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ABSTRACT

Although there are marked individual differences in the effect of aging on learning and performing motor skills, there is agreement that humans process information less efficiently with advanced age. Significant decrements have been found specifically with motor tasks that are characterized as externally-paced, rapid, complex, and requiring rapid decision-making and multiple responses. The likely causes of poorer performance with age are based on limitations in the ability to: (1) discriminate between relevant and irrelevant input; (2) quickly identify and categorize input into meaningful and familiar information; (3) quickly rehearse a large quantity of information in short-term memory for storage in long-term memory, or pass it on to the decision mechanism; (4) make rapid decisions based on available information; (5) make a series of motor responses autonomously; and (6) interpret and use information about the response in subsequent trials. Despite limitations in cognitive and motor performance that are inherent in aging, the elderly are quite capable of contributing to society and to the maintenance of their own well-being when provided with the appropriate environment in which to function. This paper identifies likely causes of limitations in cognitive processing and suggests guidelines for providing the elderly with quality instruction to facilitate the learning, remembering, and performing of motor skills. (Author/NB)

CHANGES IN INFORMATION PROCESSING WITH AGING: IMPLICATIONS FOR TEACHING MOTOR SKILLS

by

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Abstract

Although there are marked individual differences on the affect of aging on learning and performing motor sl..ls, there is widespread agreement that the human organism processes information less efficiently with advanced age. Due primarily to deficits in the central nervous system, our ability to take in, deal with, and appropriately respond to information decreases with the aging process. Significant decrements have been found specifically with motor tasks that are characterized as externally-paced (in which the speed and direction of the stimulus and response is not under the performer's con- trol), rapid (in which speed rather than accuracy is a primary component), complex (entails more than one component and/or the use of different sense modalities performed almost simultaneously), requiring rapid decision-making and multiple responses. The likely causes of poorer performance with age are based on limitations in the ability to: (a) discriminate between relevant from irrelevant input, (b) quickly identify and categorize input into meaningful and familiar information, (c) quickly rehearse a large quantity of information in short-term memory for storage in permanent (long-term) memory, or pass it on to the decision mechanism, (d) make rapid decisions based on available information, (e) make a series of motor responses autonomously (in the virtual absence of thinking), and (f) interpret and use information about the response in subsequent trials. The purposes of this chapter are to identify the likely causes of these limitations in cognitive processing and to suggest guidelines for providing the elderly with quality instruction to facilitate the learning, remembering, and performing of motor skills. The objective of this chapter is to demonstrate that despite limitations in cognitive and motor performance that is inherent in aging, the elderly are quite capable of contributing to society and to the maintenance of their own well-being when provided with the appropriate environment in which to function.

AN INFORMATION PROCESSING APPROACH FOR

TEACHING MOTOR SKILLS TO THE ELDERLY

As the average age of our population continues to climb, the care and well-being of the elderly will of increasing importance. Improvement in health through advancements in medical research will bring a longer life span to the older members of our society. But merely living longer is not enough. Logically, these individuals should continue to lead productive, satisfying lives. Government, in an attempt to reduce ever-increasing costs in health care is concerned with improving the person's quality of life rather than merely prolonging it. This includes, as scientists and health care workers have already found, maintaining a physically and mentally active lifestyle. It is apparent that educators, medical practitioners, and recreation leaders will carry the burden of providing older citizens with the opportunity to meet this need. The federal government, for example, recognizes the potential contributions of older members of the work force by prohibiting mandatory retirement in federal jobs. And an increasing percentage of the population will be spending more and more time in recreational pursuits. What this all means is that the need of older persons to learn and perform physical skills, for a variety of physiological and psychological reasons, will continue to grow.

The purposes of this chapter are: (a) to discuss the unique needs of the elderly as learners and performers of motor skills, and (b) to describe the use of instructional techniques in teaching motor skills that meet these needs. To understand the psychological factors which underlie motor skill acquisition and retention, an information processing model will be used to detect how a person deals with information and the changes that occur with age. Once we can identify the effect of aging on a person's ability to process information, guidelines can be offered on the teaching of motor/sports skills which utilize the individual's strengths and minimize his/her weaknesses. Thus, the chapter will be divided into four sections: (1) describing an information processing model for learning and performing motor skills, (2) identifying the structures and processes in the model which are uniquely affected by aging, and (3) teaching motor skills which meet the particular needs of the elderly performer.

Before continuing, three issues need to be addressed in order to keep the aging process in perspective. First, it's important to remember that <u>each person ages differently</u>. Some age sooner than others or have certain limitations that are unique to that individual. This chapter is concerned with tendencies with aging that may or may not be experienced by an older person. Second, the term "elderly" is defined differently among research scientists. Is there a difference in a person's ability to learn and perform motor tasks at age 65 years than at 75 or 80? Apparently there is. Butler and Lewis (1977) categorize the elderly as young-old (ages 65-74) and old-old (age 75 and older). It is widely held that the salient deficits in performing motor skills, when compared to younger persons, is far more prevalent at the old-old stage (Welford, 1969, 1977).

The third issue is crucial to any attempt at analyzing the effect of aging on performing cognitive and motor tasks - the role of physical activity in the way an older person thinks and performs. Reviewing the literature on the effects of physical activity on performing motor skills goes beyond the purpose of this chapter. Nevertheless, it is important to recognize that despite the normal deficits that occur with age in performing physical and cognitive tasks, a program of vigorous exercise markedly slows the aging process (see Shephard, 1978 and McPherson, 1986). This is also true in terms of the persons information processing capability - to perceive an event, decide what to do about it, and then carry out the action decided upon Spirduso & Clifford, 1978).

<u>Information Processing Models</u>

Through observing the behaviors of individuals in response to various environmental demands and features, scientists have been able to identify certain structures and processes in the performer's central nervous system that describe learning and performing skilled movements. For example, Welford (1968), among others, determined that the performer must identify information before a decision can be made to respond to it. The greater amount of data that must be identified, the slower the response. These identification and response functions were subsequently referred to as perception and decision mechanisms, respectively. So, as you'll see shortly, most information processing models include these structures as components of how person's take in and react to information - hitting a baseball, for instance.

Numerous information processing models exist in the literature. The models that will be used in this chapter are adapted from Marteniuk (1976) for performing motor skills and Singer (1980) for learning and remembering them. Each are based on a multitude of research studies.

The Human Performance Model

It will become evident that human performance is dependent on the individual's ability to sense, attend to, process, store, and transmit information. The human performance model is illustrated in Figure 1. It depicts in input of stimuli in the form of informative or irrelevant data, sense organs, a filter device, the perceptual mechanism, the decision mechanism, the effector mechanism, muscles, internal feedback, and external feedback.

