden under a pillow and love simple hiding and finding games, including hiding themselves by putting a blanket over their heads or closing their eyes. However, they do not seem to separate place and object for when an object is moved from place to place they tend to look for the object where it was first hidden. Around eighteen months children will search in all hiding places which suggests that they can visualise the object in their mind and have a concept of it as a permanently and independently existing thing (Fein, 1978). Table 2 gives the stages in the development of object permanence.

*Cause and Effect*

Infants also have to learn about cause and effect. For example, upon hearing a rattle in an adult's hand, younger babies may wave their own hands about, perhaps as though these movements can occasion the noise. Between 4-8 months babies become very interested in exploring objects and discovering movements that cause rattles to rattle or objects fall to the floor. They like to practice these movements often, to the exasperation of adults. Between 12-18 months trial and error behaviour with objects is widespread; babies are experimenting with latches, opening cabinets, fitting objects in holes, throwing toys, pushing them under water, and extending their understanding of the relationships between cause and effect.

Time is an important factor in the infant's understanding of simple causal relationships. While physical distance between objects which are related in a cause/effect sequence does not appear to bother them, long delay in time does. At eighteen months they know that a switch turns on a light somewhere else and pulling or pressing a button here rings a bell or flushes a toilet there because these spatially separated events are very closely linked in time.

In summary, in infancy, intelligence is based on sensory, perceptual and motor activities and babies need ample opportunity to promote its development through sucking, feeling, touching, pulling, throwing, and pounding objects, in a safe environment. Quick diversion or play, rather than smacking, is the more productive way at this stage of keeping infants away from objects that may be injurious. Punishment may teach them *not* to be intelligent and interested, or to equate self-enquiry with anger. Negative responses to children's activity may may thus lead to problems with learning and discipline.

*The Development of Symbolic Thought*

A difficult question to answer is When do babies appear to turn this sensory-motor thought into a form which can represent objects in a symbolic fashion in the mind? Hypothetical answers involve physiological notions of the following kind. When adults and older children attend to something that interests them their heart rates decrease, just as do those of infants. But, when adults and

*TABLE 2*

*THE DEVELOPMENT OF OBJECT PERMANENCE*

STAGE 1 - 2
Piaget has carefully observed the development of object permanence during the first 3 years of life. Before the age of 4 months (Stages 1 and 2 of object permanence), the infant behaves as if an object that is "out of sight is also out of mind".

STAGE 3
Children in Stage 3 (4 to 8 months) begin to show that they can maintain contact with absent objects. When an object falls to the floor, they will lean over to look for it rather than simply stare at the point from which it disappeared. In addition, they can anticipate that a whole object exists when they have seen just a part of it. If a large enough part of an object shows from behind a screen, they will reach for it. But if the visible part is made smaller, the infant's reaching hand will stop abruptly. At this stage, children make no attempt to recover objects that have disappeared from view behind an obstruction such as a cloth or cup, even though they are physically capable of doing so.

STAGE 4
Stage 4 children (8 to 12 months) show substantial progress in the development of the concept of object permanence. If an object is covered by a cloth or a cup or if it is moved behind a screen, the child will search for it. However, the child's object concept is still limited to looking for an object where it was first hidden. Suppose the object is hidden behind one screen (A) and the child repeatedly finds it there. Now, if in full view of the child, the object is hidden behind a different screen (B), the child will continue to search where it was first hidden (A), although he or she WATCHED it being hidden somewhere else. Infant's behaviour at this stage shows that they realize that objects continue to exist when hidden. However, such knowledge appears to be accompanied by the belief that objects are located at some PARTICULAR point in space (behind screen A, for exmaple). There is as yet no realization that objects continue to exist if moved from place to place.

STAGE 5
During Stage 5 (12 to 18 months), children become able to disassociate the object from the place where they are accustomed to finding it. They will search for the object where it was last seen, no matter where it was previously hidden. But suppose a small object, hidden from sight by the adult's hand, is moved from one hiding place to another. Children will search for the object in the place where they saw it last. At this stage, children do not yet reason that the object must have been moved to another place while it was covered by the adult's hand.

STAGE 6
During Stage 6 (beginning at 18 months), children acquire a full-fledged concept of object permanence. If a small object is hidden in an adult's hand and then placed in one hiding place after another, children will search in all of the hiding places and even in the adult's hand until they find the object.

NOTE: These ages are rough indications only. Babies vary enormously.

REFERENCE:

Fein, G.C. *Child Development*. Englewood Cliffs, NJ: Prentice Hall, 1978.

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children are actively thinking, whether memorising or making calculations, their heart rates increase (Fein, 1978). Studies show that one-year-old infants who watch a toy car rolling down an incline and knocking over a plastic object begin to anticipate the car's motion and look toward the object. As they do so, their heart rates increase. Thus, if an increase in heart rate in infants indicates an increased rate of mental activity (as it seems to in the case with older children and adults), then this kind of research suggests that infants begin to represent things symbolically at about one year of age (Fein, 1978).

This symbolic thought is not yet abstract thought. The processes of logic have yet to be learnt. Symbolic thought is representational and perhaps rather like simplified picture records of objects and events. Deduction, induction and psychological complexities are not part of it. Further, researchers believe that symbolic thought in infants is concerned primarily with objects and physical action (Piaget & Inhelder, 1967); Fein, 1978; Craig, 1979).

By twelve to eighteen months infants begin to be able to imitate actions they have never performed before, such as an adult touching the tip of his/her tongue with his/her forefinger (Fein, 1978). This kind of imitation is not mechanical behaviour. The infant has to recognise a correspondence between the thing being imitated and the part of themselves capable of performing the imitation. This involves relating one event in space to another. This relationship of "one thing above another", "one thing below another", or "one thing beside another" can be put together and taken apart in the mind. By eighteen to twenty-four months these kinds of capacities and memories have advanced to the stage where a toddler can imitate a model when the model is no longer present.

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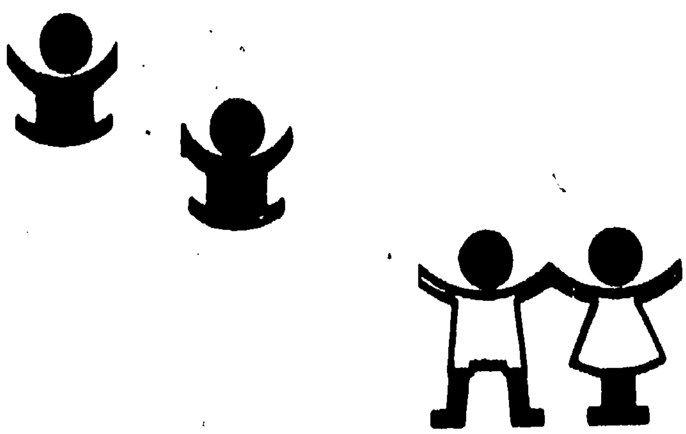


The acquisition of the symbolic function qualitatively alters how children think. They can now represent things internally rather than in sensory-motor signs. Symbolic thought is also linked with and enhanced by the acquisition of language. Once a child can represent something in words rather than by pointing, carrying and similar activities, then communication with others and, therefore, learning, is speeded up considerably. With words the young child is now able to represent things that are not immediately present and also the past and the future.

Many years ago Jean Piaget (1951) described the pre-schooler's thought as *pre-operational* and his ideas, with modifications, have influenced researchers considerably. I have also found his theory very useful but have revamped it somewhat in the light of my own work and the following practically-oriented description is a mixture of that, Piaget's work and that of a number of others such as Margaret Donaldson (1978).

First, what did Piaget mean by "operational" and "pre-operational" thought? He saw operations as systems of cognitive acts or an organised network of related acts represented in thought. Examples include logical operations such as adding or subtracting and "infra" logical operations involving time, space, and quantity (Fein, 1978, p 234). The pre-operational child has not yet knitted his/her symbolic representations into the systems of higher thought processes.

