Chapter 5

PERCEPTUAL-MOTOR DEVELOPMENT
Over the years the hyphenated term perceptual-motor has taken on a variety of meanings for different people. As a result a certain amount of confusion exists regarding the topic. To some perceptual-motor refers to all overt motor skills; the hyphen merely serves to express the interdependence of perceptual and motor responses. To others perceptual-motor has erroneously come to be associated with so-called perceptual-motor programs, which have sprung up all over North America to deal with children who have cognitive, emotional, and motor problems. For these people perceptual-motor means a remedial program designed to overcome learning deficits.

It is our hope that this chapter will clarify some of the issues surrounding the broad topic of perceptual-motor development. First there will be a theoretical overview that tackles definition. Second, the development of the various perceptual modalities, including the perception of body awareness, will be discussed. Last, the implications of perceptual-motor development for physical education will be examined. This chapter will differ from many of the others in that the development of the various perceptual modalities across all four developmental stages will generally not be discussed. Since the bulk of perceptual development occurs during infancy and the early childhood years, the discussion will, by and large, be confined to these two developmental stages.

WHAT IS PERCEPTUAL-MOTOR DEVELOPMENT?

As you read this page your eyes are focused on the printed words, your ears pick up the noise of a fan in the room, and you may even be writing down some notes. All that is occurring in the above example could appropriately be termed perceptual-motor. The first two events, namely, vision and hearing, start off being received by specialized receptors (eyes and ears). We term this reception sensations. However, sensations must then be organized and interpreted in the brain to be meaningful. It is this organization and interpretation that we term perception. The writing down of notes is primarily an overt motor event, but it should be noted that we do actually receive sensory information during the execution of motor responses. Thus, it is not difficult to understand why we have coined the term perceptual-motor, for indeed all of our overt motor behaviors require a strong perceptual component. Fig. 5-1 illustrates the perceptual-motor system. In summary it can be said that the perceptual-motor system contains the following components: (1) a sensory (afferent), (2) a central processing (perception), and (3) an overt motor (efferent) response.

Since Chapter 3 dealt essentially with the motor component of the perceptual-motor system, this chapter will describe the development of the perceptual component. When the word "perception" is used, most of us think of visual perception. This is somewhat understandable in that vision is the dominant sense in most people; however, as Fig. 5-1 illustrates, it is not the only source of sensory input. We can have auditory (hearing), tactile (touch), kinesthetic (awareness or feeling), olfactory (smell), and gustatory (taste) perception.

In complex motor performance we rely on all of our senses to perform efficiently in an integrated manner. Although perceptual processes may develop somewhat independently of motor responses, we cannot perform motor skills without perception (Cratty, 1970a). For a more extensive discussion of this point consider an example that illustrates the integration of various perceptual modalities. A baseball player uses vision to perceive the velocity, location, and spin of the ball; the player’s ears detect subtle movements of the catcher, perhaps by cuing location of the pitch; the hands squeeze the bat, thereby providing pressure; the player is aware of the location of the arms and bat (kinesthesis), and possibly the player tastes the bubble gum or chewing tobacco and smells the hot dogs in the stands (it is hoped that the batter will not be focusing attention on the latter two events).

On the basis of the preceding discussion, which spelled out what perception referred to as well as its documented relationship to motor activity, it can be said that perceptual-motor development refers primarily to changes in a child’s sensorimotor processes as a function of age. With increasing age a child is better
able to process complex sensory information. Since this is intricately related to motor responses, the child also has better control over motor acts such as running, catching, throwing, and hitting.

Williams (1973) points out that as children grow older the changes in the sensori-perceptual components are of three major forms: (1) a shift in the hierarchy of the dominant sensory systems; (2) an increase in intersensory communication; and (3) an accompanying improvement in intrasensory discrimination. The shift in dominance of the sensory system is characterized by a shift from early tactile-kinesthetic dominance in children to a primary reliance on visual information. More specifically, during the early years (infancy) a child relies heavily on information gained from fondling objects and perhaps tasting them. However, in later years the more sophisticated visual system begins to take over as the dominant source of information for regulating motor acts.

The second developmental change in sensori-perceptual processes is that of improved intersensory communication. With increasing age the child is able to rely effectively on numerous modalities for useful information in regulating motor behavior. Rather than relying exclusively on one modality, the child is able to utilize multimodal information efficiently.

The third change that reflects a more mature sensori-perceptual process is the development of increased discrimination capabilities by the various modalities. In essence the child is able to see better, hear better, and respond to other stimuli with greater facilitation; finer discriminations are being made. As a result of this increased sensory control greater motor control is also developed.