Insert Figure 1 about here

Incoming stimuli. The awakened human organism is constantly bombarded with a vast array of input, some of it meaningful and informative and some of it nonsensical. Light, sound, touch, smell and taste are examples of the types of stimuli that impinge on the sense organs, often simultaneously. Actually only data that is informational in content, i.e., of some potential meaning to the person, what Singer (1980) calls, situational information, is susceptible to subsequent processing.

Sense organs. These are the receptors of this information - what we see, hear, feel, smell, and taste. The sensoe organs are responsible for receiving information, cues, and signals. When it comes to learning and remembering motor skills, the most important of these senses is sight, with tactual information becoming more important at later stages of performance (Fleishman, 1972). It is imperative that learners have visual information from which to determine the demands of a task and observe the correct manner in which it is performed. Ironically, sight becomes measurably less efficient in comparison to auditory input in older persons. More about this later.

Filter mechanism. Imagine being bombarded with so much information that none of it made any sense. In fact, less fortunate individuals have a nervous disorder in which they are unable to sort out what they should attend to and what should be ignored. Broadbent (1958), in his filter theory, was probably the first to hypothesize the existance of a neural structure, which he labeled a "filter." This structure allowed a person to selectively attend to and process input that was thought to be the most pertinent, meaningful, and familiar to the individual. This important process is called selective attention. It prevents or inhibits non-meaningful, redundant, or irrelevant data that might interfere with learning, making rapid decisions, and responses. This filter mechanism has been shown to deteriorate with age, and therefore has important implications in teaching motor skills to the elderly (Welford, 1958).

Perceptual mechanism. So far, information is entering the system and the person is attending to it. But it is not meaningful until it is identified or categorized. The perceptual mechanism is critical to further processing because it is here where the input goes in one, two, or three directions simultaneously: (1) to the decision mechanism where the person passes the information on to determine the immediate course of action, (2) to short-term memory (STM) where new information is rehearsed and is either passed to long-term memory (LTM) for permanent storage or to the decision mechanism for subsequent action, and/or (3) to LTM where information which was previously stored is contacted and identified. As we'll see later, perception, an area that is critical to rapid decision-making and predicting future responses, becomes inhibited due to aging. Although, as we'll also see, something can be done about its deterioration.

Decision mechanism. A performer might ask, "Which way do I go?", "When do I begin my response?", or "Do I go left or right? Forward or backward?". In fact, not responding at all might be a decision. The primary objective of the decision mechanism is to decide upon a plan of action "by selecting from memory an appropriate plan that will suit the specific needs of the situation" (Marteniuk, 1976, p. 23). Here, the performer is searching for the correct plan of action just prior to its initiation, the result of which comprises the effector mechanism.

Effector mechanism. Have you ever marveled at your ability to walk and chew gum at the same time? Imagine how difficult it would be if you had to plan and think about every movement. Performance would be relatively slow, while lacking coordination and efficiency. In advanced competitive sport, most athletes engage in a series of rapid responses in the virtual absence of thinking. Only in this way can they execute a series of complex movements simultaneously in a coordinated, efficient manner. They can do this by the development of what is called a motor or movement program (see Schmidt, 1982 or Singer, 1980). A motor program, then, is a plan of action or a series of pre-planned movements that is performed automatically. Whereas the decision mechanism is "On your mark, get set," the effector mechanism is the "Go!" The effector mechanism is apparently unaffected by aging.

Muscles. The contraction of muscles causes a physical response. Although there are obvious decreases in muscular strength and endurance with aging, any deficit in the processing of information is not due to changes in muscle tissue. As we will discuss later, the source of changes in performing motor tasks is found in the central nervous system (Marteniuk, 1976; Welford, 1958). The primary importance of muscular responses in motor skill acquisition is its provision of internal and external feedback.

Internal feedback. Skilled performers often know in advance whether their response is accurate. This is because a multitude of practice attempts offers response-produced feedback which feeds back into the effector mechanism and allowing, if time permits, corrections to be made as the movement proceeds. This internal "feedback loop" is based on information about the desired speed, location, distance, expended energy, and force of movement provided by mechanisms located in the muscles and tendons (see Sage, 1977 or Dickinson, 1974, for a further explanation). The type of feedback that compares actual performance with the intended movement is called knowledge of performance (KP).

External feedback. What was the result or outcome of the movement? Here, the person compares what a movement accomplished with the intended goal. ..his is referred to as knowledge of results (KR), a necessary component of learning (Singer, 1980, among others). In a superb critical review of the motor learning literature on the effects of KR in the psycho- motor area, Salmoni, Schmidt, and Walter (1984) contend that KR is almost exclusively verbal in nature rather than visual or tactual. They argue that a learner can observe the end result of their actions but may be unable to detect the causes of their performance error without verbal input from an expert observer. Traditionally, others (Gentile, 1972; Magill, 1985; Marteniuk, 1976, among others) described KR as information about performance outcome that reaches the individual in visual as well as verbal form. However, it is agreed that a person who verbally interprets the process of movement in attaining the goal, i.e., explaining the reasons for the performance outcome, is engaging in augmented knowledge of results.

The Motor Learning Model

The primary component of learning something is storing it, in this case, skilled movements, in memory. Thus, the structures that will be added to Figure 1 will be concerned with the storage and retrieval of information into and out of memory - actually two memories, short-term and long-term (see Figure 2). In an adaption from Singer's (1980) model of processing informa-

Insert Figure 2 about here

tion, the ability to remember and reproduce skilled movements is a function of the ability to store them, a process psychologists call <u>encoding.</u> Encoding is the ability to transform information into a form that is meaningful to the learner to facilitate its later retrieval, i.e., the process of decoding (Norman, 1969). These processes occur in STM and LTM.

<u>Short-term memory.</u> Marteniuk (1976) defines STM as "a memory system that rapidly loses information in the absence of sustained attention of that material" (p. 85). Thus, after information is identified in the perceptual mechanism, the person covertly rehearses it - sustaining attention - which allows it to be acted upon in some way. Either the person can make a decision based on this data or it can be stored in LTM. How long must information be acted upon before it's lost? Researchers aren't certain, but the best guesses are that unless new input is rehearsed from between 20 to 60 seconds, it will be lost (that's why we do not remember every word we read in a sentence; to do so would require rehearsing each word). However, if the information is familiar to the learner, it can be transferred to LTM rather than forgotten. Two important points surface about STM with particular reference to the elderly: (1) that familiarity of new information facilitates its retention, and (2) that remembering information requires the opportunity and time for covert rehearsal. In other words, learning is a relatively slow process for people of any age.