Piaget believed the abstractions of higher thought processes may be broken down into actions and relationships between them (1951). For example, any mathematical expression such as X + Y is based on the actions of bringing things together, X - Y on separating them, while the word "and" would not be comprehended if, somewhere in one's past as a child one had not repeatedly played at putting things together. Thus, in order to construct such cognitive operations pre-schoolers need plenty of exploratory play with objects and space to build and arrange. Kephart (Craig, 1979, p 299) has applied Piagetian notions to the development of children's reading and writing. For example, to be able to distinguish "m" and "w" or "p" and "b" one needs to have had lots of active experience with "up and down" and "right and left" as a very young child. Where there are problems, the child or adult may be helped by actively practising actions which represent missing symbolic functions. These physical activities also enhance memory. Children remember words and rules best by enacting them (Phillips, 1983b).

Thus, whereas the infant is largely involved in exploring objects with his/her fingers and other sensory-motor activities to discover the "roundness" of a ball, or the "squareness" of a box, the pre-schooler is extending this sensory-motor information into an understanding that objects may be represented in words and that both may be organised in various ways by classification and simple sentences. However, it is suggested that the mental operations of the pre-schooler are not yet integrated into the kinds of networks that characterise higher thought processes and for this reason they think differently from adults. What are these differences?

*Combining and Transferring Information*

An example of the difference between the thinking of the pre-schooler and that of an older child or an adult is that the latter is able to combine classes of objects and express them in a unifying relationship: all boys and all girls = all children. An adult can also combine any two relationships such as A > B and B > C into one relationship that combines them both: A > C (transitivity).

Similarly, if it is demonstrated that brass bar (A) weighs the same as brass bar (B) and (B) weighs the same as lead ball (C), older children and adults generally conclude that it follows that (A) and (C) are the same weight. Preschool children on the other hand rely on the logic of their perceptions and the cognitive operations that can invoke A = B and B = C are not yet organised into a cognitive system that can integrate both into the conclusion that A also equals C. Thus they do not make such transfers.

A domestic example concerns Andrew aged 5½ years. Andrew watched his parents weighing separately on the kitchen scales two bananas and an orange. He saw the first banana (A) balanced on the scales by the second banana (B) and agreed that they weighed the same. He then saw the orange (C) balanced by the banana (A) and agreed that they weighed the same (A = C), but when asked (without weighing them) about the orange and the second banana (B and C) he asserted that they would not weigh the same because they "look different". He did not transfer the ordering of relationships.

Nor do young children always transfer simple observations from one set of circumstances to another. Andrew, when much younger, although thoroughly used to a wading pool in the local park, did not understand that the sea at the beach was also water. "What's that?" he kept asking when they first arrived. Even when he tried it with his toes he argued that it wasn't water because it "runs after me!". Thus young children have difficulty in transferring information and rules, which apply in one situation to another. The instruction that one does not touch things in a particular shop does not mean the child automatically transfers the instruction to another shop without repeated practice. Further, it is very confusing since parents touch and pick up goods in supermarkets, and in other situations children are encouraged to imitate their parents.

Thus, the number of rules taught should be explained carefully and restricted according to the young child's memory capacity. A three-year-old, for example, can not cope effectively with more than three or four simple rules, and these are best learnt through the child and adult doing and saying them together repeatedly in various and changing circumstances. This established the motoric record that becomes the concept.

*Reversing Observations*

Another organised network of cognitive acts typical of higher thought processes, as distinct from symbolic thinking, enables reversibility or the ability to return to the starting point when thinking something out. Thought processes are reversible and permit an understanding that quantities remain the same or are *"conserved"* whatever the change in their shape. For example, liquid poured from a standard tumbler into a taller thinner glass is seen as remaining the same quantity because there are compensations in width and height. Adults and older children are capable of reversing the processes involved and understanding this. They understand two logical operations *(1) identity* (nothing is added or subtracted) and *(2) reversibility* (the liquid can be returned to its original state by reversing the state-changing process) (Stassen Berger, 1980).

However, *conservation*, or the idea that the amount remains the same when the shape changes is not at all obvious to young children. Rather they tend to pay attention solely to the height of the container and say the taller glass contains more. This is why they tend to complain vociferously if everyone's drink is not in identically-shaped glasses. Similarly, in a make-believe game with clay, if the young child rolls a ball of it into a long sausage he/she is likely to argue that there is now more clay. The child interprets the taller glass or the longer piece of clay as more because he/she assimilates his/her perceptions into the scheme "taller and longer" are "bigger" without accommodating other apparent facts, such as "narroweris less". Pre-schoolers have trouble with the conservation of liquids, number, matter, length and area, and primary children with volume. These are depicted in Table 3.

Apart from the illustration in Table 3, another well-known example of the pre-schoolers inability to conserve time is observed when such children recognise that they were born after an older sibling, but that does not preclude the possibility that they might not catch up or soon overtake the older sibling or parent (Piaget & Inhelder, 1967).

Many of these examples show a characteristic of preoperational thought which is *centration* (Piaget & Inhelder, 1967), or the centering of attention on one feature of a situation to the exclusion of all others. This tendency is common in many areas. For example, pre-schoolers tend to centre exclusively on *their* relationship with the family; Anne aged 3, for example, would not accept that her mother was also a daughter and became very argumentative when she heard her maternal grandmother call her mother "daughter" because, to Anne, a daughter is a little girl, like her, not a grown woman and "Grandma is too old to be a mother".

*Egocentricity*

This centration on their own perceptions and relationships as applicable to all has been described as *egocentricity* (Piaget & Inhelder, 1967; Elkind, 1978). It is the tendency not to reverse social relationships and not to see the reciprocal perspective of another (reciprocity) and does not mean that the child is selfish. Rather it means that pre-schoolers often believe that everyone reacts to the world or perceives events as they do. Thus Anne, upon hearing her mother cry after the divorce of her parents, offers her mother her favourite teddy bear as a comforter. She is unselfishly willing to give up something she loves to help, but she assumes that mothers are comforted by the same things as small girls.

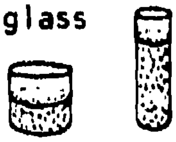
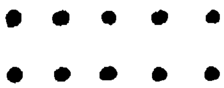
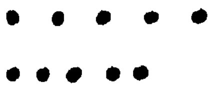
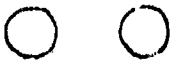
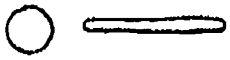
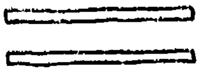
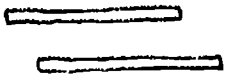
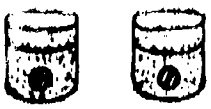
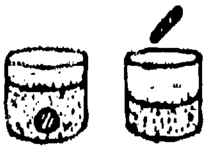
Pre-schoolers define sadness in parents in terms of their own distress. Anne blames herself for the divorce. She thinks it is because she was naughty because, from her point of view, she is the pivot of the family. Through their egocentricity young children may suffer considerably and be misunderstood by adults during and after the death, divorce or illness of a parent or relation. Jeremey, aged 4, thought he had killed his father because he had disobeyed him: Felicia, aged 5, when told that her parents were divorcing because they did not love one another anymore worried that her parents would fall out of love with her and abandon her. This reaction is not unusual.

However, it cannot be assumed that children are exclusively egocentric. The fallacy of this conclusion has been demonstrated by Margaret Donaldson (1978). It depends on the child's experience. In Piaget's experiments children were asked to describe their view of some mountains and a toy landscape from various angles, and then asked what an adult, presently positioned differently from themselves, would see. The children were apt to assume that everyone saw just what they saw (Piaget & Inhelder, 1967).

However, Borke (1975) asked 4-year-olds to describe what the Sesame Street character Grover would see of some farm animals and a house by a lake with a sailboat from different positions. They got it right because they had so often enjoyed and absorbed Grover's experiences as similar to their own. Similarly, they accommodate themselves to the limitations of toy animals or will "baby" talk to a younger child. However, where their experience is limited, children believe everyone sees and feels as they do. It is through extensive play with

*TABLE 3*

*CONSERVATION*

| | Child states | Adult | Adult asks | Preconceptual children usually answer: |
|---|---|---|---|---|
| Conservation of Liquid | two glasses of lemonade are equal  | pours one into a taller thinner glass  | which glass contains more? | the taller one |
| Conservation of Number | rows of coins are equal  | reduces spaces in one row  | which row has more coins? | the longer one |
| Conservation of Matter | balls of clay are equal  | stretches one ball into a long shape  | which piece has more clay? | the long one |
| Conservation of Length | sticks are of equal length  | moves one stick  | which stick is longer? | the one that sticks out this way |
| Conservation of Area | the toy cows have the same amount of grass to eat  | moves toy barns together in one field  | which cow has more to eat? | the one where the barns are not together |
| Conservation of Volume | the glasses of water contain two equal balls of clay  | changes the shape of one ball  | which piece of clay displaces more water? | the long one |

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other children, and interaction in games, that children become practised in taking other points of view and less egocentric.