**MEASURING PERCEPTUAL ABILITIES**

Measuring the development of perceptual abilities in young children is a difficult task methodologically. By and large infants are not cooperative subjects when it comes to experimentation. Nevertheless, several ingenious methods have been developed to measure the various parameters of visual perception. The most general technique involves simple experimenter observation. The observer notes behavioral changes such as attention, motor behavior, excitement, and so forth when various stimuli are presented. The work of Gibson and Walk (1960) exemplifies the observational technique (see p. 71) (Fig. 5-2). A second technique that attempts to determine whether infants can perceive various stimuli involves the monitoring of physiological responses such as heartbeat and respiration. This technique assumes that perception of a novel stimulus (visual or auditory) stimulates the infant's physiological processes. As the infant becomes habituated to the stimulus, there is generally a deceleration in responses such as heartbeat. An example of such a study is Bridges' (1961). A third technique employs principles of conditioning and is perhaps best exemplified by the experimentation of Bower (1966). Basically researchers such as Bower teach the infant to make a response such as head turning to a stim-
ulus; then the stimulus is changed in some way, and the researcher notes whether head turning occurs. If the response does occur, it is interpreted as an indication that the infant considers the two stimuli similar.

Experimentation with children does become easier as they increase in age and become verbal. We can then simply ask them what and how much they can see, what they can hear, and where the sound is coming from. Although the earlier-described experimental techniques, particularly the physiological and conditioning ones, are ingenious, we must be cautious in our interpretation of the results, since our assumptions regarding infant responses to stimuli may not be correct.

COMPONENTS OF THE PERCEPTUAL-MOTOR SYSTEM: PERCEPTUAL MODALITIES

Visual perception

The topic of visual perception is so broad and extensive that whole books have been written on specialized aspects of it. Instead of dealing with all the concerns surrounding visual perception, the topics of perceptual acuity, perceptual constancies, depth perception, and the perception of moving objects will be covered. Those wishing a more extensive treatment of visual perception are referred to the references.

Visual acuity (clearness of vision) will introduce the topic of visual perception, since it pertains to the basic question, How well can a child see? Up until the time of Fantz's (1961) pioneering work in infant perception it was thought that neonates could see very little, if anything. Fantz, using the technique of presenting paired stimuli, demonstrated that neonates preferred to look at patterns rather than gray fields. Based upon this observational technique Fantz (1965) reported, in a later publication, that infants can see stripes of 1 mm (⅛ in.) at a distance of 22.5 cm (9 in.) from the eyes; at 3 months of age the infant can see 0.4 mm (⅛₄ in.) stripes at a distance of 67.5 cm (15 in.). Pick and Pick (1970) in reviewing the literature on visual acuity in infants reported that infants 0 to 1 month have Snellen vision in the range of 20/150 and 20/400. Beyond this age Pick and Pick report a fairly rapid rate of improvement until 10 years, when maximum acuity is attained for most children.

When we observe a jumbo jet airliner on the ground, we all marvel at its tremendous size. As it lifts off the ground and gains altitude, the image on the retina is actually quite small; however, we are still able to perceive the initial size of the airliner. This ability to perceive constant size is referred to as perceptual constancy. Other constancies include shape (recognizing shapes from different angles) and color (recognizing colors even when there is partial darkness). Although rudimentary forms of these constancies are present during the first months of life, most have a developmental course that extends through early childhood.

Related to the constancy phenomenon is object permanence, the ability to perceive the existence of an object that has been removed from visual contact. If you present a 2-month-old infant with a toy, then put a screen between the child and toy, remove the toy and then the screen, the 2-month-old will show some surprise, indicating that the infant expected the toy to still be there. Although the child will not search for the toy, there is some evidence of early object permanence (Bee, 1978). By about 6 months the infant exhibits greater signs of object permanence. If a toy is dropped over the edge of a crib, the infant will look for it. Also at about this age a child will search for an object that is partially hidden. However, if the object is completely covered, the infant will not bother to search for it even if he viewed the covering. Between the ages of 8 and 12 months the infant begins to search for covered objects, indicating that at about 1 year most infants have grasped the fact that objects continue to exist even though they cannot see them.

Depth perception is a necessary skill for size constancy. Its developmental course, however, is not certain. Theorists and researchers cannot agree on whether depth perception is present at birth, develops as the nervous system matures, or is dependent on learning. The classic study by Gibson and Walk (1960) on an apparatus called the “visual cliff” provides some hard evidence that infants are capable of perceiving depth at least as early as 6 months.
eyes are several centimeters apart in the head and consequently receive a slightly different image.

We also have more crude observational data on infants around 3 to 4 months suggesting that they possess some form of depth perception. When objects are placed within grasping range, the infant will invariably attempt to grasp the object. When the object is out of grasping reach, the infant will rarely grab for it.

The now-classic study by Held and Hein (1963) strongly points to the fact that movement, particularly self-induced, is necessary for the adequate development of depth perception. Held and Hein raised kittens in the dark until the age of 8 to 12 weeks, thus incorporating a research technique generally referred to as deprivation. The kittens were then exposed to visual stimulation three hours per day in a unique manner. One, called the experimental kitten, was paired with another (the control kitten) at opposite ends of a pivoted bar. The bar was set inside a vertically striped cylinder, and the kittens were harnessed in such a manner that the experimental animal walked the control animal around the cylinder (Fig. 5-3). Both kittens were deprived of seeing their limbs and other body parts. The control kitten was raised off the floor and hence did not move itself; it received a free ride. When tested for depth perception on a "visual cliff," the experimental kittens made appropriate depth responses, whereas the control kittens displayed random responses when presented with illusions of depth. This very clever experiment demonstrated not only that movement was important for the development of certain perceptual abilities, but also that visual perception is dependent upon experience. One is not born with endowed perceptual abilities.

