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ABSTRACT

The perceptual and cognitive processes involved in learning to play the piano are examined as sources of confusion and problems which might be encountered by the young learning disabled piano student. The paper is reported to be based on personal observations during private piano instruction, published and unpublished literature, and a summer workshop on teaching learning disabled children to play the piano; and some of the technical terms from the fields of music, psychology, and learning disabilities are defined. A survey of related research covers the topics of the functions of the central nervous system during piano playing and the processes and problems involved in reading music from the score. In a third chapter, the data from teaching experiences is presented in the form of case studies to illustrate the implications of topic areas from the previous chapter for learning disabled children (7-15 years old). Among conclusions were that the processing of the verbal language used in music is probably similar to that of verbal language processing in other subjects; therefore, to be successful in understanding musical language, the child probably needs language integrities; and that there is need for further research in the area of music and the learning disabled child. (SB)

Abstract

of

An Exploration of Perceptual and Cognitive Processes Involved in Piano Study with Implications for Learning Disabled Children

by

Dorothy Cordes Gilles, B.M.E., M.Ed.
Evanston, Illinois 1972

The purposes of the paper were to investigate the perceptual and cognitive processes involved in learning to play the piano, to examine sources of confusion and problems which might be encountered by a young piano student, particularly a child with learning disabilities.

A child with a learning disability is one who has normal or better intelligence, yet his nervous system does not receive, organize, store, and transmit information in quite the same way as that of a so called "normal" child (L. L. Rogan, "Have You Ever Known a Perceptually Handicapped Child?" Evanston, Illinois, Fund for Perceptually Handicapped Children, Inc., 1965, p. 1). He may show great inconsistency in performance in academic areas. He may have little difficulty with computation in math, for instance, but be quite inadequate in reading ability. He may possess and use a large vocabulary when he speaks but be unable to spell the same words on paper.

Causes of the child's problems are numerous and nearly impossible to pinpoint. They may result from injury to the brain tissue, or from electro-chemical imbalance in brain functioning, or a lag in neurological development.

Research done for this paper involved the reading of published and unpublished literature in the fields of piano study, music perception, and learning disabilities and participation in an experimental piano workshop having internationally known learning disabilities authority, Dr. Laura Lehtinen Rogan, as consultant. Another source of data was the recorded observations and analysis of specific personal teaching experience.

The literature explained some of the mental processes involved in piano playing and revealed that it is a most complex act dependent upon efficient functioning of the central nervous system. The writer related these processes to learning behaviors which are characteristic of some learning disabled children.

Specific problems and confusions of the writer's piano students, some of whom had been identified as learning disabled, were analyzed. In addition, analysis of the workshop students' learning behaviors was done. It was also found that some learning disabled children, although deficient in language and academic skills, may be quite adequate or even gifted in music. This raised the question of whether music is processed in the brain in a different manner than language or perhaps in a way unlike other nonverbal symbolic system processing, such as mathematics.

Evidence was given that even in the presence of a loss of brain tissue or a brain lesion (as some learning disabled children may have) certain functions may continue to operate and may be capable of being trained so that learning can continue to occur. Even if there is a brain lesion causing severe language disturbances, musical aptitude may be preserved. And a learning disabled child without a brain lesion but having an immature central nervous system may also exhibit at some time previously latent musical abilities.

Therefore the generalization cannot be made that all learning disabled children will encounter difficulties in music study. Each learning disabled child has his own pattern of strengths and weaknesses. If the various piano tasks draw upon those specific skills in which the child is weak it is likely that he will be momentarily, but not necessarily permanently, frustrated.

There is every reason for a piano teacher to be optimistic in teaching children with learning problems. One cannot be certain how much growth can still take place; the child can compensate for a temporarily stunted facility and later discover it. Through music study he may become aware of a capacity of which he was previously ignorant. Music study can afford the child an opportunity to successfully explore necessary concepts, but the teacher must plan carefully to give the child sufficient success experiences to enable him to cope with the frustrations occurring when working in his weaker areas.

Specific areas discussed in the paper:

Score Reading Difficulties

- Inability to read vertically, (seeing each vertical column of notes as a unit)
- Reading one note at a time
- Reading both clefs but treating them as though they were separate lines
- Too narrow a span of visual focus
- Regressive movements of eyes
- Poor visual recall of notes seen
- Inability to keep eyes moving ahead on the score
- Not using eyes in a binocular fashion, as a team
- Evasion of score reading
- Inability to understand "high" and "low" on the score
- Confusion concerning the alphabet names of the keys
- Inability to reverse the alphabet when determining note names
- Thinking note stems are related to note names
- Confusing the names of the lines and spaces of the two clefs
- Misinterpreting the position of note stems as indicating pitch direction
- Confusing notes which seem to be mirror images of each other
- Inadequate aural understanding of the musical sounds represented by symbols
  - Poor auditory perception of musical sounds
  - Inadequate auditory imagery
  - Deficient tonal memory

Comparison of Score Reading to Language Reading

Weak tactile, kinesthetic senses

Fine motor coordination difficulties

Spatial orientation at the keyboard

- Problems in crossing the midline of the body
- Difficulty relating the direction of melodies on the score to direction on the keyboard

Short attention span, distractibility of child

Difficulties in understanding musical terms

Abstract nature of the musical language

AN EXPLORATION OF PERCEPTUAL AND COGNITIVE PROCESSES INVOLVED IN PIANO STUDY WITH IMPLICATIONS FOR LEARNING DISABLED CHILDREN

A Research Paper

by

Dorothy Cordes Gilles, M. Ed.

August, 1972

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CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS

The Problem

Statement of the Problem

The aims of this paper are to investigate the perceptual and cognitive processes involved in learning to play the piano and to examine sources of confusion and problems which might be encountered by a young piano student, particularly a child with a learning disability.

Limitations of the Problem

The paper will deal only with the intellectual and motor skills involved in piano study. Emotional factors and musical interpretive abilities will not be discussed. Various types of problems will be presented and possible causes suggested; however, specific remediation procedures are outside the scope of this paper.