Long-term memory. Scientists tell us that human use only about 10 percent of their capacity to remember information. So it is virtually certain that we have the capability to learn remember new things throughout life no matter what our age. Long-term memory is limitless. But the best news about LTM, especially when it comes to remembering motor skills, is that it's permanent and enduring. "Once you've got it, you've got it," as one professor noted.

From an information processing prospective, our ability to retain a skill is based on the manner in which it is encoded and stored. Perceiving incoming information that has been previously learned is a function of its contact in LTM where it has already been encoded and stored. Then, upon its return to the perceptual mechanism, the data travels either to the decision mechanism if a rapid response is needed. But what if the learner has more time to think abuot the information and wants to remember it permanently? In this case, the data may go to STM where it will be rehearsed prior to making the decision.

A key trait of LTM is that using it is relatively time-consuming in comparison to reacting quickly to external stimuli. Retrieving information out of LTM is a primary activity that separates older from younger performers (discussed later). One primary purpose of this chapter is to explain the most effective instructional strategies to help ensure the storage and retrieval of skilled movements in LTM.

Summary of the Information Processing Models

The processing of information after it enters the system is a series of complex transmissions in order to perform skilled, meaningful movements. Learning a motor skill requires more thinking and, hence, takes more time then executing movements that have already been mastered. The primary component of the learning IP model are the memory stores. The perform- ance model, however, is based on taking in and reacting to information very quickly, sometimes in the virtual absence of cognitive activity. A summary of these rapid responses found in the IP performance model is typically in the following sequence:

(1) Stimuli enters the system through the sense organs (primarily eyes, ears, and touch in performing a motor skill),

(2) A barrage of data, especially if it was non-meaningful, would prevent a person from making sense out of it. So a filter mechanism prohibits the entry of certain input while allowing the most pertinent, familiar, and intense (e.g., brighter or louder) stimuli to continue the processing journey.

Information that is "filtered out" is unattended and leaves the system.

(3) The arriving information is then identified, organized, and/or categorized. A ball in flight is visualized, i.e., perceived, and its features such as its location, trajectory, and speed, is continuously and quickly analyzed.

(4) Based on this analysis - in reacting to a single stimulus, this analysis might take only 200 milliseconds, less than one quarter of a second - a decision about the timing, extent, and direction of the overt response.

(5) The decision to "go" stimulates a motor program in the effector mechanism. This program is comprised of a pre-planned series of actions that hae been previously learned and executed in automatically - without thinking about what to do and how to do it.

(6) The motor commands are sent to the muscles for coordinated, skilled movements.

(7) How did the act feel? Was it executed properly? How does the intended movement compare to what actually occurred? During and immediately after the movement the performer receives internal feedback (knowledge of performance - KP). This information, provided internally in the nervous system and externally through verbal instruction (augmented KP), is used to make corrections in the program and in subsequent actions.

(8) What was the result of the movement? Did the movement accomplish the intended outcome? This second type of information feedback is called knowledge of results - KR. The person uses this information to correct errors in performance and to make alterations in future responses.

The IP learning model is comprised of many of the same features in the performance model, but is somewhat more complex due to the use of memory stores where skilled movements are remembered. The learning model is identical to the performance model with the exception of processes which occur in STM and LTM.

Upon being identified or recognized in the perceptual mechanism, the stimuli will either:

(a) be retrieved from LTM where it may have been previously learned and stored (e.g., the height and trajectory of that ball tells me to move back for the catch),

(b) be contacted in STM where it will be mentally practiced before being permanently stored in LTM (e.g., "To do 'this' I have to do 'that'") and/or be retrieved from LTM in preparation for making an accurate judgment in the decision mechanism (e.g., "I remember this. What I have to be able to do is 'that.'"), or

(c) go directly to the decision mechanism if maximal response speed is required ("Ready, go!").

One of the more salient features of the IP learning model is the extra time it takes to process information to learn and make an effective response. Although this is characteristic of learners of all ages, the relatively older individual needs somewhat more time than his/her younger counterpart. The next section will review how the processing of information for learning and performing motor skills changes with advanced age.

Information-Processing and Aging

It is becoming increasingly less popular in our aging society to inform an elderly person about deficits in the way a person thinks and performs physical tasks simply due to the aging process. As one elder told me after a conference presentation, "This old gal is doing just fine." Indeed, the older person who maintains a physically and mentally active life will "age" less quickly and, in some tasks, perform equally to or better than others much younger (see the next section for a brief literature review on this topic). Undoubtedly, the above respondent was doing "just fine." But the aging process does result in slower, less efficient motor performance under certain conditions. Lets pinpoint where this slowing occurs and under which conditions based on the manner in which we process information.

Sense organs. Aging affects the detection of both visual and auditory cues. Elders are less able to visually focus on the relevant environmental cues. Because of visual limitations with aging, older people are more dependent on auditory input to obtain information as the basis for making decisions and responding. However, although audition tends to be stronger in the elderly than vision, higher pitched tones are more difficult to perceive. This presents a problem when speaking to an older person in a relatively loud voice. An increase in vocal amplitude raises the pitch of a person's voice making it more, not less, difficult to hear. In addition, older person's are aware of being addressed in a loud manner and are often embarrassed by it. So, sh-h-h-h, keep it down.

Filter. This is a primary area where the system begins to deteriorate with age. To understand the deficit in this segment of the processing system, imagine having a conversation while attending a football game with the crowd cheering all around you. You can hear the other person but with far more difficulty than if you communicated when the stadium was less populated. As our hearing begins to become less acute with age, we become more susceptible to "neural noise," i.e., random neural activity (Welford, 1962). The relationship between the ability to detect a signal and the interfering neural activity is called the signal-to-noise ratio. According to Welford, "Various neurological changes in the brain and falls in the sensitivity of the sense organs, such as are known to occur in older people, would tend to lower the signal level, and...ambient 'noise' level tends to rise with age....The signal-to-noise ratio would be lowered and the information transmission capacity thereby reduced" (p. 141).

Perception. There is a disproportionate rise in time to respond to a stimulus as the task becomes more difficult with older performers (Brinley, 1965). There are two probable causes for these slower reactions. The first concerns the person's immediate response to a stimulus - reaction time. The second cause is a function of limitations in short-term memory.