Perception of moving stimuli. Despite the increased concern for perceptual development in the last several decades, few experimental studies have investigated the perception of movement, either of objects in space or children's own bodies. Pick and Pick (1970) point out that many more studies have looked at children's responses to apparent movement (sequencing lights that adults perceive as moving) than to true movement. Nevertheless, a few
significant studies have made some interesting revelations about the perception of movement.

Most of us have undoubtedly observed that infants are extremely captivated by objects moving in their visual field. It is not difficult to get a very young infant to track a large slowly moving object. Haith (1969) has reported that infants as young as 3 to 5 days old will respond to the intermittent movement of a visual stimulus. The novelty of the stimulus does not appear to wear off, since the infant continues to track the object even after repeated presentations. At 1 month the infant is capable of following an object through an arc of 90 degrees. During the next several months the ability to track objects through a greater range of motion increases. In addition the child can track faster-moving objects and can even follow the object as it reverses its field. It is also at this time that the infant begins to notice movements of its own arms and legs and becomes fascinated by them. As the infant matures, she continues to be impressed with the movement of balls, cars, and other inanimate and animate objects; at the same time she increases her ability to track the object accurately from the center to the periphery of her visual field.

One of the best studies to investigate the development of the perception of moving objects during the childhood years was conducted by Williams (1967). In a cleverly designed study Williams had children ages 6 to 11 years old judge the speed and direction of a projected ball. The children were asked to move as quickly as possible to a spot where they thought the ball would land. The children never received feedback regarding the actual landing of the ball past its initial projection because a canvas ceiling interrupted the flight of the ball. As would be expected, the older children were significantly more accurate than the younger children in estimating the flight of the ball. Williams noted some interesting sequential changes in the development of this particular perceptual skill. Children in the age range 6 to 8 years did not seem capable of monitoring their motor behavior with visual information. When the ball was projected, these children would run as fast and as far as they could, thereby consistently overshooting the true landing point. Nine-year-old children, however, began making accurate but slow judgments; this suggests that at this age children are capable of using visual information to control their motor behavior, but slowly. The 10-year-old children displayed even different characteristics. They responded more quickly than the 9-year-olds to the moving stimulus but were less accurate in their judgments; in essence they sacrificed accuracy for speed. The 11-year-old children demonstrated a more fully developed interphase between the perceptual and motor components since they responded both quickly and accurately.

The research evidence just presented on visual perception points out that in contrast to motor abilities some visual abilities are highly developed at a very young age. For example, it was pointed out that the newborn is capable of seeing objects quite clearly, particularly if the objects are presented within a restricted range. Further, evidence was presented show-
Auditory perception

Auditory, like visual, perception is a complex process that contains many identifiable subskills. Some of these subskills include: awareness (ability to indicate that there is sound or no sound), discrimination (ability to recognize differences in sounds), localization (the awareness of source or direction of sound), figure-ground differentiation (ability to select relevant from irrelevant stimuli), and memory (ability to store and recall what one has heard).

Although the experimental research in auditory development is sparse, there are data regarding the development of the first three subskills in infants. The other auditory subskills have been investigated and described more in clinical settings where children, because of diagnosed deficits in auditory perception, have impaired language development, motor development, and basic intellectual functioning.

Numerous research studies using indicators such as changes in cardiac response, direction of gaze, and motor activity level have demonstrated that infants are sensitive to sound from birth onward. Wertheimer (1961), for example, showed that infants only 2 minutes old moved their eyes in the direction of a series of sounds. This would seem to indicate that infants are not only sensitive to sound but are also aware of the directional source, something we call auditory localization. Kessen and co-workers (1970) present an excellent review of numerous other studies that demonstrate early competence in auditory perception.

Attempts have also been made to quantify infants' sensitivity to other properties of sound, such as intensity and frequency or pitch. Some of the early attempts were futile because of the use of crude instruments for emitting these sound properties, for example, squeak of a rubber rat, the crinkling of paper, and other assorted sound-makers. There does, however, seem to be a consensus among researchers that infants display differential responses to sounds of high and low frequency (Pick and Pick, 1970). It is generally found that low-pitched sounds tend to quiet a distressed infant, while high-pitched sounds tend to cause "freezing" behavior followed by agitation. Perhaps this is why parents almost universally coo to their fussy infants in low-pitched voices.

Auditory acuity in older children has not been studied as extensively as it has been in infants. There is, however, one study that provides at least some descriptive data on the auditory skills of school-age children. Eagles and co-workers (1963), using a large sample of children between the ages of 5 and 14, reported increased sensitivity to sound until age 13. At the age of 14 there was a slight decrease in sensitivity. It should be pointed out, however, that the difference between the 5- and 13-year-olds was very slight (6 to 7 db). Because a large number of subjects were used the differences were statistically significant. Whether this difference is functionally significant is open to question.