Reason for Selecting the Problem

A child often has his first contact with formal piano instruction at an early age. Often the experience is a happy and fulfilling one, but sometimes it is wrought with problems.

The complexity of music learning and the demands that formal instruction place on a child may not be fully understood by well-meaning parents and perhaps not even by the trained piano teacher.

During several years of piano teaching, the writer became increasingly aware that for some young children the process of learning to play the piano could be a very demanding experience, perhaps even a frustrating one in certain respects.

Instead of merely labeling these children as being "non-musical," the author considered other possible causes for their confusion and lack of understanding. Observations were made and carefully recorded so that after the lesson the notations could be analyzed.

One area of special difficulty seemed to be that of learning to read the music symbols and subsequently playing the correct keys of the piano. Another area of difficulty involved various problems in motor coordination. Some students could not manage independent finger action while others were unable to strike keys simultaneously with their left and right hands.

A portion of the students were insecure in locating specific keys without first looking down at their hands. They seemed to encounter difficulty in adjusting to the topography, or the "feel," of the keyboard.

Some children appeared to be confused by the abstract nature of the music vocabulary, and may not have been able to conceptualize clearly the musical ideas inherent in the compositions studied.

After studying the results of the observations, the author began to see striking similarities between the behavior of the troubled piano students and that of some of the learning disabled children with whom she had previously worked.

The process of analysis prompted a further questioning. Now not only was there the consideration of why these particular piano students were not learning, but there were also the questions of whether these troubled piano students could have undiagnosed learning disabilities or lacked sufficient neurological maturity to handle the abstract thinking required in formal piano lessons, particularly in the reading of musical symbols.

There was a need to discover if learning disabled children could have special difficulties and what the nature of these difficulties might be: A thorough examination of the mental processes involved in learning to play the paino seemed to be a logical starting point for gaining an understanding of the problem.

It seemed important to study these questions more deeply for a more complete comprehension which could be applied to the teaching of these students and others with similar problems. It also seemed to be a subject worthy of investigation because an understanding of the problem by other piano teachers could add to an awareness of children's individual learning patterns and could foster a deeper empathy for their difficulties.

Method of Study

As a starting point, literature was examined concerning the perceptual and cognitive processes which are involved in piano study. In addition, material describing intellectual behaviors of learning disabled children was studied.

In the summer of 1971 the investigator was privileged to be a participant in an experimental piano teaching workshop having L. Lehtinen Rogan, Ph. D., Clinical Director of the Cove School, Evanston, Illinois, and an internationally known authority on learning disabilities, as consultant. Two other piano teachers participated, S. Harris and V. Kovitz.

The teachers sought a better understanding of the learning disabled child in general and of the individual learning patterns of their workshop students in particular; they hoped to develop and experience new ways of teaching which could be applied both to these and to other children.

Rogan agreed to participate in the workshop to gain a better insight into what piano study involves, since she is often asked by parents whether their children should take piano lessons. In addition, she has an appreciation of music and is interested in ways to make music more meaningful to the child (8, p. 2).

Two of the students who were involved were from Cove School, a school for children with learning disabilities; the third had learning problems but had not yet been evaluated. Much of the information which was generated by this rather unique project will be described in detail in Chapter Three.

Knowledge gained from the workshop was related both to the survey of literature and to the personal teaching experiences previously recorded.

Thus the sources of information for this paper were threefold: personal observations during private piano teaching, published and unpublished literature, and the summer workshop of 1971.

Although not all of the questions posed initially were answered with certainty, there is now a foundation upon which to build additional research.

It seems appropriate at this point to define some of the technical terms used which are part of the vocabularies of the fields of music, psychology, and learning disabilities.

Definition of Terms

Afferent. Conducting toward the central nervous system or toward higher centers in the central nervous system (7, p. 323).

Auditory. Pertaining to hearing or to the sense of hearing.

Auditory discrimination. The ability to recognize similarities and differences between sounds.

Auditory image. An auditory experience of realistic dimensions for which there is no apparent physical stimulus (3, p. 99), the occurrence of mental activity corresponding to the perception of a stimulus, but when the stimulus is not present (7, p. 331).

Auditory perception. The central processing of stimuli received through the ears by which one gains meaning from what is heard.

Aural. Pertaining to hearing or to the sense of hearing, often used in the field of music.

Bass clef. The sign for the bottom staff of the grand staff which fixes the position of the bass notes (those which occupy the bottom staff).

Beat. The audible, visual, or mental marking of the metrical divisions of music (2, p. 107).

Binocular fusion. The ability to hold a focus and to use both eyes as a team for vision.

Cerebellum. A large expansion of the hindbrain, concerned with the coordination of voluntary movements, posture and equilibration. In man it lies at the back of and below the cerebrum and consists of two lateral lobes and a central lobe (2, p. 197).

Cerebrum. The anterior and upper part of the brain, consisting of two hemispheres, partially separated by a deep fissure but connected by a broad band of fibers, and concerned with voluntary and conscious processes (2, p. 197).

Cerebral cortex. The outer layer of gray matter which invests the surface of the cerebral hemisphere (2, p. 273).

Chord. A combination of musical tones that are sounded together.

Cognition. A state of comprehensively knowing (12, p. 59) including four levels of learning: perception, imagery, symbolism, and conception (11, p. 216).

Cognitive. Pertaining to cognition.

Conception. The ability to think in the abstract, to categorize, to recognize the relationships among experiences (8, pp. 42-43).

Conceptual. Pertaining to conception.

Convergence. A turning of the eyes inward to bear upon a near point (2, p. 265).

Decoding. The ability to gain meaning from a code of graphic representations (printed words) of spoken language sounds (visual decoding or reading) (4, p. 91).

Distractibility. A behavior in which a person pays attention not only to essential stimuli but also to the unessential; the inability to ignore unessential stimuli involving any of the senses (5, p. 32).

Dynamics. Loudness or softness of musical tones.