Reaction time (RT) has been described as that period of time from the presentation of a stimulus to the beginning of a muscular response. Although older people show greater variability in their performance, they do not tend to be statistically different than younger persons in simple RT, i.e., making one response to a single stimulus (Shock, 1962, among others). However, when response demands become more complex, e.g., having more than one signal or response alternative, marked slowing in the elderly exists (Welford, 1958). The causes of this slowing goes beyond the scope of this chapter, but these observations should be considered in providing motor skill instruction to older people.

Short-term memory. Short-term memory is especially important in learning motor skills. During skill acquisition, the individual tries to add each of the skill's parts together in a progressive manner until the whole movement asumes a form of its own (Marteniuk, 1976). One of the functions of STM is to take in and rehearse information for immediate use, usually for purposes of decision-making. Another function is to register and store information in long-term memory. Extensive reviews of the literature by Craik (1977) and Welford (1958,1977) for cognitive and motor tasks, respectively, indicate that age-related decrements occur more conclusively for planning and decision-making than for storing input. Researchers contend that deficits in STM are due primarily to less ability to rapidly integrate and rehearse new data, especially of a complex nature. This limitation dissipates in closed tasks when the speed of information is relatively slower (Anshel, 1980).

Greater susceptibility to irrelevant, interfering stimuli, a preoccupation with monitoring the previous response, difficulty in focusing attention to the proper cues - an attentional deficit, and a decrease in visual and auditory acuity all partially explain age-related changes in STM. This is particularly the case with tasks which involve the processing of visual, as opposed to auditory, stimuli (Craig, 1977). The good news is that elders and younger persons are similar in the ability to remember a motor skill relative to initial performance (Anshel, 1978).

Long-term memory. The permanat storage of information and motor skills is generally resistent to aging. In his literature review, Cratty (1973), in agreement with Anshel (1978, 1980) and Craig (1977), concluded that "long-term retention is less affected by old age than is short-term memory of immediately needed performance elements" (p. 242). Tasks which are highly motoric are more impervious to forgetting compared to more cognitive tasks. The results of past studies in the verbal learning literature, however, indicate that age decrements are more likely and more severe in tasks that involve recall than recognition (see Craig, 1977). Thus, it appears that any significant loss in LTM is likely due to the failure to store the novel skill in LTM rather than the ability to retrieve it, although more research is needed in this area (Singer, 1980).

Decision-making. In addition to STM, perhaps the most salient performance deficit with aging occurs in the decision mechanism. Older people differ more from younger ones in the time taken to make decisions to initiate an action as describe in the perception section. These differences are noted in choice reaction time tasks when the person is offered more than one stimulus and/or given more than one response alternative. Birren and Botwinick (1955) found that age groups differ as a function of the choice of which response to make. According to Singleton (1954), "The difference (with older subjects) in overall speed is not due to slower movements so much as to longer times spent at points where the movement direction must be altered" (p. 171).

The probable cause of slower decision-making capacity is that older persons spend more time (up to .5 sec) monitoring their previous response before swithcing attention to a new signal. This is particularly true in continuous-type tasks which require a rapid response. Thus, the processing of information from perception to decision-making is delayed.

Motor programming. The ability to perform a series of well-learned responses automatically is not dependent on age. People of all ages are capable of performing at, what Fitts and Posner (1967) call, the autonomous stage. But elders are less able to program a series of actions due to their preoccupation with monitoring their past actions (Welford, 1958). The elderly are more concerned with accuracy than speed. This is likely due to both neurological (lower signal-to-noise ratio) and social reasons (they are more self-conscious than others about being perceived as incompetent). The key issue is that programming a series of movements is less dependent on age per se than on the behavioral tendencies of older persons during the performance of these movements. The elderly prefer, and can more easily program, tasks which are relatively low in speed and complexity.

Muscles. Despite the obvious decreases in muscular strength and endurance that occurs with age, differences in movement speed and accuracy between younger and older individuals are a function of changes in the central nervous system, not because of muscular deterioration. However, there is a slowing of sensory and motor fibers past the age of 50 years (Mayer, 1963). This means that although the ability of muscles fibers to contract is not significantly slower later in life, the speed at which signals translate perception into action does slow down. Why? Accoding to Mayer, with aging (1) there is a degeneration of nerve fibers, (2) the oxygen supply to nerve cells slows with age which decreases cell metabolism, (3) the temperature of nerve branches become lower, and (4) the peripheral neuromuscular system becomes less sensitive. It is perhaps at this point, more than anywhere else, where vigorous physical activity is most beneficial, an issue discussed shortly. As Cratty (1973) concludes, "differences in movement speed (as a function of age) seems to be caused by a lessening of the ability to integrate input to output in the central nervous system, rather than to movement capacities at the peripheral level" (p. 241).

Using feedback. Because the elderly monitor the accuracy and success of their responses more closely than younger performers, information feedback is a valuable asset in learning and performing motor skills. To compensate for this extra time, elders need - and take - longer to view input. This can be good and bad. This can work to the person's advantage in that feedback is frequently solicited in the form of knowledge of results and used for future performance attempts. But the potential disadvantage is that a preoccupation with outcomes can prohibit the intake and use of knowledge of performance (KP) in which attention if focused internally on the correctness of movement execution rather than only on the results. In other words, the person may acknowledge a lack of success without knowing its possible causes and how they should alter future responses.

Ironically, there is evidence that elderly learners do not use information feedback as effectively as their younger counterparts. This is particularly true with continuous tasks when each signal or movement follows immediately after a response. For example, Brown (1961) found that older subjects failed to utilize important directions that ostensibly would have facilitated comprehension of a complex motor skill. One possible reason for not using feedback efficiently is again related to the tendency of older performers to monitor their previous response. This makes them less receptive to external input. This view is supported by research that shows that the elderly tend to make more errors of omission (exclude necessary skill components) than commission (make performance errors) (Talland, 1959, among others).

Teaching Motor Skills to the Elderly

We know some of the information processing limitations that accompany the aging process. There are changes in the ability to take in, deal with, and respond to internal and external information with advanced age. These changes require certain considerations when teaching motor skills to an older person. The purposes of this section are to determine the optimal conditions and instructional strategies for teaching motor skills to the elderly. Instructional considerations will be linked with the unique needs of older learners given the changes in their ability to process information. But before doing so, there are a few pre-instructional issues that should be addressed which directly affect teaching success. These issues center on the social and psychological needs of the elderly.