Touch, taste, and smell

The perceptual modalities of vision and audition were described as complex yet rather advanced, even in the infant. The following three modalities, sometimes referred to as the "lower senses," are not considered advanced in infants. It is also true that considerably less research has been conducted on these "lower senses." It is commonly believed that infants are relatively insensitive to pain stimuli, even those born free from effects of the mother's medication. Sensitivity appears to be greater in the region of the head than of the extremities. This is, of course, consistent with the principle of cephalocaudal and proximodistal development. An interesting sex difference has been reported by Lipsitt and Levy (1959). Using shock as a pain stimulus the researchers concluded that girls were more sensitive to pain than boys.

Very few studies have been conducted on the development of taste and smell. We do not know that children have a larger distribution of taste
buds in their mouth than adults, but it is not known whether this means children have greater sensitivity to taste. Many parents testify unequivocally that their children are sensitive to taste even during infancy. Cake and ice cream seem to taste better than vegetables. It is also known that the newborn is capable of responding to odors by turning away from unpleasant ones such as ammonia or acetic acid (Mussen et al., 1974).

In general it seems that infants show some early sensitivity with the lower senses and that this sensitivity increases up to early childhood, at which time children are capable of mature responses.

**SEX DIFFERENCES IN PERCEPTION**

There is relatively little definitive information available regarding possible sex difference in perceptual skills. The limited literature does, however, conclude that girls have a lower tolerance for pain and are more responsive to taste differences than boys. No one has speculated on the practical significance of these small differences. Maccoby and Jacklin (1974) have gathered a tremendous amount of data on possible sex differences in perception and basically conclude that boys and girls are remarkably similar in responsiveness to visual and auditory cues.

**PERCEPTION OF THE BODY, OR BODY AWARENESS**

At the outset of this chapter it was indicated that the thrust of the chapter would be to describe developmental changes in the perceptual component of the perceptual-motor system. By this we meant that we would deal with perception of such modalities as sight, sound, touch, taste, and smell. It would be remiss in the discussion of perceptual-motor development not to deal with the development of perception about one's own body, something we term body awareness. One could logically argue (and rightly so) that the development of body awareness characteristics should be discussed with the development of fine and gross motor skills, cognition, or, for that matter, language. Body awareness does indeed have implications for the development of all these skills, but since a great number of perceptual-motor theorists (particularly those who have developed remedial programs) pay a great deal of attention to the development of body awareness characteristics, we have chosen to discuss body awareness in this section of the text.

Body awareness characteristics are numerous, poorly understood, and often provide as much confusion to readers as they do to the children who are in the process of developing these characteristics. In the literature are such terms as laterality, lateral dominance, lateral awareness, body part identification, right-left awareness, directionality, and so forth. An attempt will be made to provide some structure, definition, and a description of the developmental course of these body awareness characteristics.

The newborn infant is not capable of perceiving much about its body; however, during the first month there appears to be at least a crude awareness that his body is distinct from the surroundings. Although this may not be a "true conscious" awareness, it may be what Piaget calls a prereflective awareness. As the child grows, he becomes cognizant of his capabilities in moving arms, legs, head, and trunk. Later on as the child learns to recognize verbal cues (or labels), he is capable of identifying a body part with a particular word. The ability to label body parts is therefore one of the first body awareness characteristics a child develops. Although there is little normative data in the literature, our interactions with infants indicate that children as young as 12 to 15 months are capable of accurately identifying body parts such as nose, ears, eyes, hands, and feet, first on their own bodies and then later on other people. As these children get older and are exposed to experiences that increase their body part vocabulary, they are capable of accurately identifying most body parts. Data from Ilg and Ames (1966) indicate that by the age of 5 years, 80 percent of the children were able to name their eyes, and about 50 percent were able to identify eyebrows. For some children, then, eyebrows are not an early part of the vocabulary. Williams (1973) indicates that at age 5 years, 55% of the children accurately describe their body parts, and this ability increases in a linear manner until age 12 years, at
which time there is 100% accuracy. Williams al. points out the importance of vocabulary development and environmental interaction (adult influences) for the mature development of this ability.

The development of laterality, the ability to distinguish between the two sides of the body, is developed quite early in most children. Although the child may not have the verbal labels left and right, he does in fact have the conscious notion that there are two hands, two feet, two eyes, and so on, and that they are on two different sides of the body. It is thought that the development of laterality is really the foundation for the development of other body awareness characteristics. After children develop what we have called laterality (3 to 4 years), they begin to attach the verbal labels left and right to these distinctly different sides of the body. Although left and right are in the child’s repertoire of words, he is not capable of correctly labeling the two sides of the body. The correct labeling of the two sides of the body is termed lateral awareness, a process that is usually not fully developed until about 7 years. Although most researchers are interested in the development of left-right characteristics, other body spatial descriptions such as front-back and up-down are also developed. In fact these relationships (front-back, up-down) are developed before left-right awareness (about 3 to 4 years).