Efferent. Conducting away from higher centers in the central nervous system and toward muscle or gland (7, p. 323).

Frontal lobes. The two front halves of the cerebrum, anterior to the central fissure (7, p. 330).

Grand staff. The top or treble staff and the bottom or bass staff when they appear together in a musical score. It is composed of ten lines in total.

Hyperactive. Exhibiting constant motor activity having no apparent organization.

Image. The reliving of a sensation in the absence of the original stimulus (2, p. 602).

Integration. Central synthesis (in the brain) of multiple stimuli which are presented to the same sense or to different senses (4, p. 51).

Inter-sensory integration. Processing of multiple stimuli which are being transmitted through different senses. It is also called association (4, p. 51).

Intra-sensory integration. Processing of multiple stimuli which are being received through the same sense (4, p. 51).

Kinesthetic. Pertaining to kinesthesia or the sensation of movement or strain in muscles, tendons, and joints (2, p. 672).

Learning disabled child. A child with normal or better intelligence whose nervous system does not receive, organize, store, and transmit information in the same way as does that of a normal child (9, p. 1).

Ledger line. One of the short auxiliary lines used for writing notes which lie above or below the staff.

Midbrain. The middle segment of the brain (2, p. 763).

Modality. A learning pathway through one of the senses, mostly used in reference to visual and auditory senses.

Neurological. Pertaining to the nerves or the nervous system.

Notation. The representation of musical tones by means of symbols.

Note. One of the signs used to show the pitch of a musical tone and its duration.

Note head. The oval-shaped part of a note found at the end of the note stem.

Note stem. The part of a note which is a vertical line; it is attached to the note head.

Perception. A single unified meaning obtained from sensory (sense) processes while a stimulus is present (2, p. 899).

Perceptual. Pertaining to perception.

Peripheral. Outside of, situated in the periphery (2, p. 902).

Periphery. The area in which nerves end (2, p. 902).

Phrase. A series of tones that progresses to a point of repose, sometimes called a "musical sentence" (10, p. 376).

Pitch. The highness or lowness of a tone, determined by the number of vibrations it has per second. The faster the vibrations are, the higher the tone it creates (1, pp. 153-154).

Pitch discrimination. The ability to differentiate between musical tones, to hear, for example, that a particular tone is higher than another.

Proprioceptive. Referring to sensory excitations originating in muscles, tendons, and joints (2, p. 972).

Receptor cells. The end organs of sensory or afferent neurons (nerve cells), specialized to be sensitive to stimulating agents (2, p. 1011).

Reversibility. A principle of thought identified by Piaget as the ability to "unthink" a thought. The two chief forms are negation (not male = female) and reciprocity (not better = worse) (6, p. 162).

Rhythm. An orderly series of pulsations in music.

Scale. The series of tones, taken in direct succession, which form a key (1, p. 172).

Sensory. Pertaining to sensation (2, p. 1103).

Staff. The five parallel horizontal lines used in musical notation upon which notes are placed.

Stimulus. Something that excites an organism or part of the organism to activity (2, p. 1188); external energy acting on a sensitive cell (receptor or neuron) (7, p. 340).

Tactile. Of or pertaining to the organs or sense of touch.

Tempo. Rate of speed of performance in music.

Thalamus. The upper half of the diencephalon (front end of the brain stem), mainly afferent in function (7, pp. 328, 340).

Theme. A melodic phrase or motive on which a composition is founded (1, p. 190).

Time signature. The two numbers placed at the beginning of a piece of music; the upper number represents the number of beats per measure, and the lower number tells what kind of note will be equal to one beat.

Tonal memory. The ability to remember tones. It is often used to refer to the ability to remember a succession of tones or a melody, but it can also refer to remembering the rhythm, harmony (combination of tones) or, in effect, the total sound of a composition.

Tracking. The act of visually following printed symbols in a direction, such as left to right in reading.

Treble clef. The sign for the upper staff of the grand staff which fixes the position of the notes occupying the upper staff.

Visual discrimination. Recognition of similarities and differences when the stimuli, presented visually, are increasingly similar (11, p. 186).

Visual figure-ground. The ability to perceive objects or symbols in foreground and background and to separate them meaningfully (13, p. 3).

Visual input problem. Inability to gain meaning from a visual stimulus.

Visual-motor. Referring usually to the eyes and hand; if these are coordinated one can write, cut, manipulate objects without gross errors (13, pp. 3-4).

Visuo-spatial problem. A difficulty in understanding spatial relationships; often used in reference to perceiving relationships that are symbolized on paper.

Word association. The connection of ideas in thought stimulated by the hearing or seeing of a word.

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CHAPTER II

SURVEY OF RELATED RESEARCH

Although there exists a substantial amount of literature on different aspects of piano playing, few authors have dealt in depth with the learning processes that are involved. Only two references were found concerning the potential problems of the learning disabled child who undertakes piano study, an unpublished paper and a transcription of tapes recorded during the piano workshop mentioned earlier.

The most appropriate topic to consider first is the central nervous system and how it normally functions during the act of playing the piano. A general knowledge of the "normal" is basic to a better understanding of any suggested deviations from this functioning.

The Central Nervous System As Involved in Piano

Kochevitsky described the human brain as containing "many billions of nerve cells which are connected to each other through nerve fibers" (14, p. 21). Because of these connections all nervous elements of the brain influence one another. Our behavior is dependent upon this interaction of nerve cell units (14, p. 21).

Many psychologists believe that the cerebral cortex is divided into several parts which are separate from one another but interconnected. According to Kochevitsky, there are motor and sensory areas, with visual, auditory, tactile, and other subdivisions. There may be a "free space" consisting of a large number of cells ready to receive new impressions, create new connections, and store them (memory). In addition, some points which are already involved in a specific activity can change their physiological role and become connected with some other activity of the organism. The cerebral cortex is comparable to an extremely complex switchboard (14, p. 21).