Lets face it, many societies in the world, certainly in North America, do not have a very flattering stereotype of the older person. They are perceived in a relatively negative, disrespectful manner. Consequently, many people who interact with the elderly are less than cordial, sensitive, and understanding their needs. Gerontological researchers (see Butler & Lewis, 1977) have found that the attitudes, feelings, behaviors, and perhaps most important, the capabilities of many elders are far superior to the less complimentary traits commonly held by others. The ability to successfully teach a motor skill to an older learner is directly linked to understanding and responding to these unique traits. Here are the four most salient issues that relate to an effective teaching and learning situation.

1. "We're not identical, you know." One unique trait about the elderly population as opposed to their younger counterparts is the extent to which older people differ from each other. This is particularly true with respect to learning and remembering verbal material (Craik, 1977) and perform motor skills (Welford, 1979). One probable cause for

these differences is the relationship between the person's lifestyle and subsequent cognitive capabilities. As Goldfarb (1975) concludes, "...persons who continue in work or who have equivalent activities have better memories in chronologic old age than those who do not" (p. 154). Therefore, the educator should not consider all older people similar of mind, body, and spirit.

2. "I'm not a child, you know." Older people do not like to be patronized. These are people who, in many cases, have struggled to survive in their early years and have earned the right to be respected like any other person. They are most annoyed when they are not. Any coach in sport knows that stressed, under-motivated athletes will not perform up to their capability. Teachers know that students will become underachievers if treated in a condescending, unpleasant manner. The older learner will react similarly. The person who interacts with the older adult in an appropriately respectful and sensitive manner will receive a similar response. As Johann Wolfgang von Goethe, a German poet, once said, "Treat people as though they were what they outght to be, and you help them to become what they are capable of being."

3. "Why are you shouting at me?" Have you noticed how many people tend to raise their voice when addressing an elderly person? The speaker is likely making the assumption that aging and poor hearing go hand-in-hand. To some extent, it does. We do lose a certain degree of auditory acuity. However, the auditory component that a person loses first are higher pitched sounds. And when a person raises his/her voice, which direction do you think the pitch goes? If you said "up," you're right. The higher pitch that accompanies a louder voice makes it more, not less, difficult for an older person to process auditory input, especially if they are wearing a hearing device. Further, the elderly are usually conscious of the speaker's raised voice - and they are embarrassed about it. Clearly, then, speaking louder to an older person is contra-indicated unless advised otherwise.

4. "I hope I don't fail." Older people suffer from very low self-confidence. This is an especially important point when it comes to learning and performing motor skills. Without the feeling that learning and performing skills is attainable - even likely - the person will not make an optimal effort to be successful. The teacher's job is to develop and maintain sense of self-confidence and trust in the older person. This entails two instructional strategies: (a) The environment must be risk-free. That is, the learner must feel that it's desirable to attempt new skills without any fear of retribution. There must be no fear of failure. And, (b) the teacher should provide reinforcing comments about the learner's efforts, improvement in performance, and of course, the response outcomes if they are in fact successful.

Turning now to the instructional process, lets first consider the structure or process within the IP model that changes with advanced age followed by the recommended instructional strategy.

Sense organs

The elderly: (1) are more reliant on auditory than visual information due to a marked decrease in visual acuity and a marked slowing in the speed of visual processing as opposed to processing auditory data, and (2) are more susceptible to interfering environmental stimuli - both visual and auditory -than are younger people.

Instructional strategies. (1) Offer verbal cues before and during task performance. For example, Gallway (1974) suggests that a person overtly verbalize the words "bounce" and "hit" when visually tracking and hitting a tennis ball, respectively. Also, the instructor should verbalize information a person needs to know before learning and performing the task instead of, or in addition to, reading it. And finally, the instructor should verbalize feedback on the quality of the individual's performance rather than relying on visual input to obtain information about the response. (2) The learning environment should be void of factors which could interfere with the individual's ability to perceive input. The elderly need stronger input cues than younger learners to overcome limitations in the functioning of sense organs (Welford, 1958). Examples include unusually bright or poor lighting, inclement weather conditions, extraneous noise, and a low figure-ground discrimination, i.e., the manner in which a person selects and visually tracks objects from their backgrounds and the relative dependency on the object, or its surroundings, when making perceptual judgments (Cratty, 1973). Objects should have a color and/or shape that is distinct from their background. In short, keep the surrounding performance environment void of distractions and the objective of the task salient to the performer.

Filter

Older learners have more difficulty separating relevant from meaningless input, especially when the content is complex and enters the system rapidly. Typically, the type of information that passes through the filter is meaningful and familiar to the person and is viewed as purposeful for successful task completion. Thus, using a person's name during skill instruction is highly beneficial to establish the person's proper level of arousal (readiness) and facilitate the appropriate attentional focus.

Instructional strategies. To help older learners deal with, what is perceived as, a barrage of rapid information, teach them what type of input to ignore. The best way to do this is to facilitate the person's attentional focus on the relevant cues based on the guidelines of Robert Nideffer (1981). Nideffer originated the concept of attentional style in which each person have a predisposition for directing his/her attention in a certain direction - internal versus external and narrow versus broad. A more important component of Nideffer's theory is that each skill has certain attentional requirements, and that performance success is partly based on attending to the proper task components. For example, shuffleboard requires a narrow, external attentional style as the performer focuses exclusively on the target for which he/she is aiming.

Thinking about a response strategy before making the actual movement entails a broad, internal attentional focus. The teacher, then, should first determine the appropriate attentional needs for each task and help develop the older learner's ability to meet these attentional demands.

Perceptual Mechanism

At the perceptual stage, the person's is asked to identify, categorize, and transform incoming information into something that is meaningful and, if necessary, quickly stored or retrieved from the memory stores. Adamowicz (1976) refers to perception as the "registration phase" (p. 45). Although the filter mechanism dismisses most of the unnecessary and intrusive input, perception is where information is acted upon and given meaning for further processing, e.g., decision-making, covert rehearsal in STM, or permanant storage in LTM. Thus, the ability to make sense out of the input is crucial before it can be acted upon and given an appropriate response. Under certain conditions, the aging process decreases a person's ability to perceive information accurately and expeditiously.

It is important to remember that actions which follow the perception of information can be performance-based, such as rapidly responding to a stimulus, or learning-based, for instance rehearsing information before it is stored in long-term memory or acted upon where it is used immediately for decision-making. Therefore, suggested guidelines for teaching motor skills to the elderly differ in accordance with the objective of the task, making rapid responses with relatively little cognitive activity (performance) or engaging in slower movements which allow for rehearsal and storage (learning).