A term that is often confused with laterality is lateral dominance. Lateral dominance is merely a preference for use of the left or right hand, left or right foot, and left or right eye. If no dominance is reflected, an individual is referred to as mixed dominant. Dominance is usually assessed (informally) by observing the hand and noting which hand is preferred in throwing, cutting, and writing tasks. With the foot one likewise observes which foot is preferred for hopping and kicking. The dominant eye is usually designated as the preferred eye in aiming at an object or some similar task.

The development of preferential handedness, eyedness, and footedness is a most interesting process, one in which there is still incomplete understanding and some myths. Areas of controversy include the following: whether the preferred use of one of the hands, eyes, or feet is something we are genetically endowed with or is something we learn; whether incomplete or mixed dominance results in cognitive, emotional, and psychomotor disorders; and how hand, eye, and foot dominance are related to cerebral dominance (one side of the cerebral cortex is physiologically dominant in interpretive functions).

Handedness has been investigated more than all the other dominance characteristics put together. It appears that during infancy children employ the use of both hands in playing with toys and “shoveling” food into their mouths. At 1 year of age the infant does not appear to have a preferred hand. Some parents consciously encourage the infant to develop a preferred hand by placing toys and other objects in the infant’s right hand. As the child approaches late infancy (2 years), she begins to prefer the use of one hand. According to the data of McCarthy (1972), at the age of 2½ about 58% of the children have established a dominant hand. Table 5-1 shows that by age 3, 70% have established hand dominance. It is interesting to note that this figure does not change much until age 8½; this suggests that there is a certain amount of ambivalence between the ages of 3 and 7 regarding the development of a dominant hand.

An interesting cross-cultural study by Motegi (1977) showed that hand dominance is not nearly so complete in Japanese children. Although the percentage was nearly the same for 2½-year-olds as that reported by McCarthy, children between the ages of 3 and 4½ are markedly lower in the development of hand dominance. At ages 4 and 4½ less than 50% of the Japanese children had established hand dominance. This is a significant contrast to the 70% figure reported by McCarthy on American children. Data from Belmont and Birch (1963) also add that by age 11, 94% of the children have established hand dominance; the remaining 6% are mixed dominant.

The development of footedness, according to Belmont and Birch (1963), is different from handedness and eyedness in that children establish an early clear-cut preference for a particular foot (Table 5-2). By age 5, 94% of the children in the Belmont and Birch study had estab-
Table 5-1. Hand dominance by age*

<table>
<thead>
<tr>
<th>Age group</th>
<th>N</th>
<th>Right-handed</th>
<th>Left-handed</th>
<th>Total</th>
<th>Percent with dominance established†</th>
<th>Percent not scorable</th>
</tr>
</thead>
<tbody>
<tr>
<td>2½</td>
<td>102</td>
<td>53.9</td>
<td>3.9</td>
<td>57.8</td>
<td>33.3</td>
<td>8.8</td>
</tr>
<tr>
<td>3</td>
<td>104</td>
<td>66.3</td>
<td>3.9</td>
<td>70.2</td>
<td>24.0</td>
<td>5.8</td>
</tr>
<tr>
<td>3½</td>
<td>100</td>
<td>70.0</td>
<td>2.0</td>
<td>72.0</td>
<td>26.0</td>
<td>2.0</td>
</tr>
<tr>
<td>4</td>
<td>102</td>
<td>67.7</td>
<td>3.0</td>
<td>70.7</td>
<td>27.5</td>
<td>2.0</td>
</tr>
<tr>
<td>4½</td>
<td>104</td>
<td>64.4</td>
<td>5.7</td>
<td>70.1</td>
<td>27.9</td>
<td>1.9</td>
</tr>
<tr>
<td>5</td>
<td>102</td>
<td>66.6</td>
<td>3.9</td>
<td>70.5</td>
<td>29.4</td>
<td>0.0</td>
</tr>
<tr>
<td>5½</td>
<td>104</td>
<td>66.4</td>
<td>5.8</td>
<td>72.2</td>
<td>27.9</td>
<td>0.0</td>
</tr>
<tr>
<td>6½</td>
<td>104</td>
<td>67.3</td>
<td>3.8</td>
<td>71.1</td>
<td>28.8</td>
<td>0.0</td>
</tr>
<tr>
<td>7½</td>
<td>104</td>
<td>71.2</td>
<td>3.8</td>
<td>75.0</td>
<td>23.1</td>
<td>1.9</td>
</tr>
<tr>
<td>8½</td>
<td>106</td>
<td>80.2</td>
<td>4.7</td>
<td>84.9</td>
<td>15.1</td>
<td>0.0</td>
</tr>
</tbody>
</table>

*Reproduced from the McCarthy Scales of Children’s Abilities by permission. Copyright © 1970, 1972 by the Psychological Corporation. All rights reserved.
†To be categorized as dominance established a child had to be observed and rated on at least three of the four items on hand dominance, and all of his ratings (whether three or four) had to be consistently right-handed or consistently left-handed. All children who were rated on at least three of the four handedness items, but who did not respond with the same hand each time, were categorized as dominance not established. Children who were rated on two or fewer items (due to items not administered because of the limits of testing, items refused by the child, or the examiner’s failure to record hand preference) were categorized as not scorable. However, a few children who were rated on only two items and responded inconsistently to them were categorized as dominance not established.