Through the nervous system the human organism constantly reacts to external influences. This process, although incompletely understood, is believed to be electrochemical and consists of nerve impulses. The sensory (afferent) nerve fibers conduct specific impulses to the central nervous system from the parts of the body which are externally stimulated. From the central nervous system the orders for motor activity (reaction) are transmitted along motor (efferent) nerve fibers to specific peripheral organs. In this way the nerve centers receive and interpret external sensations (stimuli) and control all movement (14, p. 21).

The simplest motor acts are involuntary movements which are made in response to stimuli acting upon our senses. These are realized through the motor centers of the spinal cord and are executed without participation of the cerebral cortex. They become indispensable ingredients in the more complicated movements in which conscious and subconscious elements combine in different and constantly changing proportions. These proportions differ for each individual and for each separate activity which the person is performing (14, p. 21).

Many seemingly simple motor acts like walking, running, eating are actually very complicated performances. During these activities the brain is receiving specific information from the cells located in the skin, muscles, tendons, joints, and ligaments. As stated before, the cerebral cortex is thought by many to have various sensory areas which are projections of the sensory organs. In the examples given above of motor acts we could say that the motor area of the cortex appears to be a projection of the motor apparatus. Each muscle, tendon, joint, and ligament has its representatives in the motor area of the cerebral cortex (14, pp. 21, 24). Posture, spatial relationships, passive and active movements of separate parts of the body, contraction and relaxation of muscles and the condition of the joints, tendons, and blood vessels--sensations from all of these are sent along afferent nerves from the peripheral areas to the corresponding group of receptor cells in the motor area of the cerebral cortex and in the cerebellum. Because these sensations originate in body parts, they are called "proprioceptive," which means self-perceiving. These sensations are intensified by tactile sensations from the receptor cells in the skin. These tactile sensations are also referred to the brain to the tactile-sensory area (14, p. 24). Information received through the skin (tactile) and through the sense of movement (kinesthetic) is integrated in the brain. This process is called "haptic perception" (5, p. 39).

In the brain all incoming stimulations from movements are perceived, analyzed, and synthesized, and passed back to the periphery in the form of signals to continue, to change, or to stop motor activity. Each movement, conscious and unconscious, is immediately reported back to the motor region of the brain and recorded there. In this way the brain is kept in touch with all the motor activity of the peripheral apparatus. In like manner the auditory region of the cortex is a projection of the auditory organs; the visual region, of the retinas of the eye (14, p. 24).

Proprioceptive sensations and the whole past experience with these sensations (all of which is recorded in the brain) are of extreme importance for the direction of movements and the degree of energy put into them, as well as for the construction and mastery of new movements. Reason initiates, maintains, and guides effort toward acquiring a new motor act, but it would be impossible to learn a new movement just by observation or verbal explanation without previous motor experience (14, p. 24).

Our consciousness plays a specific role in very complex voluntary motor activity. We may not be conscious of how we function but we are concerned with the purpose of our action. The cortex actuates the motor apparatus as a whole, it decides the purpose, strength, and energy of a movement and controls its realization. The motor impulses from the cortex go initially to the sub-cortical centers of the midbrain and cerebellum. These sub-cortical centers are responsible for the preliminary setting of the muscle system for the beginning of each new movement; innervation of muscles and amount of tension; sequence, rhythm, smoothness and swiftness of movement. Spatial and temporal regulation of movement forms depends on the fine cooperation of the cortex with the sub-cortical centers. Activity of the midbrain and cerebellum takes place usually without the individual being conscious of it (14, p. 22).

It can be said that both conscious and subconscious processes take place in the act of playing the piano, although it is impossible to determine exactly in what respective amounts. The greater the share of processes that are automatic or subconscious the more natural, economical, and precise each movement becomes. But no matter how perfectly the midbrain and cerebellum may operate, their ability to adjust to ever-changing external conditions is limited. Between the primary motor elements, or motor cells of the spinal cord, and the thinking part of the brain, the cortex, new direct connections are made, and the activity of the lower centers is modified and perfected (14, p. 22).

When forced to new adjustments, the motor activity of these lower centers is overburdened with unnecessary movements and over-tensions of the muscles, causing awkwardness. Gradually the cortex learns to master the subordinated mechanisms and to reorganize their work. Regulated by the cortex, motor activity now becomes skillful, graceful and flexible (14, p. 22).

The balance of the body and the extremities in space is accomplished automatically by the cerebellum and is present constantly when the arm is in a horizontal position, as in piano playing. The balancing of the forearm horizontally must be done with the help of the motor mechanism of the cortex, which initiates graduated muscle contraction quickly in accordance with requirements. By constant training a person strives to achieve maximum control of the cortex over all lower motor centers; he learns by experience and thus increases the efficiency of the higher centers. If the higher brain centers do not control the lower, the lower ones act independently; the organized coordination is disturbed and thus precision and smoothness are lost (14, p. 22).

Excitation and Inhibition of Nervous Processes

Kochevitsky explained the importance of excitation and inhibition, the fundamental processes of nervous activity. He said:

> To respond instantly to ever-fluctuating and often abruptly and powerfully changing surroundings, these processes must be very flexible, able to adjust their mutual balance suddenly. When a stimulus creates excitation, the result is a discharge of impulses. Inhibition suppresses superfluous (or even harmful) excitation. The restraining, coordinating and protective role of inhibition is of utmost importance in the integrative activity of the central nervous system, particularly in its highest divisions.
>
> The behavior of an individual depends on the balance of excitation and inhibition. This behavior is determined by innate properties of the nervous system, one of which is extraordinary adaptability. Because of this extreme adaptability, the organism can modify its behavior influenced by the constant training to which it has been subjected from the day of its birth.
>
> Since fast, even piano playing is the result of precise balance between these two basic processes of nervous activity, both processes require special training, particularly the inhibitory (14, p. 25).