Instructional strategies. Strategies that facilitate perception in the elderly to learn and perform motor skills are a function of: (1) anticipating incoming information, (2) pointing out the relevant features of the task and the environment in which it will be performed, and (3) consolidating these relevant features into meaningful and recognizable units. Singer (1980) suggests using the following techniques to enhance the perceptual mechanism:

(a) Develop the proper sensory and motor set. "Set" is a person's readiness to use appropriate sensory modalities to receive information (Brinley, 1965). When an athlete hears, "On your mark, get set, go!" his/her set should be focused on the starter pistol. This sense of auditory readiness is referred to as sensory set. However, sometimes it is more appropriate to focus one's attention internally on the physical response, just prior to lifting a heavy weight in power lifting, for instance. Attention that is directed to the movement in response to a particular stimulus is called motor set. When attention is directed toward the proper set, perceiving and reacting to the stimulus occurs more quickly.

(b) Develop anticipatory cognitive strategies. What are the demands of the approaching task? What environmental considerations should be acknowledged prior to receiving the information? Successful baseball pitchers know that the ability to throw a curve ball accurately in a situation that requires a strike will greatly enhance their success because the batter is probably expecting a fast ball. Help the older performer deal with subsequent input by providing cues about response alternatives, e.g., "Watch out for 'such and such.' If 'this' happens, than do 'that' but if 'that' happens, be ready to do 'this.'" The ability to predict stimuli greatly improve the person's ability to deal with, and respond to it quickly and accurately.

(c) Analyze the features of the task and the environment. Performance improves when skills are learned and executed in the proper context and situation. Instruction should consist of practicing how to deal with incoming stimuli or with producing skilled movements: (1) in the proper sequence, and (2) under conditions that simulate the actual demands of the task. Learning to operate a wheelchair, for example, might include making sudden stops and quick turns to the left or right, or descending steep embankments. Each hand has a certain task that should be executed in a particular manner. These skills should first be learned under simulated conditions and then performed under simulated conditions before skill mastery is assured.

But perhaps the most efficient way to deal with perception in old age is to provide an environment or situation for the older person that is compatible with certain processing limitations which were mentioned earlier. Examples include:

1. requiring or allowing longer viewing time of stimuli before a response,
2. reducing the speed of the incoming information,
3. allowing more time for the person to alter the direction of movement,
4. using cues that remind the person of previously learned tasks, e.g., "Remember when we did 'such and such' yesterday? Well, try to do the same thing but this time do 'this.'" According to the educational psychologist Robert Gagne´ (1977), one of the most effective ways to promote learning is to attach "old" learning (i.e., what a person has already mastered and retained) to "new" learning.
5. allowing more time to monitor the previous response before presenting a new stimulus. Remember that older people are more concerned with accuracy than speed.

Short-term Memory

They don't call this "working memory" for nothing. Much activity occurs in STM before, during, and after performing a motor task. The aging process reduces the ability of STM to take in and remember information that is, for the elderly, relatively complex, rapidly produced, and abundant.

Instructional strategies. There are several very clear recommendations in teaching motor skills based on these STM deficits.

1. Have the older person engage in self-paced tasks instead of externally-paced activities. Having an environment in which the individual is able to regulate the speed of incoming information and outgoing responses is an important factor in performance success.

2. Instruct, and allow, the person to use self-talk as a self-induced mental strategy. This reinforces the objectives of STM processing.

3. Researchers have found that a greater age-related deficit in STM occurs in the storage/encoding phase of learning rather than in the retrieval of permanently stored information. This means that the learner should try to store meaningful cues that can be subsequently used to retrieve information.

4. Another reason to rehearse cues is that it reduces the amount of information a person is asked to store, an important factor because aging results in less effective coping with too much input as compared to younger learners. Further, storing cues - which represent a larger chunk of information - allows the person to retrieve more information when that cue is contacted in LTM. Researchers (Adamowicz, 1976; Welford, 1977, among others) contend that the inefficient use of retrieval cues could be an important reason for a deficit in STM with advanced age.

5. Promote the use of mental imagery throughout the learning process. Evidence exists that a greater amount of information can be covertly rehearsed in STM if it's in imaginal, as compared to verbal, form (Pavio (1971) (see Harris & Harris, 1984 or Orlick, 1986 for the proper use of imagery strategies). Mental imagery is also apparently a useful technique to facilitate the storage and recall of information in LTM.

Long-term Memory

We never stop becoming surprised at an older person's uncanny ability to recall events, feelings, and skills from decades ago. Anything that could be remembered from over 50 years ago had to have been quite important and given some thought over the years. Indeed, researchers have found that LTM is probably the least cognitive process affected by age. For example, Wimer and Wigdor (1958) found that older subjects took nearly twice as many trials to learn as did the younger subjects. But the age groups did not differ in terms of retaining what they learned. They concluded that "the primary deficit in old age seems to be in learning ability, not retention"

(p. 295). And Hulicka and Weiss (1965), in support of Wimer and Wigdor's results, found no age differences in reall after a 1-week interval for material that had been learned to criterion. Welford (1966), however, acknowledges that aging does affect LTM. Based on his review of the literature, he concluded:

> Although the knowledge and experience stored in memory obviously increase with age, there are signs that older people often have difficulty in getting at it when required. This difficulty probably accounts for the longer time taken by older people to identify objects - a slowing which, although not great in absolute terms, can nevertheless cause hestitation and confusion in the face of unexpected events (p. 5).

Instructional strategies. It seems that the primary objective in teaching motor skills to the elderly is the efficient storage of it into LTM rather than how to retrieve it. However, as Welford (1966) suggests, retrieval can be a problem if elders are not given sufficient time to do so. The following suggestions to facilitate the storage and retrieval of information from LTM appear warranted.

1. If older people need time to identify objects and finding previously stored input, give it to them. Don't rush the person to recall information faster than is absolutely necessary.

2. Even better, avoid placing an older person in the position where the rapid recall of information is required. Slower, stable environments are more compatible with the needs of older people.

3. Researchers have found that a far more common memory deficit occurs in recalling information than recognizing it (see Craik, 1977, for a review). Thus, provide visual and auditory cues that allow the person to scan his/her LTM for that can help detect stored material.

4. One technique that has been shown to improve recall/recognition in LTM is <u>mental imagery</u>. In his theory of dual-coding, Pavio (1971) asserts that information can be encoded and stored in two forms, verbal (linguistic) and nonverbal (imaginal). Consequently, input stored in both forms is more accessible than input stored in only one system.