Table 5-2. Laterality preferences for children (5 to 11 years)*

<table>
<thead>
<tr>
<th></th>
<th>Handedness (%)</th>
<th>Eyedness (%)</th>
<th>Footedness (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>76</td>
<td>53</td>
<td>85</td>
</tr>
<tr>
<td>Left</td>
<td>10</td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td>Mixed</td>
<td>14</td>
<td>26</td>
<td>4</td>
</tr>
</tbody>
</table>


lshed foot dominance. It has been our experience that children as early as 15 months prefer to use only one foot in kicking a ball.

Eye preference does not exhibit the same degree of laterazation as foot and hand preference. Twenty-six percent of the 5 to 11-year-old children in the Belmont and Birch study failed to exhibit a clear-cut preference for the use of one eye.

An interesting finding from the laterality research is that there are low correlations between preferences for a specific hand, foot, or eye. Many people incorrectly believe that if an individual is right-handed she will also be right-eyed and right-footed. This is not necessarily the case. The reported low correlations indicate that if one is left-handed, there is a good chance that this individual will not be left-eyed or left-footed. Further, if there fails to be consistency across handedness, eyedness, and footedness, there will not necessarily be learning problems or psychomotor problems—a common misconception. Although there is considerable controversy regarding incomplete dominance, left-handedness, and learning disabilities, there are some theoreticians who strongly believe that lateral dominance is a necessary condition for avoiding learning problems.

Before concluding the discussion on handedness a brief comment will be made on the interesting ongoing debate regarding the genesis of handedness, namely, whether handedness is learned or inherited. Most of the available cross-cultural data on incidence of handedness point out that about 90% of the adult human population uses the right hand for skilled activities. You will note that the McCarthy data for children through 8½ years show an 80% incidence of right-handedness, suggesting that
Understanding is not yet complete at this age. Numerous studies have been carried out during the past hundred years in an attempt to determine the genesis of the 90% right-handed phenomenon. A recent comprehensive review by Hicks and Kinsbourne (1976) shows that Wilson reported on a topic called "palaeolithic dexterity" as early as 1885.

Collins (1970) is probably the most avid supporter today of a learning/cultural influence on the development of a preferred hand. He provides some very interesting human and animal studies to support his claim. Hicks and Kinsbourne claim, however, that the overwhelming evidence supports a genetic explanation of handedness. A more recent study by Coren and Porac (1977) using a most unusual "historic" technique also lends some support for a genetic predisposition for left- and right-handedness. Coren and Porac sampled over 1100 pieces of art work from a period spanning 500 years and demonstrated that the incidence of right-handedness before 3,000 B.C. was about 90%, and that this figure has not changed significantly to the present. It is indeed remarkable that this research technique demonstrated similarity in incidence of right- and left-handedness over a period of 50 centuries. Our thoughts on the controversy of the origin of handedness are similar to those of Cratty who stated, "Eye, hand, and foot preference seem initially to be determined by heredity and are later molded by subtle social and cultural pressures" (Cratty, 1970a, p. 42).

Directionality refers to the ability to identify and relate objects or people other than self to each other in terms of left and right (Chancy and Kephart, 1968). In other words, a child has mature directionality capabilities when it is no longer necessary to refer to his own body to conceptualize about positions and directions of objects in external space. It is speculated that this conceptualization is an outgrowth of the development of awareness of one's own body first. That is, it is first necessary for a child to develop an adequate reference system within himself before it is possible to relate objects to each other in external space in terms of right and left. There does seem to be some support for this developmental notion, since lateral awareness is mastered by most children by the age of 7, but directionality skills are not mastered until about 9 years. Perhaps an example will more clearly illustrate the difference between directionality and its hypothesized precursor, lateral awareness.

If one were in a room looking at two chairs with each chair in a different half of the room, the observer (if mature) should conclude that one chair is in the right half of the room and the other object is in the left half. The terms right and left half are totally dependent upon the location of the person who is viewing them. If another individual was located in the same room but facing a different direction, the labels right and left would be incorrect. In this case where the terms left-right are dependent upon the position of the observer, we are employing the use of lateral awareness.

Suppose the concern is not with where the chairs are in relationship to the observer but with where they are in relationship to each other. The observer must then state which chair is to the right or left of the other, without consciously referring to her own body. The observer in essence must place herself in the position of one of chairs and relate this to the position of the other chair. This skill is termed directionality.

It is speculated that incomplete development of lateral awareness and directionality leads to a variety of learning disorders such as having difficulty in distinguishing between b's and d's, inability to read maps, and difficulty in performing certain mathematical computations. Although this hypothesis seems entirely logical, there are presently few empirical data to support or refute it.