The excitatory process is formed more quickly and easily and is more stable than the process of inhibition, which weakens easily and disappears under certain circumstances. As a result of this weakening of inhibition, muscle contractions are not regulated correctly. The frequency of incoming stimulations becomes higher than the ability of the neuro-muscular apparatus to reproduce the repeated acts of excitation. Consequently a change in the rhythm of excitation can occur, and the fingers do not start to work at the precisely determined instant. They move out of time, and the muscles, after having finished the needed contraction, do not relax properly (14, p. 25).

One of the basic properties of the nervous system is to unite simultaneous and subsequent excitations in complexes; therefore, the described conditions tend to continue. The chain of movements seems to shrink; its links begin to overlap each other; playing becomes uneven (14, p. 25).

Irradiation and Concentration of Nervous Processes

According to Kochevitsky, the execution of a complex movement requires precise timing and involvement of the least muscle work needed for any particular action. This is obtained by the localizing of the excitatory process (14, p. 26).

After a conditioned response to a definite stimulus has been established, other stimulations of the same sensory field produce the same effect, but they are weaker. If the original stimulus is reinforced and is repeatedly followed by an unconditional stimulus while the other stimuli are not reinforced, the first stimulus will become more and more specialized, and the organism will now respond only to that stimulus (differentiation) (14, p. 26).

When excitation, because of some stimulation, arrives at certain cells in the brain, it is not confined to these cells but tends to spread or irradiate, involving other cells that are not directly related to this stimulation (generalization).

Excitation and inhibition are mutually connected processes, however, according to the principle of reciprocal induction (which is a contrasting relationship in which one process induces the opposite process). So the state of excitation at a certain point of the cortex immediately calls forth an inhibitory process around the excited area. After practice, this area gradually becomes more narrow, meaning that excitation is concentrated at the starting point, and inhibition is strengthened at the surrounding points (14, p. 26).

Usually every reflex act inhibits all activities unrelated to it, and the spread of the original excitation becomes concentrated in certain points of the central nervous system. The law of irradiation and subsequent concentration applies to both excitatory and inhibitory processes, and is of utmost significance in the elaboration of temporary connections in forming conditioned reflexes (14, p. 26). Repeated application of the unconditional stimulus, or the movements of the playing apparatus, diminishes the extent of irradiation and helps to concentrate excitation. This will then affect only the concerned cells of the motor region of the cortex (14, p. 26).

According to the law of reciprocal induction, the stronger the excitation directed along a specific path, the weaker its irradiation over the motor region of the cortex. Strong excitation will be encircled by strong inhibition. This is what we experience when we concentrate our attention on the motor act we are executing. We gradually eliminate superfluous movements and unnecessary muscle contractions; we gradually achieve more natural and smoother movements, finally performing them automatically. This means that the nervous act is now localized in the proper area (14, p. 27).

This process of motor act concentration is shown in increased ability to achieve differentiated, independent movements. First we can observe this differentiation in muscle groups that are far from one another such as those of the right and left hands. Later, we can see differentiation in muscles of one arm, and eventually, in the independence of adjoining fingers (14, p. 27).

Development of Motor Skill and Its Application to Piano Playing

A baby's movements are random because of general, undifferentiated responses. Gradually the child learns to perceive distance and form of objects in his environment through his motor activity. He connects proprioceptive and tactile sensations with visual sensations; the visual stimulations become signals of needed movements (14, p. 30).

If the child wants to grasp something, he will make many helpless grasping movements at first. When one of these movements happens to be successful and he grasps the object, the sensation from the movement is connected with visual stimulation from the object--its form, location, and other features. After additional trial and error the child begins to see with increasing precision, later responding with only the necessary movements on the basis of these visual stimulations (14, p. 30).

Later in life reasoning and vision will become more important as guides to creating and mastering new motor acts, the beginning, selecting, and maintaining of the appropriate form of movement. But the sensory-motor experience will always remain an indispensable ingredient (14, p. 30).

The lack of sensory-motor experience in its special application to piano playing partly explains why it is so difficult for an adult beginner to gain motor skill, even though his intellect and ability for understanding the concept of movement are more highly developed than that of a child (14, p. 30).

Each new form of movement is initially visually projected on the basis of previous experience and development of visual-motor connections. The movement is then performed according to the visual projection, producing those proprioceptive sensations from the motor act which become the material for construction of intricate motor complexes (14, p. 30).

The beginner in piano playing, looking at the chosen key of the keyboard, visually projects movements of his arm and finger in order to reach the key. This stimulation is directed into the motor area of the cortex where cells activate the muscles used in the movement. This is experienced as an anticipation of movement that is far from exact because it does not coincide with actual conditions. The eye still is unable to calculate the dimension of the movement, the resistance of the key, and the tactile sensations coming from pressing this key. When the player reaches the key and presses it, he receives proprioceptive and tactile sensations. His motor action includes at first superfluous muscle contractions and redundant movements (14, p. 30).

In addition, according to the principle of generalization, these proprioceptive sensations expand over a large part of the motor region of the cortex with rather vague contours. As the player repeats his actions many times in practicing, the motor action changes form and becomes unsteady and probably even worse than it was the first time. Gradually, however, under conscious application of careful listening (auditory feedback and subsequent control), everything irrelevant is omitted, and only purposeful movement is fixed by inhibition which encircles the excited centers of the motor region of the cortex. The player, through his auditory sense, evaluates the result of the motor act, the sound (14, p. 30).

Often, as a result of the pedagogy of his particular teacher, the pupil, seeing the note symbol, finds the corresponding key, presses it, and looks for the next symbol, and so on. He fails to take time to listen to the result of his motor act of pressing the key. From the beginning, the piano teacher should stress to the pupil the importance of listening to the sounds that he produces (14, p. 30).

Kochevitsky carried this process one step further and stated that the real sequence of events should be as follows: 1) auditory stimulus in the form of an inwardly heard tone or image of a tone to 2) anticipation of the motor act to 3) motor act resulting in actual sound to 4) auditory perception and evaluation of the actual sound (14, p. 30).