5. The principle of <u>encoding specificity</u> (cf. Gagne', 1977) indicates that recall from LTM is improved when the person uses the same cues when retrieving information that were used during its storage. This suggests that it would be preferable to attach new input to previously stored information. The person should be asked to recall something from the past that they could already perform or had previously learned to meet new task demands.

<u>Decision Mechanism</u>

There is a noticeable slowing in the decision-making process with aging. The primary source of this deficit is thought to be within the central nervous system in deciding what movements to make rather than in the execution of those movements. Another reason for making slower decisions is the greater tendency of elders to spend time - perhaps 150 to 200 msec) monitoring their previous response before switching their attention to a new signal. They are more cautious about making accurate, appropriate responses. Consequently, they make relatively more errors of omission and fewer errors of commission.

<u>Instructional strategies</u>. If the elderly tend to be concerned with performance accuracy, it makes sense to provide tasks, skills, and recreational endeavors in which <u>accuracy is more important for success than speed</u>. The type of skill that is most compatible with this need for performance accuracy and a slowing of decision making is referred to as <u>self-paced or closed</u> (see Singer, 1980). As indicated earlier, closed, self-paced skills include a stable environment in which the performer controls response initiation and speed. Decision-making is slowed and deliberate; the

opportunity exists to monitor responses prior to a subsequent attempt. This need partially explains the popularity of common physical activities of older people such as fishing, shuffleboard, billiards, dart-throwing, and bowling, among others.

Effector Mechanism

Two primary characteristics separate younger from older performers with respect to developing a motor program, i.e., executing a series of movements in the virtual absence of cognitive activity. First, as described earlier, the elderly tend to check their actions more than the young. Second, this additional post-response monitoring time causes an over-anticipation of the next arriving stimulus. Consequently, older performers: (1) need more time to reorganize their "expectancy set" (Brinley, 1965), and (2) are less able to program a series of movements (Welford, 1969), and (3) have a limited capacity to program their movements for only a short sequence and in a relatively short time period, but not for a complex series of actions. Despite these limitations, motor programming is older performers is certainly feasible under the proper conditions.

Instructional strategies. Considerations to facilitate the development and execution of motor programs in older performers include: (1) providing instruction in the correct movement sequence so that the learner is able to organize, practice, and later speed up the rate of responding to appropriate levels, and (2) making the individual aware of response-produced feedback, especially derived from the sense modalities. This heightened awareness will contribute to subsequent changes in automated response. This can be accomplished by: (a) focusing the performer's attention on particular bodily movements just before, during, and/or after executing an action, (b) asking the person questions about the sensations that accompanied their response, and (c) providing knowledge of performance - precise, qualitative feedback on the correctness of their movements.

Internal and External Feedback (KP and KR)

It has been shown conclusively that motor skill acquisition and retention are virtually nonexistent without some form of feedback, either external (KR) or internal (KP) (Salmoni, et al. 1984). Older adults differ from their younger counterparts in their need to seek and obtain more information about a task both before and after it's performed (Cratty, 1973). This coincides with their concern for accuracy, even at the expense of speed. The elderly engage in far more self-monitoring during and after motor responses than younger persons. They rely more heavily on, and feel a greater concern for, KR and KP as sources of information about future performance than the younger learner. One would think, therefore, that older adults would consider KP and KR as a priority in the learning process. Apparently this isn't necessarily so. There is some evidence that older people make less use of both types of feedback than younger individuals, particularly in speeded, externally-paced tasks (Brinley, 1965; Welford, 1966).

Welford (1977) proposed two possible explanations for the tendency of elders not to make better use of KR and KP. First, whereas younger subjects program and monitor a regular series of stimuli as wholes, older performers tend to react to and monitor each stimulus individually. This preoccupation with segments of a task minimizes the person's ability to obtain and use information about the whole task after it has been performed. Older subjects "are less able - or less willling - to omit such monitoring" (p. 475). Second, the rate at which information is transmited and stored slows with aging. Therefore, elders use KP and KR less efficiently because they need more time to process and apply it toward future performance. It should be remembered that feedback is used in STM where it is rehearsed and stored in LTM and/or used in decision-making. The capacity and efficiency of STM becomes lower with age.

Instructional strategies. Elderly learners do not differ markedly from younger persons with respect to the importance of receiving KP and KR, especially at the initial stages of learning. According to Magill (1985), Singer (1980), and Salmoni et al. (1984), verbal feedback on performance should include the following components. It should be: (a) positively stated (we retain information better when it's based on what we should, rather than should not, do), (b) specific ("Nice going" has it's place in teaching, but it's non-informative), (c) behaviorally-based (the feedback should be based on observable actions), (d) quantitative ("You were off target by two feet to the right"), (e) verbally-presented (according to Salmoni, et al. 1984, if it's not verbal, it's not KR), (f) offered soon after a response followed by another attempt (referred to as a short post-KR interval), and (g) be offered consistently (i.e., not constantly, i.e., after every trial, but on a regular basis).

The Human Component: A Final Word

Sophisticated, valid, and reliable research is certainly needed to explain the likely causes of age-related changes in how we learn and perform motor tasks. However, this information, and how it's used to provide instruction, is useless unless two issues are addressed. The first issue is that only a motivated, emotionally and physically healthy person can continue to learn and grow later in life. No set of teaching and performance techniques can overcome a depressed, unstable, person. Sadly, far too many elderly maintain a low self-image and little self-confidence, especially in societies in which the elderly are disrespected and perceived as a burden to society. Older people need to stay physically active and have a positive disposition on life. In fact, according to United States Census Bureau projections, during the 1980's there wil be a 15 percent increase in the 65- to 74-year-old population and a 33 percent increase in the 75-and-over group (Newsweek, 11/1/82). As our nation ages, it will become increasingly important to maintain the health and well-being of our older society. And it will become more and more important to ensure that older people are not just staying alive longer, but are living productive lives. Actively engaging in recreational and professional pursuits will go a long way toward meeting this objective.

The second issue centers on the persons who work with the elderly. Older people are not children. They command the same - perhaps even more - respect as any mature adult. Any gerontological worker/educator who finds it difficult to interact with older people in a sensitive, patient, and pleasant manner is clearly in the wrong business. Older people are sharply aware of how they are perceived by another person, and unless the perception is positive, i.e., "This person respects me," they will become relatively unresponsive, perhaps even spiteful, toward the person. Growth and improvement in the performance of daily tasks will be negligable. Thus, the relationship between worker/educator and the older learner must be positive and based on trust and mutual admiration. As American historian Henry Adams said, "A teacher affects eternity; he can never tell where his influence stops" (The Education of Henry Adams, p. 20).