The measurement of these body awareness characteristics, namely, laterality, lateral awareness, and directionality, has been confounded to a few instruments that require subject-examiner interaction (Belmont and Birch, 1963; Benton, 1959; Elkind, 1961; Harris, 1957). For example, a child might be told, "Raise your right hand, touch your left ear" (lateral awareness) or asked, "Is the pencil to the right or to the left of the penny" (directionality). It is our opinion that some of the inconsistencies regarding the development of body awareness characteristics and its implications can be attributed to a lack of adequately standardized
measuring instruments. A recent instrument developed by Lockavitch (1977) seems to hold promise for improved research findings in this controversial area.

**SEX DIFFERENCES IN BODY AWARENESS**

Although there have been suggestions made that more boys tend to be left-handed than girls and further that they exhibit more confusion in lateralization (Brain, 1945; Hildreth, 1949), the studies of Belmont and Birch (1963) and Harris (1957) failed to verify this. Belmont and Birch concluded from their study that boys and girls do not differ on right-left awareness. The “hard data” therefore indicate that no significant sex differences exist in the development of body awareness characteristics.

**IMPLICATIONS FOR PHYSICAL EDUCATION**

**Relationship between perceptual, motor, and cognitive abilities**

At the beginning of this chapter it was pointed out that the hyphenated term perceptual-motor referred to the fact that perceptual and motor processes are interdependent components of a moving, growing, and learning individual. It could also be said cognitive processes interact with the perceptual-motor system. The interaction of perceptual, motor, and cognitive processes can perhaps best be depicted by Fig. 5-4.

There are some experimental data that support the position that perceptual, motor, and cognitive processes are interrelated in some ways. For example, evidence was presented earlier from the Held and Hein (1963) experiment showing that movement was necessary in kittens for adequate perceptual development. On the whole it is safe to say that the existence of this relationship is based more on observation and intuition than “hard” experimental data (for example, observations that children with learning disabilities have perceptual problems, motor problems, and often emotional problems). Nevertheless, several psychologists, educators, and other professionals have such a strong conviction regarding the relationship between cognitive, perceptual, and motor abilities that they have proposed so-called perceptu-motor theories that attempt to show causal connections between these three processes. In other words these theorists maintain that movement is essential for the development of perceptual skills and that both of these skills are essential for cognitive development. According to some theorists (Frostig, 1966) perceptual deficits are responsible for learning disabilities in children. This discussion of the relationship between movement and cognitive development is continued and further elaborated on in Chapters 6 and 7. At this time, however, an overview of selected theories that postulate a causal relationship among perception, movement, and cognition is provided.

Perhaps the most controversial theory is that proposed by Doman and Delacato (1959). Doman and Delacato believe that many perceptual, motor, and cognitive disabilities stem from inadequate neurological organization. Doman-Delacato’s central concept is based on the assumption that as the human organism grows, there is successive development of the brain and spinal cord. Doman and Delacato believe that perceptual-motor and cognitive disabilities can be remediated through a process called “patterning.” Their treatment, among other prescriptions, calls for passive and active responses relating to crawling, creeping, and walking. In essence they attempt to restructure the organization of the developing nervous system so that the child can reach full development. It should be pointed out that the Doman-Delacato theory has been heavily criticized by both educators and medical specialists. Although positive case studies have been reported.
the literature, no experimental studies support the efficacy of the theory.

Kephart (1960) has advanced a perceptual-motor theory that involves educating the peripheral functions, rather than central nervous system functions. It is Kephart’s belief that the adequate development of certain motor skills may tend to inhibit the child’s development in other, more sophisticated skills. Kephart argues that today’s complex society no longer offers the child the opportunity to explore his environment, and thus he develops the improper perceptual-motor match. If children do not learn to match sensory data to motor data, difficulties in reading, writing, and movement activities result. Therefore, perceptual inefficiency is suggested as a major cause of initial failure in school. While research results on the effectiveness of this program are contradictory, Kephart’s theory and program have received widespread support among special educators, psychologists, and physical educators.

Barsch (1968) has supported Kephart’s hypothesis by claiming that perceptual processes (visual, auditory, tactual, kinesthetic, gustatory, and olfactory) are antecedents to intellectual development. The quality of perceptions, as suggested by Barsch, is derived from the maturation of skills of movement efficiency.

From earlier efforts by Barsch (1965) came the development of his Movigenic Theory. This theory relates learning to efficient movement patterns. It suggests that movement efficiency is a prime requisite to the total architecture of the human organism. According to the Movigenic Theory the organism matures as it moves. The increased use of symbols begins to replace motoric ways of learning, although symbolic fluency is initially dependent on efficient movement patterns.

Frostig’s training programs have specifically emphasized visual perception as it relates to motor ability (Frostig, 1966). It is her belief that it is important to develop several basic visual skills. These are visual and motor coordination, figure-ground perception, perceptual constancy, perception of positions in space, and perception of spatial relationships. The motor aspects of Frostig’s program are agility, coordination (eye-hand), flexibility, strength, balance, and endurance (Frostig, 1970).