*Animism and artificialism*

There is another aspect of egocentricity in children which may, in some cases, be a result of teaching. This is animism and is seen in the way preschoolers egocentrically represent the action of physical events and objects by means of their own activity. Thus, the rain, winds, clouds, stars, and all things are characterised as making the same movements (running, hurrying, blowing) and affects (crying, being sad) as they do. Preschoolers also tend to assume every thing in the world is alive as they are. They attribute the psychic to the physical. For example, if they drop a stuffed toy animal they might cry because they think they have hurt it.

Similarly, many children assume that because they make things out of clay, blocks, sand, or kitchen utensils or their parents buy things, that everything in the world is made or obtained in the same way. An example of this *artificialism* is seen in 3 and 4 year old beliefs that babies come ready made and that parents buy them in a store or hospital. The mother of one 3-year-old decided to answer his questioning fully and explained the entire process of intercourse, conception, prenatal development and birth. When she finished he said "That's the silliest story I ever heard!" (Stassen Berger, 1980, p 309), presumably because it did not fit the artificialism of his reasoning.

Older pre-school children may think the baby is manufactured, perhaps out of blood and bones from the butcher and put together by the mother in her tummy or that she ate a chicken or a fish and turned it into a baby. The reasoning of the child should be respected. It is an ingenious combination of fact (the baby is inside the mother) and the assimilation and accommodation of this fact to their own schemes as to how things are made.

Children's description of natural phenomena also often shows artificialism. Mary, aged 4, explained that the grass had grown by the river so that she would not hurt herself when she fell. To the pre-schooler, the stars are made to warm us and give us light, mountains to climb on, and lakes to sail on. The child does not think that anything occurs by chance. As Stassen Berger (1980, p 310) points out "Both artificialism and animism seem amusing to older children and parents, who prefer scientific explanations of natural phenomena. However, pre-school ideas probably make sense if one does not know or believe in the rules and findings of science. Indeed, the pre-operational child's concepts are very similar to those of legends, myths and early religions and philosphy."

*Intuition and association*

Another cognitive system of higher thought processes is that which permits sequential associations. Most older children and adults know that the same point can be reached by different paths, or that adding 2 + 3 + 4 + 5 achieves the same result as adding 5 + 4 + 3 + 2. However, very young children, between 2 and 4 years of age, rely heavily on intuition and have not formed the network of logical operations that lead to the above conclusions. For example, if three coloured balls, white (A), black (B), and red (C), are rolled through a cardboard tube or behind a screen, the child is able to predict that they will emerge at the other end in the same order. However, when asked to predict the order in which the balls will emerge if the tube is turned through 180 degrees with the balls inside, the child will not do so and may resort to intuitive predictions such as: "Since the white one (A) as the leader this time and the red one (C was the time before that, then the black one (B) must have a turn as leader and come out first". The child has not yet knit isolated cognitive operations into a comprehensive cognitive system which recognises that if B is between A and C it must also be between C and A.

For the same reason a second grader does not appear to appreciate that in order to relate a story to a friend he/she must remember what it was that caused the main character's action, what the character did, and what the results of the action were, in sequence. Second graders appear to choose at random and without sequence what they regard as critical elements in their stories (Stassen Berger, 1980).

*Cause and effect*

A consequence of this *prelogical* thinking is the tendency of very young children to concentrate upon one aspect of an event rather than on the relationship between events. Thus, they do not always think in terms of cause and effect, nor do they understand the nature of chance or accident. A child who falls over may blame another child several feet away. Pre-school children sometimes interpret the phrase "it was an accident" to mean "don't blame me". Thus, a child may hit her brother and protest "it was an accident" (Stassen Berger, 1980, p 308). Assertions of this kind cannot always be interpreted as lying. It also demonstrates, as does most of the material in this section, why it is futile arguing with pre-schoolers. They do not "reason" as adults do. Children learn through physical activities with objects and play with others. As indicated previously, motoric factors are particularly important and preferable in establishing meaning and remembering in young children (Saltz & Dixon, 1982; Phillips, 1983b). Pretend play and doing the activities involved in instructions are more effective than purely verbal instructions or hitting. The evidence is that children learn better by doing and find it hard to learn from the "don't" type instructions typical of our culture (Phillips, 1983b).

In summary, for the pre-schooler, explanations are found in connections which constantly contradict one another and as things appear to be rather than in the logical necessity and general laws of cause and effect. For example, a child will argue that small boats float because they are light and that large boats float because they are heavy and carry themselves. This is *transductive* reasoning (Piaget, 1957).

*Classification*

Piaget described the thought of the child in the early pre-operational stage as *pre-conceptual*. Pre-concepts are the notions which the child attaches to the first verbal signs he/she learns to use. The child aged 2-3 years will be just as likely to say "slug" as "slugs" and "the moon" as "the moons", without deciding whether the slugs encountered in the course of a single walk or the discs seen at different times in the sky are one individual, or a single slug or moon, or a class of distinct individuals (Piaget & Inhelder, 1969, p 27).

This is because pre-schoolers do not always link into one cognitive network the concepts of "one", "all" and "some", or their perceptions of the part and the whole of a class or group. For example, when the child of 3 or 4 years is required to classify counters or tokens of different forms, colours, and sizes - to put together those which are alike - he/she tends to put them together one after another, on the basis of their resemblance and spatial proximity. He/she seems to have no immediate recognition of objects which are alike, say in form or colour or size. Similar objects are placed next to each other in either linear or two-dimensional arrangements. These resemblance relationships, however, are still extremely unstable. At the earliest level of classification procedure, the child loses sight of his/her criterion - the one with which he/she began - and ends up instead, with a complex kind of "object"; he/she might call it a "train" or a "house" (Piaget, 1951, p 138).

However, the degree of conventional classifications depends on distinguishing features salient to the child. For example, a child is shown seven toy dogs. It is established that he/she knows each breed well and that there are four collies, three poodles, an Irish Setter and a German Shepherd (Stassen Berger, 1980, p 306). He/she agrees readily that there are seven dogs and "they are all dogs". However, when asked are there more collies or more dogs most children say "more collies" presumably because this is the most salient group for them and they don't have the network which shifts from the subcategory "some" (collies) to the general category "all" (dogs).

Where the contrast between the whole and the part is made clear by the use of an adjective that has meaning for the child, results indicate the child can classify. For example, the toy dogs were placed on their sides and the child was told they were all sleeping, so that there is some meaningful emphasis for the child on the whole class and the child is then asked: "Are there more collie dogs or more sleeping dogs?", the ability to classify is more likely to be exhibited (Donaldson, 1978). This also explains why pre-schooler's have trouble with adult rules and explanations and why they need to be enacted and repeated in every changed circumstance and underlined in some way that is relevant to the child.

Unfortunately, the child's capacities to classify objects is often evaluated in terms of what adults would do with the same materials. This judgement ignores the possibility that children might classify according to other principles. For example, suppose a very young child is shown these six shapes:

While adults tend to prefer class functions based on the geometric figures or Euclidean grouping thus:

young children prefer classifications based on the properties of the forms or a topological grouping thus:

*Some Applications*

*Pre-schooler's drawings*

The originality of children when they are free to express themselves is rarely equalled after the age of 7 (Fein, 1978). These findings (Moran et al, 1983) may attest to the effect of socialisation and schooling which makes children and adolescents, who spend large amounts of time in formal school settings, more cautious about expressing unusual ideas. The originality applies to uses of things, interpretations and drawings. Here I can only say something of developmental trends. The child's earliest drawings are "scribble pictures" in which the child seems to be more concerned with the activity of drawing rather than with the results or the correspondence with reality (Golomb, 1974). They are pre-operational.