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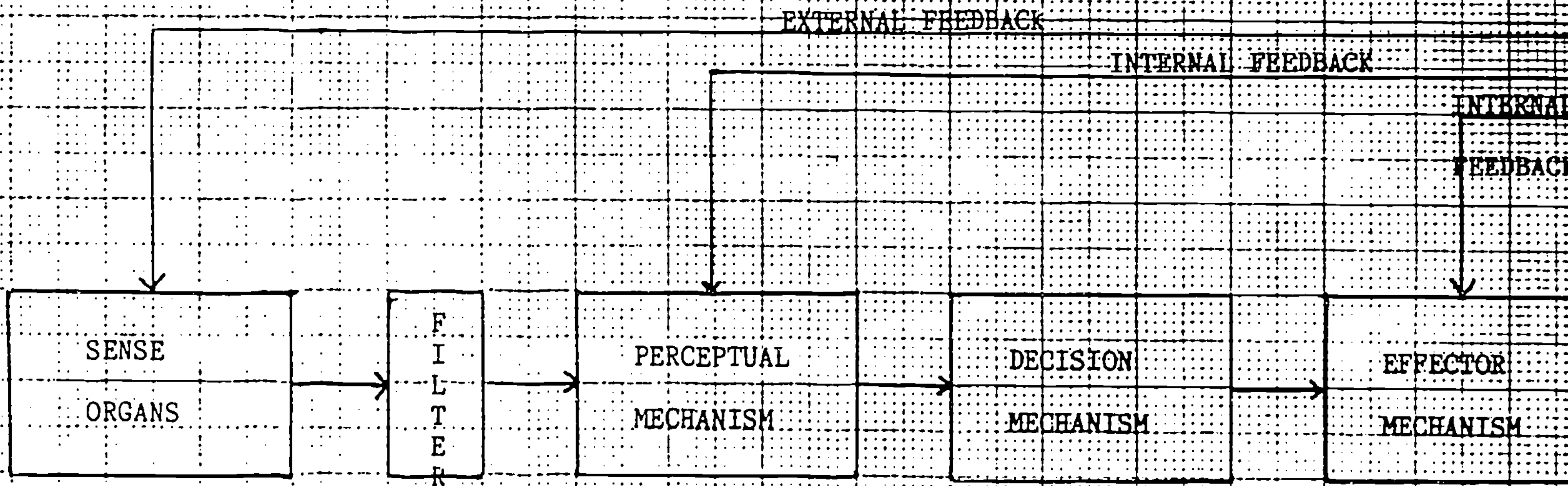

Figure 1. Information processing model of human motor performance.

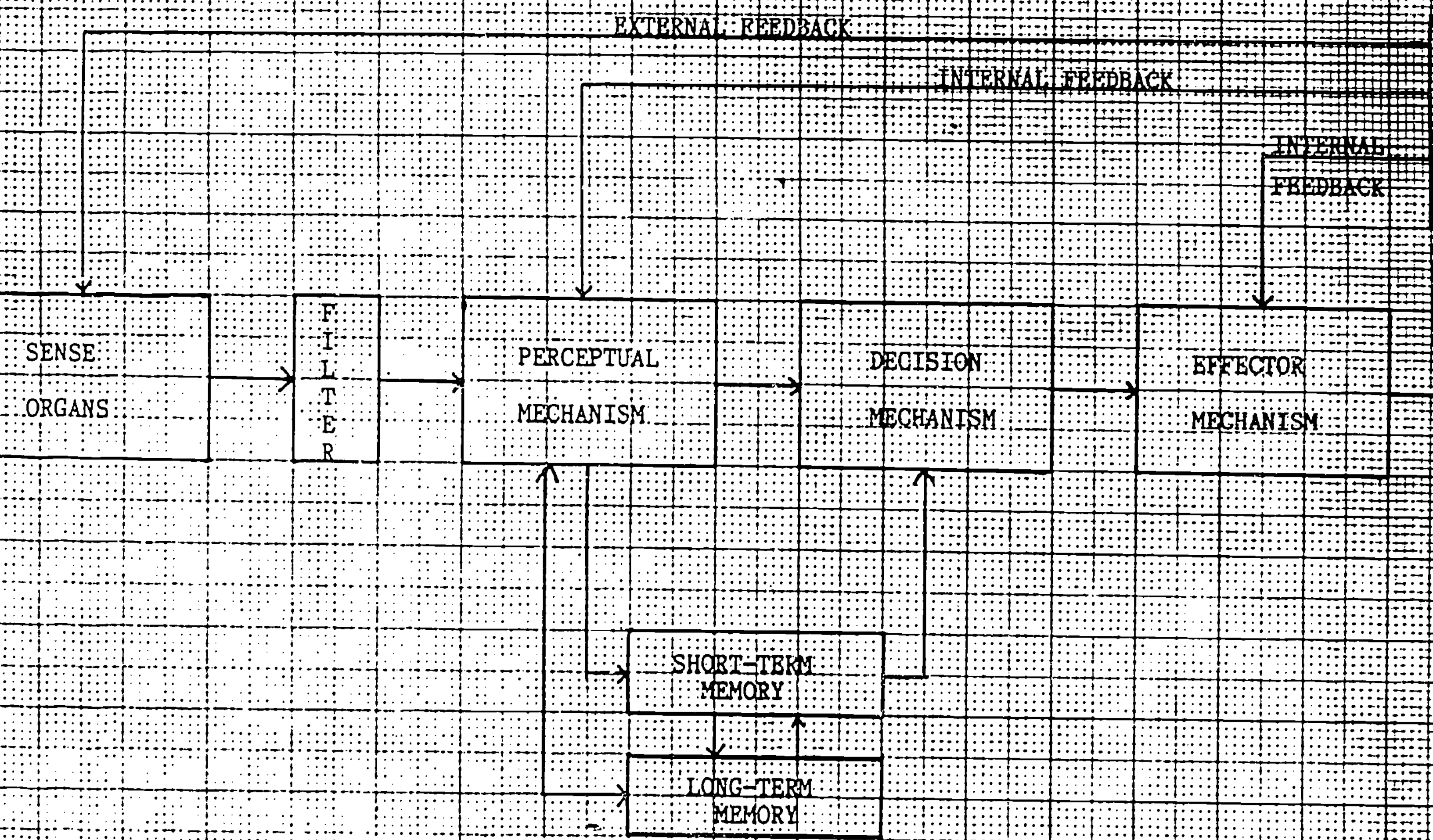

Figure 2. Information processing model of motor skill learning.