In Kochevitsky's opinion, this sequence holds true even if the tone that the pianist is going to play is some distance away from the tone he is playing at the moment. He said that the inwardly heard tone (or image) stimulates the precise motor activity of the player's performing apparatus, and the pianist's auditory imagery of tonal distance (degree of pitch difference between tones) dictates the exact dimension of lateral movement of the arm toward the proper key. This sequence develops through years of experience from connections having been repeatedly formed between points of the auditory and motor areas of the cortex (14, p. 33).

John Bergan defined an inwardly heard tone, or an auditory image as follows:

> . . . an auditory experience of realistic dimensions for which there is no apparent physical stimulus. By realistic dimensions is meant that the auditory image tends to be a replication of an auditory experience initiated in the environment. . . . Such an experience would be abstract in the sense of being indistinct (2, pp. 99-100).

Reading Music from the Score

General Explanation

The note symbol may now be added to the sequence described above. The student first is stimulated visually by the note symbol and with great speed this stimulation is transmitted from the visual to the auditory area of the brain, creating an auditory image of the tone which the symbol represents. So the sequence becomes: 1) visual stimulus of the note symbol, 2) auditory stimulus of the inwardly heard tone, 3) anticipation of the motor act, 4) the motor act resulting in actual sound being produced, and 5) auditory perception and evaluation of the sound heard. In all of this the leading and controlling element must be the auditory monitoring, so to speak (14, p. 31).

To reiterate, music or note symbols are symbols for sound. In effect they are "signals" of the sound just as words printed on paper are signals of the objects which they designate. Verbal symbolism is a second signaling system; music symbolism may be also. (The stimuli which come directly to our receptors, visual, auditory, and tactile, constitute the first system of signals of reality.) (14, p. 23)

The system of notation may be grouped into three general categories: 1) symbols which indicate the pitch of musical sounds; 2) symbols which indicate the temporal duration of musical sounds; and 3) symbols which indicate certain related aspects of musical interpretation such as tempo, dynamics, phrasing, and style of performance. It is a type of coding system with symbols standing for specific meanings (26, p. 1).

The process of music reading, then, may be considered the process of reading and interpreting the various kinds of music symbols and converting these symbols into sound. This does not imply accurate reproduction at first sight, but does suggest that the individual needs to acquire sufficient skill in understanding and interpreting the meaning of the symbols so as to ultimately reach a high level of correct response. The symbols become a guide for action, with the individual making frequent value judgments regarding the accuracy of his performance, and consequently changing that performance to agree with these judgments (26, p. 4).

Visual and Visual Motor Processes

Some of the factors involved in rapid and accurate reading of music at the keyboard are a sense of positional relationships, a conditioning for immediate response, and a developing sense of security. The student must develop a strong sense of position on both the staff and the keyboard. He must be able to see that a particular note symbol is higher than the symbol next to it, for example. He must also associate the note or a group of notes on the staff with a specific key or group of keys on the keyboard (10, p. 2); he must know where the key or group of keys are located on the keyboard and be able to find them instantly, usually without looking at his hands.

The notes of a melody move up and down by definite, easily recognized intervals; the notes form partial or full scale patterns or follow a chord structure, and these and other melodic patterns may be repeated at higher or lower pitch. Each note or group of notes must be read in relation to the pattern of which it is a part, in positional relationship to the surrounding notes, and/or within the harmonic structure of the composition (10, p. 2).

The visual stimuli of seeing the note symbols must be followed by immediate response with the motor apparatus. A note pattern should come to mean a hand shape or a finger pattern on the keyboard (10, p. 2).

A strong sense of security is a basic component of all acts of motor skill. The more a student knows about the music elements involved as "wholes" or "gestalts," the greater the sense of security. An awareness of repeated note patterns, phrases, chords, rhythmic grouping, themes (in short, the organizational structure of the music) is essential to good reading (10, p. 2).

What is meant by "gestalts" in music reading? Fredrich explained as follows:

> A "gestalt" is a form, a figure, or a grouping of factors which the eye grasps readily as a unit of perception. A good example is our acceptance of the symbol for the geometric square, rather than breaking it down into its elements of four straight lines of equal length inclosing four right angles. A "good" gestalt has such properties as regularity, simplicity and stability.
>
> The eye perceives related factors as a unit rather than as an assembly of separate parts. The eye normally sees a figure in relation to its ground, the area immediately surrounding the figure. The eye favors natural groupings, alike in the steps separating the parts, and favored by the nearness of the parts (10, p. 18).

An example of a "gestalt" in piano music is the G Major chord in root position which always appears on certain lines of the staff called "g," "b," and "d." When the root position appears in the score it always uses these three lines. Through experience a student can gain a kind of "picture" of this chord as using these three lines and no others. The note symbols should not be looked at individually but should be seen as a whole. When playing rapidly the student need not take the time to think of the names of each of the notes; he merely thinks "G Major chord, root position." With much experience this process becomes nearly automatic. Because an organized visual approach is used, much time has been saved, and the performer is able to read more rapidly and efficiently. He learns to group note symbols into patterns based upon the similarity of the notes to each other.

In a study of twenty-six subjects between the ages of eleven and forty-one years of age having one to twenty years of experience with music, Jacobsen found that there were specific types of score readers. He classified the types as "immature," "average," and "mature" (11, p. 10).

He found that the speed of recognition in reading the notation determines the rate of performance. The rate of performance is determined by the number and duration of fixation pauses (in which the eyes stop moving and focus or fixate at a particular point on the page). It is also determined by the number of regressive movements (eye movements in a backward direction, covering material that has just been seen) (11, p. 110).

"Immature" readers were described as taking up to eight times as much time as the "mature" readers to perform the music samples given them. They also played with indistinct rhythm. Their eye span (or distance which the eyes preceded performance) was no more than one note; in other words, they were reading note by note and locating separate keys on the keyboard. "Average" readers could visually "take in" as many as four notes; "mature" readers, as many as eight (8, p. 111).