A little later the drawings are still pre-representational but the children begin to show pride in the results and "explain" the picture. "It's a dog. He's got his mouth open. He's barking."

By about 3 years of age children begin to see the representational possibilities of art. They draw things and people although these may be implied rather than explicit. Typically, their drawings of persons frequently possess a global head and some rudimentary facial features.

At 4 years the tadpole drawing appears. The primitive global figure is replaced by a circle with two vertical lines extending down from it. The figure is incomplete. During the remainder of the pre-operational period, the figure gradually becomes more differentiated and more complete in the conventional sense.

Thus children's spontaneous drawings show a developmental sequence which progresses toward adult conventions of how the object should be symbolised. With help they can draw very sophisticated features so they do appear to know what the human body looks like.

*Dreams*

Here again there is a sequence of stages. At first the child's judgement is governed by the appearance of things. Just as there appears to be more water in a taller glass, a dream to a child appears to come from outside and take place in the child's room (Piaget, 1951). Later, he/she vacillates between an "internal" and an "external" explanation and guesses that the source of dreams is in the head but that they are made externally, perhaps in the bed or from air, just as children in the middle stage of the development of conservation may say at one time that a taller glass contains more water and another time that a wider glass contains more. Finally, the child comes to see dreams as internal, both in origin and in the experience of them; this recognition is parallel to the stage at which the child acquires the concept of conservation.

*The child's concept of death*

Our society treats death as unmentionable, so engendering the furtive excitement produced by the pornography of death, the horror comic, and the sick joke rather than fostering realistic understanding (Stassen Berger, 1980, p 402). Children are often denied the opportunity to have all their questions about death answered, for the denial of death by adults has resulted in a cruel fallacy, namely, the belief that children do not think about it. As I have discussed how children think about death and bereavement in more detail eslewhere (Phillips, 1980), I shall be brief here.

Children younger than 6 rarely think that death is universal, inevitable or final. Animism and artificialism prevail. They often think that only people who want to die, or who are cowardly, evil or careless, succumb and that the dead can be revived by a physician's "needle", by giving them hot food or by keeping them warm. Pre-operational pre-school children, in the process of assimilating the events they have observed to their own schemes, may think hospitals are places where one is killed, since grandma and several others died there (Phillips, 1980).



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Until the age of 5, many children consider death as rather like sleep, or a journey, and that one can awake or return from death. Indeed, it might be like a birth with the possibility of a fresh start. To wish a parent dead may be no more than a hope that tempers will improve afterwards. Sometimes a depressed pre-schooler's attempts at suicide are based on the hope that home or other conditions will improve afterwards. Unfortunately, these attempts may be classified as accidents through a collusion between doctors and parents which, while easing the adult's anxiety, deny the child's cry for help (Phillips, 1981).

A little later, children tend to believe that death happens only to old people. One little girl heard that her grandmother had died of old age, so she refused to eat any of her birthday cake, crying "I don't want to be 5. I don't want to die" (Stassen Berger, 1980, p 310). Concrete operational children think of specific violent causes for death such as, for example, guns, muggers, or weed killer. When children first realise that they themselves will die, they may develop irrational fears or phobias, refusing, for example, to eat certain food or sit in the front seat of the family car. Given a supportive family they will devise their own way of coping with fears about death.

Eventually, most children in late primary school recognise the finality of death and that it applies to them. This parallels the final stages of conservation in other areas. At this stage they tend to deal with their anxieties by finding the routines of funerals and burials hilariously funny or they play games which involve making an oath on their own death. Children at the formal stage of thinking realise old age, illness and a "worn out" body are the most likely causes of death (Stassen Berger, 1980).

*Professional practice*

Thus, pre-schoolers are working hard and intelligently at understanding objects and activities around them. They need lots of opportunities for their own self-learning type activities through exploration and for their questions to be answered in terms they can understand. This is very important for professional work with children.

Firstly, from an educational viewpoint, if activity and the exploration of appropriate actions are important in establishing concepts and meaning for young children, as demonstrated in this paper, then children who sit relatively still in school are likely to be at a disadvantage.

Secondly, to misinform children in order to relieve one's own anxiety (as in telling a child that a dead parent has "gone away", or an injection is going to be "just like a mosquito bite") is to set in train a string of anxieties in the child that may be long-lasting. Even common childhood illnesses need explaining carefully. Some children believe that measles spots, for example, will not go away and adults egocentrically assume that explanations are not necessary since they themselves know. Pre-schoolers try to understand meaningless words of explanation by isolating familiar features and extending those into their own logic. One child with ear-ache was told by the physician that she needed to go to the "Eye and Ear Hospital". The child ran the words together as "iron ear" and screamed on entering hospital because she thought hear ear would be replaced by an iron one.

Should screaming children who have unexplained fears about death and mutilation in hospitals be forcibly given anaesthetics? The movement to prepare children for hospital with suitable books and prior visits or the use of anaesthetics that are administered through toy telephones are ineed humane consequences of an understanding of how children think.

*Pre-operational thought in adults*

Finally, it should be pointed out that we all tend to approach a new area in which we have no background pre-operationally and have problems in transitions, reversals, associations and classifications, just as pre-schoolers do. Most have very pre-operational notions of car mechanics, for example. Many adults cannot conserve time and argue that daylight saving "fades the carpet" or necessitates more watering of the garden "since there is an hour more sunlight".

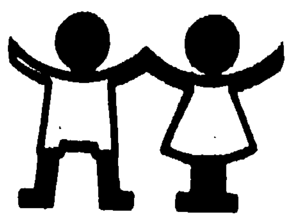
*Transitional Years*

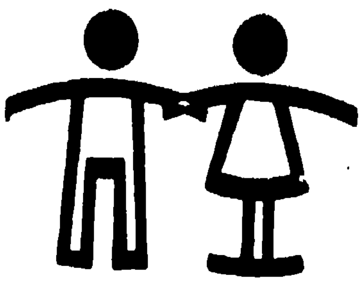
Between the end of pre-school years at 5 and the early school years at 7, there are remarkable changes not only in the complexity of thought but in the way children think. Five-year-olds use simple reasoning, little or no planning and work for praise and attention rather than for the right answer. By seven years the same child uses more complete reasoning, makes long-term plans and seeks intellectual rewards such as the satisfaction of getting the right answer.

Between the ages of 5 and 7 children usually become able to tell their left from their right, to focus on the shape of an object rather than on its colour and to distinguish the positioning differences of like figures such as "p", "q", "b" and "d" (Stassen Berger, 1980).

These years are transitional in which the child has not quite abandoned pre-operational thought, nor reached concrete operational thought.

* * * * * *





Between the ages of 8 and 10, children usually understand logical principles as long as the principles can be applied to specific or concrete examples. They can watch water being poured from a thin glass into a wide one and explain why the quantity of liquid remains the same (conservation). Once older children understand conservation they love conservation jokes such as the following:

> *Mr Jones went into a restaurant and ordered a whole pizza for dinner. When the waiter asked if he wanted it cut into six or eight pieces, Mr Jones said: "Oh, you'd better make it six! I couldn't eat eight."*
>
> OR
>
> *One day George and Bobby found an old raft, and they decided to take their picnic lunch and eat it on the raft. When they got out on the middle of the lake, George took his big thermos of lemonade and drank it all at once. Just then, the raft started to sink. George said "That'll teach me! Drinking all that lemonade made me too heavy for the raft."* (McGhee, 1976, Table 1, p 422)

*The Extension of Conservation*

By 7-8 years of age most children have learnt to conserve quantities of liquids and substances. But these same children deny the conservation of weight for reasons similar to those they used when under 7 to deny the conservation of substance, such as there is more or less clay than before because it is longer, or thinner, etc. Towards 9 or 10 years they admit the conservation of weight, and use by way of proof the same three arguments formulated in exactly the same terms as before when they admitted the conservation of substances. These are *(a)* the object has only been lengthened (or shortened) and it is easy to restore it to its former shape; *(b)* it has been lengthened, but what it has gained in length it has lost in thickness; *(c)* nothing has been added or taken away. However, we find these same children denying at this stage the conservation of volume (Table 1, pp 3-4) for the very same reasons they formerly used to deny the conservation of substance and weight. Finally, when they are 11-12 they once again use the same arguments to assert the conservation of volume (Piaget, 1953).