Getman (1962), an optometrist, has advanced the theory that a child’s growth, intellectual development, and behavior are related to movement experiences and visual development. Getman contends that the majority of learning experiences depend on visual perceptions. His perceptual-motor program is organized around six stages—

1. General motor patterns (creeping, walking, hopping)
2. Special movement patterns (eye-hand coordination)
3. Eye movement patterns (matched movement for both eyes)
4. Visual language patterns (effective communication patterns)
5. Visualization patterns (visual memory skills)
6. Visual perception organization

**Summary of perceptual-motor theories and programs**

We have reviewed the basic philosophies of a number of theoreticians who have speculated on the relationship between perceptual, motor, and cognitive abilities. These theories all contain programs that are specifically designed to enhance perceptual, motor, and cognitive development. Interestingly enough, these theories have much in common. The common denominators appear to be—

1. Training to improve basic sensory skills (visual, auditory, tactile)
2. Fine and gross motor activities to improve basic motor skills and facilitate perceptual-motor integration
3. Emphasis on transfer of perceptual-motor abilities to cognitive functioning
4. Primarily designed for children who have learning disabilities

**Role of perceptual-motor programs in the elementary school**

Although the bulk of available research fails to support the contention that perceptual-motor programs improve cognitive functioning, it is our belief that this does not constitute a rationale for eliminating perceptual-motor programs or failing to introduce perceptual-motor programs into the elementary school curriculum. Cratty (1970b, p. 18), for example, has stated:
“Many experimental findings may have no immediate use, while some teaching practices do not require ‘scientific’ verification. They may just make good sense.” We believe this is the case with perceptual-motor programs. Some aspects of these perceptual-motor programs just make good sense. One could criticize research design for failing to demonstrate academic increase through perceptual-motor programs; however, in reality we might not be able, and should not expect, to find direct contributions to academic functioning. We firmly believe—and there is some support for our position—that perceptual-motor experiences make indirect contributions to academic success. By indirect contributions we mean that perceptual-motor experiences may contribute to increased perceptual abilities, motor skills, self-confidence, attention, to better student-teacher relations, and so on, all of which may ultimately affect academic achievement. As a result perceptual-motor programs should not be measured solely by IQ score gains and reading scores, but also by changes in perceptual and motor ability, self-concept, and other important variables (Zaichkowsky, 1975).

Perceptual-motor programs do have a place in our elementary school physical education curriculum, but not at the expense of other important developmental activities. In developing our curriculum we must take into consideration the age and the specific needs of the child. As we see it, perceptual-motor programs can and should serve one of two purposes. They can function as remedial as they historically have, or they may function as preparatory or developmental. A remedial program should be individually structured to deal with the particular disability, such as sensory motor training for the deaf and blind, through the medium of movement (specialized emphasis). The physical education teacher can function as a therapist in a team with other specialists in the school, that is, a psychologist, speech therapist, and reading teacher, in structuring meaningful learning experiences for the child.

We see the preparatory-developmental program functioning in the form of readying the child for learning in a variety of situations. As a matter of fact movement experiences in regular elementary physical education classes should by nature be perceptual-motor activities, stressing gross locomotor movements and manipulative, balancing, and body awareness skills. Activities that are seen as perceptual-motor should, in our opinion, provide the solid backbone for early physical education programs. As the children get older, more specific motor skills should be taught (see Chapter 3). We need trained professionals as well as adequate time allotment for programs. Physical education graduates should, if they are deemed experts in movement, all be given thorough exposure to providing perceptual-motor experiences for normal and atypical children. Classroom teachers in areas other than physical education should learn the fundamentals of perceptual-motor theory through workshops, independent readings, and consultation with specialists.

References

Barsch, R. A movigenic curriculum. Madison, Wis.: State Department of Public Instruction, 1965.


Delacato, C. Treatment and prevention of reading problems. Springfield, Ill.: Charles C Thomas, Publisher 1959.

Eagles, E. L., Wishik, S. M., Doerfler, L. G., Melnicel


**Student projects**

1. Design several activities that help to develop the following perceptual-motor abilities—
   a. listening skills
   b. body awareness
   c. laterality
   d. directionality

   What are the specific qualities of your designed activities that make each one unique in terms of helping to develop these perceptual-motor abilities?

2. Visit a school that offers a program of remedial perceptual-motor training. Does the program follow a particular theory and practice, for example, those of Kephart, Getman, or Doman-Delacato? On what basis are students selected for the remedial program? What age and sex distribution are there in the school population? Do you agree


with their program offerings? What changes might you incorporate?

3. This might best be done as a class project. Several students should be responsible for collecting data on hand, foot, and eye preference for a number of age groups. By visiting day-care centers it will be possible to gather data from children as young as 3 years. Other students would be responsible for data gathering at a kindergarten and still others at elementary and junior high schools with a specific grade approximating a given age. Using the informal measures for hand (throwing, writing), foot (kicking), and eye (aiming) dominance, prepare a chart that will give you the percentage number of children at a specific age and sex with a right or left preference. Are these data consistent with those of McCarthy and Belmont and Birch?