Eye movements of "immature" readers included a pause for each note and sometimes two or three pauses. Regressive movements were very frequent in the "immature" readers; there were few or no such movements in the "mature" readers (11, p. 111).

The maximum range of recognition includes the number of notes which can be recognized during a fixation pause. In Jacobsen's study this range included only notes to the right of the pause. "Immature" readers read with a small range of recognition; "mature" readers exhibited a large recognition range (11, p. 112).

Achieving the maximum range of recognition requires the highest degree of concentration on the part of the player. Memory must be a factor in this process. A player might have a large maximum range of recognition but a poor memory; therefore he would require more pauses for reading. The reading process was such a slow one for the "immature" readers that they were unable to retain the notes at one pause until the instant of recognizing the notes of the next pause. The material then had to be re-read (11, pp. 112, 117).

Jacobsen found that the normal range of recognition, or the average number of notes per pause in reading, was largely influenced by the arrangement of the notation. This range seemed to be larger horizontally than vertically, since notes were more quickly recognized when the eyes were moving in a parallel fashion with the five lines of the staff than when two clefs were read, involving also a vertical range (11, pp. 112-113).

The complexity of the reading material influenced the number and the duration of pauses, the number of regressive eye movements, and the number of mistakes which occured during reading. The addition of the bass clef necessitated an increased vertical range for reading and a corresponding increase in the number of pauses and in the time required for the reading. In other words, content and not the amount of space covered by the notation determined the range of recognition (11, p. 113).

The eye-performance span decreased as the music became more complex. Most mistakes were made in reading the bass clef and the ledger line notes. The eye movements characteristic of reading of two-clef music by the "mature" and "average" readers were made from clef to clef in a zigzag manner; they gradually passed from left to right (11, pp. 116, 119).

In reporting the results of his study Jacobsen was careful to point out that eye movements are symptoms, not causes of a particular reading problem (11, p. 116).

In a survey of visual processes in music reading, H. E. Weaver stated:

> . . . the reading of the score typically progresses by rapid alternation of almost vertical movements of the eyes from one half of the staff to the other. There are also frequent horizontal movements on one half of the staff. Finally, the treble parts of chords (right hand) are

> usually read before the bass parts and the eye-hand span is variable but never exceeds a separation of 8 successive notes or chords between the eye and hand (30, p. 28).

At this point a clear distinction should be made between the terms "reading" and "sightreading." "Sightreading" means playing a piece of music immediately without having played it previously; this definition allows for silent study before playing. "Reading" allows for the player having seen and played the music before.

Conclusions reached in a study by Lannert and Ullman were that good sightreaders read ahead of the measure being played, perceive both the right and left hand staves at a single glance, profit from a preliminary study of the score, and have a good knowledge of the keyboard by touch and "sense" of location (kinesthetic and proprioceptive sensations). In this study factors significant in distinguishing good from poor sight readers were number of eye movements from score to keyboard, ability to read ledger line notes, and amount of time taken for study before playing (19, pp. 91-99).

The reader must realize that more is involved in reading music than a rapid deciphering of musical symbols as signals for action; there must be a deeper kind of comprehension of the musical materials (31, p. 11). Cady, a music educator, said in 1902 that "until music as idea is conceived, formed in thought, the musician is unrevealed" (15, p. 61).

Andrews and Diehl said that "the child's musical growth relies heavily on his understanding of the organization and interaction of the structural elements of music" (1, p. 215). Thus reading the score with understanding is a complex process which requires years for full development. It is possible that certain problems and confusions may arise in the learning process.

Problems and Confusions in Score Reading

In Lawrence's opinion, one of the difficulties in score reading is caused by the requirement of reading vertically as well as horizontally. Because of this fact, children must think vertically also. He found that the above-average reader reads each vertical column of notes as one unit, and he sees each block of notes as a single symbol (20, pp. 21, 28). This is akin to the visual "gestalt" that Fredrich described.

Lawrence added that the player's mental image of the printed group of vertical notes to be played seems to be almost instantly identified with the image of the corresponding notes on the keyboard as well as with a kinesthetic feeling of hand and finger placement. This appears to let him keep his eyes on the music without difficulty. When he must glance downward at the keys he is able to do so without losing his place (20, p. 28).

Looking down at one's hands involves a change of focus; this requires the ability to control focus for changing distances or accommodative facility. The music rack is positioned on most pianos at a certain distance from the player's eyes, while the keyboard is a different distance from the eyes. The height of the player and the height of the piano bench or chair and the distance between bench and piano will alter both the distance of his eyes from the music rack and from the keyboard, and, in the case of a very young child, the music can rest on the rack at an uncomfortably high level. There is wide variation both in heights of benches and locations of music racks between various types of pianos (grand, upright, spinet, electronic).

Many young pianists attempt to read both clefs together, but treat them as though they were separate lines, Lawrence found. The children also turn each vertical group of notes mentally into a horizontal or oblique position, actually reading one note at a time (like a G major chord being read "g," "b," "d," as given previously in discussion of the visual "gestalt" of a G major chord). Because of the natural impulse to play instantly, he tends to keep his eyes on his hands instead of on the music and loses his place when he looks up. Unconsciously, in his impatience, he attempts to form a quick mental image of the printed music rather than of the keyboard, so that he can confine his need to look up. As a result with each new assignment the struggle with double horizontal reading takes place at the very beginning, and a vague memorizing takes its place thereafter. This use of the eyes is cumbersome and time-consuming, slowing reading down to a staggering crawl. Lawrence emphatically stated that the missing factor is visual control of vertical reading. He explained that the child is not used to reading vertically because he has been trained in school to read one line at a time (20, pp. 29-30). Suddenly he is asked to read not only along one "line" but two sets of five lines each. The eyes are being asked to learn new reflexes, just as the hands must learn new reflexes for the keyboard, the ears new reflexes in the language of melody, harmony, and rhythm. Furthermore, this is often expected to happen simultaneously in some beginning piano teaching methods (20, p. 35).