It cannot be argued that all children make these transitions at the ages Piaget observed. For example, some students in first year university science courses have difficulty in understanding the conservation of volume as illustrated in Table 1 (pp 3-4). Nevertheless, on the whole there appears to be developmental progression in this and other areas. For example, the understanding that any two relations A > B and B > C may be joined into one relation that includes them both A > C (transitivity) applies first to length and size (perhaps at 7-8 years), then to weight, as in the seriation of weights in the Binet-Simon tests (perhaps 9-10 years), and then to volume at 11 or 12 years.

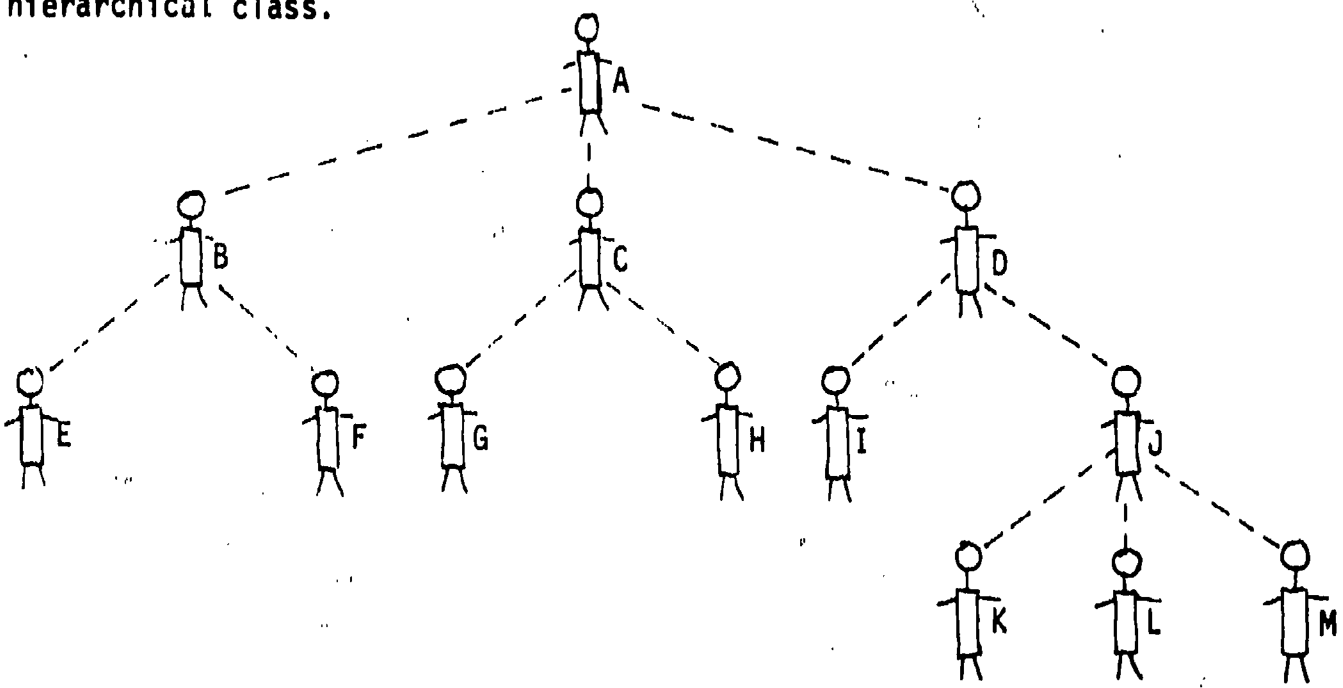
*Seriation*

The development of a similar system is important in the ability to seriate. For example, the child is given a certain number of unequal rods A, B, C, D, to arrange in order of increasing length. If the rods are obviously unequal, there is no problem and he/she can construct a series by relying on observation alone. But if the variation in length is small, so that the rods have to be compared two at a time before they can be arranged in such a series, the following behaviour is observed: Before the age of 7, on the average, the child proceeds unsystematically by comparing, for example, the pairs BD, AE, CD, etc. and then corrects the results. From 7 years onwards the child used a systematic method; he/she looks for the smallest of the elements, then the smallest of those which are left over, etc., and in this way easily constructs the series. This method presupposes the ability to co-ordinate two inverse relations: E > C, C, B, A and E > F, G, H, etc. (Piaget & Inhelder, 1969).

*Classification*

Other systems appear during the same period having a multiplication character. The child can classify the same objects taking account of two characteristics at a time such as, for example, counters which are square or non-square and red or non-red.

Concrete thinking children also learn to recognise the family as a distinct and hierarchical class.




The hierarchical classification is that grandfather A has three children (B, C, D) each of whom has two children (E and F, G and H, I and J) and one of these children, J, has three children (K, L, M). A child who can comprehend hierarchical classification can see the vertical and horizontal relationships. He/she understands that person J can be at the same time, father, brother, son and grandson, that I and J are alike since they have the same parent (D), and H and J are alike since they are related grandchildren of the same grandparent (A). These relations characterise the respective classes of siblings and cousins and show how the two classes are alike, yet different (Furth & Wachs, 1975).

This ability enables children to figure out which brands and sizes of popcorn are the best buys or to become experts in the makes of cars.

*Number and Time*

Piaget believes that these different systems of logical operations (conservation, seriation, and classification) are of special importance in the construction of the concepts of number, time, or motion, and in the construction of different geometrical relations (Piaget, 1953). For example, the simultaneous ability to classify and seriate means the advent of the system of numbers. Earlier the child may be taught to count, but experiment reveals that the verbal use of the names of numbers has little connection with numerical operations as such. The ability to use numbers meaningfully comes when the child's cognitive system permits recognition that number is a collection of objects conceived as both equivalent and orderable, so that differences between numbers are reduced to differences in the position in a series.

While classes, relations and numbers are being formed there is the construction in parallel manner of the cognitive systems that generate time. At the age of 8, the relations of the temporal order (before and after) are co-ordinated with duration (longer or shorter length of time) whereas the two systems of ideas were still independent at the pre-operational level. As soon as these become co-ordinated into a single whole they engender the notion of a time common to various movements at different velocities.

*Concrete Thinking*

As indicated earlier, up until 11 or 12 years of age children are usually incapable of the operations just described when they are invited to reason with simple verbal propositions. These operations are, therefore, concrete operations and not yet formal ones. Concrete thinking is not co-ordinated into a comprehensive system. As we have seen, the same "concrete" inferences such as those leading to the conservation of the whole, or to transitivity, may be easily handled in the case of one particular content area (such as quantity of material) and yet be meaningless for the same subjects in the case of another content area (such as weight). There is thus, a progressive structuring of mental operations with a time-lag of several years between the different fields or content areas. Concrete operations fail to constitute a formal logic since form has not yet been completely divorced from subject matter.

The concrete operational child must deal with each problem in isolation. Operations are not yet co-ordinated and, therefore, he/she cannot integrate his/her solutions by means of general theories. The concrete operational child is not completely free of his/her perceptions, and he/she is limited to solving tangible problems of the present. Thus, concrete operational children cannot deal with complex verbal problems, hypothetical problems, proportions or combinatorial logic.

*Verbal problems*

For example, concrete operational children are usually not able to solve verbal problems of the following type:

> *Edith is fairer than Susan; Edith is darker than Lilly; who is the darkest of the three?* (Piaget, 1968)

This is a seriation problem which might be done in the head without resort to concrete cases. Concrete operational children have trouble solving this problem because without the integrative basis of formal operations they cannot systematically reason about the gradations in colour.

*Hypothetical problems*

Similarly, concrete operational children have difficulty in arguing on the basis of an assumption which is obviously untrue. For example, if a class discussion were prefixed by the statement "Suppose oranges were black", concrete operational children could not proceed to solve logically any problems presented on the basis of this statement. Instead they declare oranges are orange and they cannot solve the problem.

*Proportions*

Yet another illustration of the concrete operational child's limitation to trial and error behaviour in the area of abstract reasoning is seen in his/her concept of proportions. In the pre-operational stage children can only equalise weights on a see-saw balance by unsystematic trial and error corrections. At the stage of concrete operations they discover that a small weight can balance a larger weight by placing it further from the fulcrum than the larger weight. They learn to equalise weight and length in a systematic manner but they do not co-ordinate the two functions of weight and length as a proportion. During the stage of formal operations the child comprehends the principle (W/L = 2W/2L) when he/she becomes aware that an increase in weight on one side of the fulcrum can be compensated by an increase in distance from the fulcrum on the other side (Inhelder & Piaget, 1958).

*Combinatorial logic*

Another limitation of these new operations which belongs to the logic of classes and relations, is that they still do not take into account the totality of possible transformations of classes and relations (i.e. their combinatorial possibilities). For example, a child is presented with five jars containing colourless liquids. The combination of three of the liquids (1, 3, 5) produces a yellow colour. One of the other two jars contains a bleaching agent while the other contains water. The child is shown the coloured liquid that can be produced but he/she does not see how it is obtained. When concrete operational children are asked to produce the yellow colour they typically proceed by combining two liquids at a time. After combining pairs, the systematic nature of their searching stops. It becomes haphazard or they may mix all five together which does not produce a yellow colour. Children operating at the formal level typically explore all possible combinations and systematically combine one, two and three liquids until the solution is reached (Piaget & Inhelder, 1967).

*Some Applications to Primary Children's Social Concepts*

*Children's concepts of clothes and nakedness*

Goldman and Goldman (1981) undertook a study of the views of eight hundred children aged 5-15 years on this topic in Australia, England, North America and Sweden. They found that children's concepts showed a developmental sequence which appears to correspond to pre-operational, concrete and formal stages. I shall give examples of Australian children's answers only.

The children were asked three questions: "Suppose we all lived in a nice warm place or climate, should we need to wear clothes?" "Why should this be so?" "What are the reasons for saying "yes" or "no"?" "Some people feel shy or funny about (revealing) certain parts of the body: why should this be so?"

*a)* Sample pre-operational answer:

"Yes, because you would get badly sunburnt. You need to wear T shirts. You'd go black after two or three years. Then you would be mistaken for an aborigine and you couldn't get a job then. Then there are the mossies (mosquitoes)." (boy, 9 years)

*b)* Sample concrete answer:

"It's rude, you can go only to certain beaches so they can get tanned all over. They are showing all their personal things. Its got to be kept under control." (boy, 15 years) *c)* Sample formal answer:

"No, because every one's the same. If it was hot, you wouldn't need to wear clothes, because everyone's the same (Q: Men and Women?) It wouldn't matter if everyone agreed to it." (girl, 9 years)

In summary there is a shift from *a) specific* responses which are typical of pre-operational thinking to *b) conventional* responses which correspond to concrete thinking and finally to formal type responses which are based on *c)* principled thinking.

In this study, on the whole, Australian children showed the more principled thinking at 15 than other children. It was concluded by one of the authors that climate had much to do with the result. The authors also concluded that the resulting children's perceptions were a product of societies where sexual nakedness is strongly tinged with guilt and the wearing of clothes is rationalised on moral grounds. The authors argue that their results indicate the degree to which social conventions influence how children think and how much adult mythologies and rationalisations prevent children from understanding, accepting and even enjoying the physical body and its sex organs as natural and normal.

*Children's conception of sex differences in babies*

Goldman and Goldman (1981) also found a cognitive developmental sequence in response to the question: "How can anyone know a newborn baby is a boy or a girl?"

*(1)* *5 - 7 years*
"Because mum dressed her in a dress. There's no other way to tell?" (girl, 7 years)
"The face probably looks like a boy or a girl and the hair's longer for a girl." (boy, 7 years)
"The doctor puts the name tag on the wrist." (girl, 5 years)

*7 - 9 years*
*(2)* "Girls have an exit and boys have a little willie." (girl, 11 years)
*(3)* "You can tell by its penis, its a boy. She's got something, don't know what its called. I call it a hamburger." (boy, 7 years).

In summary there is a shift from *(1)* ungeneralised specifics to *(2)* a recognition of physical differences but a tendency to label them with childish pseudonyms and finally to *(3)* not only a recognition of physical differences but a precise naming of them.

*Children's humour*

The joke-telling of school-age children demands several skills not usually apparent in younger children: the abilities to listen carefully, to know what someone else will think is funny, and to remember the right way to tell a joke. Pre-schoolers' humour is limited to single actions or words and if they remember the joke form the usually miss the point.

Daniel Yalisove (1978) analyzed children's jokes in considerable detail. He found that three types of humour were popular during middle childhood, each one reflecting different aspects of cognitive development.

*Reality riddles* are common among first and second graders and need an understanding of the way things really are to appreciate the humour. For example, in the following riddle the child must have a sense of relative size and distance: "How many balls of string does it take to reach around the world?"

(One, but it had better be a big one!)

School-age children delight in using their growing mental powers which enable them to realise such things as how big a ball of string would have to be to reach around the world (McGhee, 1971).

*Language - ambiguous jokes* centre on a play on words and are popular with fourth and fifth graders. In order to understand jokes like these the child must not only know that words can have two meanings, and that certain words that sound the same have different meanings, but must also be flexible enough to switch quickly from one meaning to the other: "Why didn't the woman leave the house even when a bear was chasing her?" (Because she didn't want to be seen with a bare behind!) This is also an example of children's jokes which poke fun at, and show an awareness of and a concern for, social conventions.

Riddle asking also provides the excitment of teasing or tricking someone, especially an adult, and is very characteristic of middle childhood. Some jokes are designed to catch the listener off guard. For exampe, the traditional answer to: "What is black and white and red all over?" is changed to "An embarrassed zebra."

*Absurdity riddles* become more common toward the end of middle childhood and involve an ability to understand that once the absurd premise of the riddle is accepted, the absurd answers are actually logical. For example, assuming that sunglasses thorou[illegible] disguise one the following becomes logical.

"What did the wild-game hunter do when a herd of elephants wearing sunglasses stampeded toward him?" (Nothing. He didn't recognise them.)

*Professional Practice*

Piaget found that, for the children he studied, the concrete stage of thought began at about 7 years and ended at about 11 years. However, other studies suggest that it does not end with primary school and, perhaps, can be seen in the thinking of secondary school students until 15 or 16 years of age. Indeed, it is apparent in the thinking of many adults. Thus, the situation is that there is probably not simply a developmental progression through sensory motor, preoperational, concrete and finally formal or abstract thought processes with each previous stage eventually disappearing but rather that in childhood, adolescence and adulthood there is a mixture of those levels of thinking in all of us and that the level in any area depends on experience, familiarity and information (Piaget, 1972).

For professionals working with children some understanding of the level at which children and adolescents are operating for the *particular topic in hand* is essential. Hypothetical and purely verbal explanations of illness or medical procedures are more than likely to be confusing for the concrete child or young adolescent. For the same reason school subjects, such as history, which are not linked to the tangible present, are beset with problems for such children. They have difficulty conserving historical time and tend to see 100 year periods in which they have been given more information as longer than others where there is less information, or they have difficulty in sequencing historical periods. They are not prone to making abstract projections about the future and approach such exercises by merely extending the concrete present. They are also confused by many teaching aids where figure and ground are defined by inference rather than concrete and clear delineation.

Children also approach social relationships in the same concrete fashion. Divorce between parents is often conceived by concrete thinking children as a problem of behaviour or organisation. One child, reluctant to be transported away from his weekday home, with his friends in the street, and his mother, to his father and his new wife each and every weekend, asked why Dad couldn't stay with his mother and the travelling back and forth be undertaken by the new wife.

*The Educational Sphere*

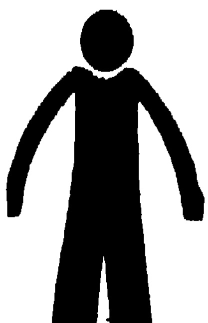
Experience and activity are basic to the development of thought processes and to the learning of entirely new subjects. The child is learning very little if he/she is merely sitting and watching. Children need to explore physical properties and engage in ordering and counting and enacting. Meaning must come before drill. Acting the meaning first and later practising with symbols is useful. The child can learn only what is understandable within his/her existing stage of cognitive development.

Where this is appreciated in the educational system there is a greater tendency to use the discovery method in teaching. However, the discovery method needs to be structured so that the child is able to assimilate new learning into his/her existing schemes or alter existing schemes without the confusion of too much irrelevant stimuli.

It is useful to identify the child's use of operations in different areas. Analysing children's responses and written work in terms of co-ordinating operations which involve transitivity, reversibility, associativity and classification is a useful basis for understanding how children are thinking. A child who cannot see that similar geographical formations may have similar outcomes even though the location is slightly different may be considered not as stupid, but lacking the associative system with respect to an unfamiliar concept. Plenty of concrete experience relevant to the child's interests may be all that is needed. In the same way many howlers which are the source of adult amusement may be analysed in terms of concrete or pre-operational modes of thinking which can constantly recur in new or unfamiliar areas whatever the age level.

Reversibility in thought may be encouraged in mathematics by placing multiplication and division, or addition and subtraction, in opposition to one another. In history the reduction of egocentricity may be encouraged by role playing and discussion methods. Traditional-style history with its stress on silent reading or teacher dictated notes probably maintains egocentricity. In fact, formal schooling which may limit interaction and discussion between pupils may well maintain egocentricity of thought and restrict the capacity to see other points of view. Pupils need to discuss and benefit from group learning games which stimulate cognitive conflicts.

Teachers need training in listening to children and understanding how they are thinking if the educational system is to capitalise on research findings. Even at best, in the traditional classroom teachers ask too many directed questions, which leaves little room to assess qualitative differences in childish thought and interests. It is not until late adolescence that learning by largely verbal instruction is feasible and I will now turn to the development of thought in adolescence.



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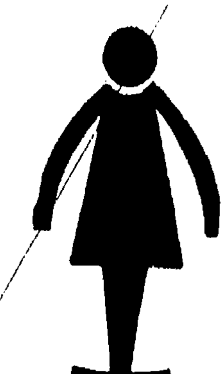

During early adolescence a qualitative change takes place in thinking processes. Central thought processes become more autonomous and increasingly dominate the peripheral processes of perception and action. Whereas the primary school child has an earthbound, concrete, practical-minded sort of problem-solving approach and his/her speculations are linked strongly with the everyday world, the adolescent is more concerned with possibilities (Flavell, 1977). The adolescent likes to (and can) indulge in the kinds of thinking exercises, such as hypothetical problems, combinatorial problems, and verbal problems, which the primary child eschewed.

It is believed that the advent of this stage has a lot to do with developments in brain structure and new structurings of knowledge which grow out of the concrete cognitions of childhood. The adolescent now discovers that thought is not as solid as he/she believed in childhood but a marvellously immaterial process which permits logical reasoning without resort to the concrete (Phillips, 1983b).

*The Egocentric Idealistic Crisis*

The adolescent is fascinated with scientific abstractions and religious systems and questions such as "Is there a God?" or "Will the human race destroy itself?" He/she likes intellectual puzzles and has grand conceptions. Having discovered that they can think, adolescents also tend to exaggerate the power of thought and believe that they only have to think about a problem to arrive at the solution. Piaget (1951, 1972) described this as a form of egocentricity peculiar to the first appearance of propositional logic in adolescence.

As he saw it, each stage of cognitive development has its egocentricism which initially distorts the use of newly-acquired cognitive structures. For example, the pre-operational child does not distinguish between his/her thoughts and those of others, and the concrete child's reasoning is egocentrically dependent upon his/her perceptions of the concrete evidence which must be present.

Having discovered he/she can think with propositional logic, without dependence on the immediate presence of the concrete evidence, the adolescent egocentrically assumes the omnipotence of logical thought. He/she may become "obsessed" with his/her new-found powers. Hence, in adolescent thought, the criterion for making judgements may become what is logical to the adolescent and not necessarily what is realistic or practicable. The egocentricism of the adolescent is this inability to differentiate between his/her idealistic thought and the real world. He/she does not always understand the pragmatics of daily living or why politicians and big business do not adopt logical, reasonable or humanitarian solutions to existing problems.

In the light of this, Piaget (1951) believed that adolescent attempts to change the family and social environment did not simply reflect a desire to deviate but represented a failure to differentiate his/her point of view from the point of view of the group which he/she hopes to reform. It is a product of the adolescent phase in which, as indicated earlier, he/she attributes unlimited power to his/her own thoughts so that the dreams of a glorious future or of transforming the world seem to possess sufficient grounds for modifying the world.

The idealistic crisis of the adolescent diminishes in adulthood when he/she distinguishes between his/her powers of propositional logic and the capacity of society to apply them. Thus, the adolescent learns to assume realistic roles in the real world. This is accompanied by a change not only in the cognitive area but in emotional ones as well.

*Formal or Propositional Logic*

By the end of adolescence many young people can reason according to the formal rules of logic and build logical thought systems to understand relationships and society. Consequently Piaget called this stage of cognitive development "formal operational thought" and this is the description used generally in contemporary texts. Unlike the concrete thinking child he/she *(a)* can distinguish the possible from the actual, *(b)* is able to use symbols to represent other symbols and *(c)* has the ability to co-ordinate variables or take a number of social factors into account at the same time.

*Combinatorial Logic*

Suppose you ask a child to write down all the different addresses that could be made up from the numbers 1, 2, and 3. The child who is able to reason at the level of formal operations will first list all the one number addresses (1, 2, 3), then all the two number combinations (11, 12, 13, 21, 22, 23, 31, 32, 33) and then all the three number combinations. He/she is able to construct the possible out of the actual or given data.

The adolescent proceeds more systematically than the younger child. He/she can systematically isolate all elements and arrange all possible combinations of these. The possibilities of such a combinatorial analysis can be quite large. For example, if faced with the problem of describing a population of animals which are divided on the one hand into vertebrates (V) and invertebrates (I), and on the other hand into those which live on land, terrestrial (T) and those which live in water, acquatic (A), the adolescent can tabulate all the possible combinations, a task well beyond the capacity of the child with only concrete operations, who can proceed only with simple additive and multiplicative class inclusions as in (2), (3), and (4), below. The combinations open to the adolescent are, on the other hand, sixteen in number and as follows:

1. No animals at all
2. Only VT
3. Only VA
4. Only IT
5. Only IA
6. VT & VA, but no IT or IA
7. VT & IT but no VA or IA
8. VT & IA but no VA or IT
9. VA & IT, but no VT or IA
10. VA & IA, but no VT or IT
11. IT & IA, but no VA or VT
12. VT, VA & IT but no IA
13. VT, VA & IA, but no IT
14. VT, IT, & IA, but no IT
15. VA, IT, & IA, but no VT
16. All four classes

The adolescent understands that propositions can be transformed and negated by logical processes. Thus, a class (e.g. mammals) has an inverse (non-mammals) or the proposition "p implies q", has an inverse "p does not imply q". Similarly, the proposition, "A is twice as long as B", has a reciprocal, "B is twice as long as A", and so on.

Inhelder & Piaget (1958) found that adolescents, as opposed to younger children, appear to be able to discriminate between these various direct and opposing operations, and also to assess their effects on one another in practical situations. For example, when given an hydraulic press wherein a weighed piston exerts pressure on the liquid in one arm of a U shaped vessel and forces the liquid to rise to a certain level in the other arm, adolescents can correctly predict the effects on the height of the liquid in the other arm if variations were made in both piston weight and liquid density. The adolescent realises that the effect of adding weight to the piston can be opposed by either (or both) of two distinct operations: removing weight (negation) or increasing counterpressure in the piston by increasing liquid density (reciprocal). He/she also appreciates that decreasing the liquid density is equivalent to adding weight. The concrete operational child goes little further than recognising that adding weight to the piston can be opposed by removing weight. He/she does not see the possibility of the four operations and that these form a system.

*Hypothetical Deductive Thinking*

Unlike a concrete thinker, a formal thinking child inspects the data, is able to hypothesise that a particular theory may explain this data, deduces from this theory what else might or might not occur and can test it. However, these abilities do not arrive abruptly but develop gradually.

In the early formal operational stage (12-14 years) adolescents begin to see many of the possible combinations necessary to solve a problem but they are not as likely as the late formal operational thinker to start with a hypothesis and organise a search for a solution. Instead, they will try many different strategies rather than approach the problem with one systematic strategy. It is not until late formal operations (15-18 years) that the adolescent operates with systematic strategies and is able to consider all possible combinations of events and situations when given a problem to solve. The distinction between these levels can be seen in a conservation of movement problem.

A pendulum bob can be made to swing faster or slower by adjusting the length of string supporting it (the shorter the string the faster the movement). When 8-12 year old children are asked how the pendulum can be made to move faster or slower, possible factors, such as length, initial impulse, weight of the bob, and amplitude of the swing, are varied in a haphazard fashion.

The early formal thinker (12-14 years) conjectures that the length of the string may influence the speed of the pendulum. However, unlike the late formal thinker he/she does not go beyond the existing data to generate an hypothesis and is content with a simple statement. The late formal thinker (15-18 years) looks for what is *necessary and sufficient* and separates out the weight and length variables and hypothesises whether the length of the string is acting alone or whether it is interacting with the weight to produce the effect (Cowan, 1978).

The older adolescents endeavour after a few trials to formulate all the possible hypotheses concerning the operative factors, and then arrange their experiments as a function of these factors. Thus, the level of formal operations opens up the possibilities of the hypothetico-deductive operations of science. By the same operation the adolescent becomes aware of the possibility of social reform mentioned earlier. Since he/she can now see that the way the world is run is only one of a variety of possible ways he/she delights in conceiving of alternative ways whereby it might be run better. In this context the adolescent conceives of ideal families and when he/she compares these ideal with reality, the real ones may be found wanting. This, in turn, may lead to rebellion against parents (Elkind, 1970).

When applying hypothetical deductive thinking to social problems the adolescent is not side-tracked as is the concrete thinking child. In his examination of the development of logical processes Peel (1971) tells the following story to his subjects:

> *Only brave pilots are allowed to fly over high mountains. This summer a fighter pilot flying over the Alps collided with an aerial cable railway and cut a main cable causing some cars to fall to the glacier below. Several people were killed and many*

*others had to spend the night suspended above the glacier. Was the pilot a careful airman? Why do you think so?*

Primary school children of 9-11 years tended to give irrelevant responses such as "No, he was a showoff". Early adolescents of 12-13 years tended to make their judgements solely on the basis of the content of the passage (especially, the collision with the cable) and typically responded, "No, because if he were careful he would not have cut the cable". Older adolescents tended to realise they could not decide whether the pilot had been careful until they knew more about the circumstances of the accident and also took into account extenuating circumstances such as bad weather, sudden loss of vision or a malfunction of the plane.

Peel found the same tendency in reasoning about historical, ecological and sociological matters. For example, were the people of Italy to blame for the water damage to art masterpieces caused by the floods in Florence? In addressing such questions older adolescents were likely to see events as dynamic and consisting of many interrelated factors and were constantly thinking of alternative possibilities.

This hypothetical deductive thinking is also applied to logical problems wherein, because they are able to consider theoretical possibilities, many adolescents can an lyse a statement logically without becoming sidetracked by the concrete. The following is an example.

*If I have more than fifty cents I shall buy a cake or a peach. If I am hungry I shall buy a cake or two buns. I have a dollar and I am hungry what shall I buy?*

The formal thinker can separate logical deduction from need or whim and arrive at the answer of a cake which covers both propositions. A concrete thinker may introduce arguments which are not restricted by the logical requirements of the problem such as "I have a dollar so I can buy a cake and two buns" or "I am thirsty so I will buy a peach as well".

The adolescent's capacity for using the hypothetical-deductive method of thought and his/her prowess with combinatorial logic suddenly makes a large number of alternatives available to him/her. Adolescents want to know why they are being asked or told to do certain things and many delight in debating parental and school rules. This can lead to family and school conflict.

*Impression formation*

There are many social implications of the development of the ability for deductive hypothesis testing. The adolescent develops a capacity for reflection and thinking about his/her thinking and that of others. He/she can reason in a complex manner ("I think that you think that I think") and can co-ordinate thoughts of others into a cohesive picture of people in general (Selman, 1976a, 1976b). How this self-reflection influences the development of the self-concept and increased self consciousness is discussed in another Unit for Child Studies Paper (Phillips, 1983a). When adolescents meet people, their hypotheses about what they are like can be tested through observation of actions and attitudes. An adolescent girl's first impression of the intelligence of a boy may be denied when she hears the perpetual banality of his conversation. A concrete thinker's impressions of others may be not so easily dispelled by deductions from practical observations.

When the adolescent is given information about another person he/she tends to integrate this with previously acquired information rather than relying solely on the concrete information at hand. In addition, rather than thinking that people always behave consistently, the adolescent is more likely than the primary school child to understand the influences, the environmental changes and the interactions that make behaviour variable. He/she also seeks more complex and hidden causes of personality rather than accepting surface appearances (Santrock, 1983).

*Using symbols for symbols*

Children who have reached the level of formal operations have acquired the ability to use a second symbolic system or the ability to let symbols stand for other symbols. This makes thought more flexible and so they can now begin to learn algebra and use symbols (such as x and y) to represent other symbols such as 1 and 2.

Similarly, words can take on more than one meaning, so the adolescent begins to understand figures of speech such as the metaphor and double entendre. Whereas many elementary school children are puzzled by the meanings of parables and fables (Elkind, 1978) and proverbs such as "you can't make a silk purse out of a sow's ear", the adolescent understands that the literal meaning of a word or phrase may be used metaphorically to suggest a similarity with something else so that a point is highlighted.

The onset of adolescence does not necessarily mean that formal operational thought will appear. It has been demonstrated that a significant proportion of college and middle-aged adults do not use formal operational thought when asked to solve problems (Santrock, 1983). There are unique and individual differences (Bart, 1971; Berzonsky, Weiner & Raphael, 1975; Higgens-Trenk & Gaite, 1970). Also, while the fourteen-year-old may reason at the formal operational level in solving algebraic problems, he/she may not be able to do so with verbal problem-solving tests or when reasoning about abstract interpersonal relationships until later in adolescence.

Thus, when the individual reaches adolescence, he/she can use sensorimotor, pre-operational, concrete or formal reasoning and may use all four depending on the circumstances. With most adolescents have the capability to engage in formal thought, whether they do or not depends on educational instruction, family and other environmental influences. For example, examination questions may limit the child to concrete responses or the way in which subject matter is presented may discourage formal thinking (Case & Fry, 1972; Siegler, Liebert & Liebert, 1973).

The possible operations of thought are not always fully used by schools, the media or in one's own activity. A literary critic may engage in the kind of analytical thinking that cannot be matched by the adolescent but the two may differ only in their familiarity with the field of literature not with the operations that could be brought to bear in that context (Piaget, 1970a, 1970b).

Piaget (1972) himself acknowledges that society and education are crucial factors in enabling an individual to attain formal operational thought. A number of studies suggest that children may pass through the pre-operational and concrete stage without the benefit of schooling (Wadsworth, 1972). But without social interactions and education in science, maths or logic, formal operational thought may be bypassed and adults may still think like concrete operational children.

The fact that not all adults attain formal operational thought has led John Flavell (1977) to conclude that the difference between mature and childish thought is not that adults are always logical and children never are, rather, it is that even when adults are not being logical, they recognise the concept of logic, whereas children do not, even when, in fact, they are being logical.

While many adolescents and adults have the cognitive competence to think logically, they do not always do so, especially when thinking about themselves.

*Thought Beyond Formal Thought*

Many accept Piaget's and others' notions of the formal stage, pruned of its egocentricity, as the height of thought processes. But is it? We live in a dynamic lly changing environment. We can use combinatorial logic, hypothesise and deduce, but are there other ways that will allow one to recognise new problems and new issues? Stuck in the concrete and formal stage as most adults are, are we blind to other forms of thinking, just as the pre-operational child largely avoids concrete thinking and the concrete child largely avoids formal thinking?

Whatever the answer to this question, it is of enormous value to understand how children and adolescents think. Life with them may not become easier as a result, but it becomes more interesting, relaxed and humane.

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