Lawrence, through years of piano teaching experience, compiled much information about the various approaches children use in reading the piano score. He concluded that even those with so-called perfect eyesight may not be using their vision with full efficiency. There are children who "use" one eye most of the time, or constantly shift the vision from one eye to the other ("monocular vision"). These children generally have a very low visual efficiency (20, p. 37).

Lawrence said:

> Two-eyed vision is called "binocular vision." While some children can see clear single images through both eyes for long periods of time, others cannot. The latter group tends to see double images and must strain the eyes in order to see the image distinctly. Visual efficiency varies over an extremely wide range. The majority of children have difficulty accomodating their vision to small symbols (20, p. 37).

Often the child who may have been told that he has "perfect" eyesight is actually being told that he does not need glasses. Yet he may have poor visual acuity, and this may create problems in attention and concentration. Such a child works under an even greater handicap than does the child who has obvious eye-muscle disabilities such as crossed eyes, for problems of the former child are not so easily recognized and understood (20, p. 38).

Lawrence described the kind of child who evades reading the score. This student has already been playing with both hands together for a considerable time. He has developed finger dexterity with accuracy and has mastered keyboard control. But he is unable to read; every note must be worked out individually and is often wrong. Every note looms as being complex and mysterious as though it were a vaguely familiar code symbol whose meaning he can decipher only after long study and investigation (20, p. 79).

Lawrence reported (20, p. 80) that as early as 1913, Curwen (7) had described music students as belonging to one of the three "sense" types: visual, audile, or tactile. She said that the visual type tends to use visual imagery; the audile, auditory; the tactile, kinesthetic imagery. She also stated that it is vital for teachers to know which type of learner her student is (20, p. 80).

An audile learner (usually called an "auditory" learner at the present time) will tend to play by ear and to avoid reading (20, p. 80). Kovitz found this tendency in children who are strong auditorially (16, p. 22). Rogan explained that this is similar to what occurs in the reading of words. For example, a person who has good sight recall for visual configurations, or for at least some of the visual patterns in words, can readily make associations to that pattern such as saying mentally to himself, "This pattern says "do," and that pattern says 'go,' and that says 'come.'" It is very difficult to teach that person phonics, because phonics is not functional to him (16, p. 22).

If a child's ears are quicker than his eyes in grasping a musical thought, there is almost always a conflict between the hearing which anticipates what is to be played and the seeing which must struggle to decipher what is to be played (20, p. 82).

A child who is strong auditorially may learn easily a tune that he has heard before, such as a nursery tune or a piece that the teacher has just played for him. He is often unable to perform a new composition that he has not heard before (20, p. 84).

The tactile learner will tend to play by "finger sense" and will try to avoid reading (20, p. 82). A child can learn some beginning music without knowing the names of the notes by following just the finger numbers which tell him which finger to use for each key. He can eventually memorize the movements of the piece, or memorize kinesthetically (20, p. 83). As long as his music remains in five-finger position (using the five fingers on adjacent keys without having to stretch for additional keys) he may be able to delude his teacher into thinking that he is reading the notes.

The names of note symbols in music use the letters "a" through "g" of the alphabet. Teachers assume, when they teach the note names, that the student knows the alphabet. Usually he does, in a forward sequence, but he may not know it in a backward sequence. There are many children who become confused when they attempt to reverse the alphabet. If the child is counting off keys in a downward direction, using a forward alphabet totally confuses the task; the alphabet letters will not match the key names (20, p. 92). It is also useful to be able to reverse the alphabet when trying to name the lines and spaces from memory backwards from a known higher note to an unknown lower note.

Often the first musical note and scale that the student learns is "c." Sometimes children are confused because the first letter of the alphabet is "a" rather than "c." They will call "middle c" an "a"; "d" becomes "b" and all of the other notes receive incorrect names. The concept of the alphabet is so mechanical that starting and continuing from "middle c" is simply too much for them (20, p. 93).

A confused reader may think that note stems have something to do with note names. He may not see the lines of the staff clearly, perhaps because of a visual acuity problem. The lines may appear to be blurred or double; his eye focus may falter. If a child has this type of difficulty even though he knows where the symbol belongs he may "see" it on the wrong line or space (20, pp. 91, 94).

There are students who become confused because of the fact that the names of the lines and spaces of the two clefs are different. Some children think that a change of stem direction is related to pitch direction. They tend to play the wrong key, moving in the opposite direction to that of the indicated note (20, pp. 94, 97).

Other children read musical symbols correctly but fail to play notes in both hands together because to them the notes don't look as though they are meant to be played simultaneously. They are miscued by the position of the stems. Stems which go up are always on the right side of the note head; stems which go down are always on the left. So if the student looks only at the stems, he decides that because they are not lined up exactly in vertical lines they should not be played together (20, p. 98).

Deutsch's findings indicated, as did those of Lawrence, that some children have trouble grasping the idea of notation. He described how some pupils cannot recognize the relationship of two adjacent notes, whether they are alike or different, or tell which one is located higher on the staff. His opinion was, provided the child's eyesight is physiologically normal, that the deficiency is merely functional and caused by the child's attention focusing on only one note at a time (9, p. 103).

Another deficiency is that of left-eyedness, which Deutsch found occurs mostly among left-handers. He said that the right eye tends naturally to read from left to right, while the left eye works in the opposite direction. If the pupil's left eye is dominant he will tend to read in reverse even when he employs both eyes, and he will find it difficult to read ahead and to integrate the notation into a whole. Music written for both hands playing simultaneously adds to the difficulty (9, p. 103).

Importance of the Auditory Sense in Reading

It is generally agreed by music educators that music reading ability depends upon developing the ability to perceive music aurally to a considerable extent. This ear "vocabulary" of musical sounds establishes the basis for music reading activities because the child is then able to work with familiar concepts and materials (26, p. 74).

Actually the process of reading music appears to depend upon three perceptual levels. Petzold indicated that these are:

> 1) the auditory perception of musical sounds; 2) the visual perception of musical symbols, and 3) the integrative, internalized process through which the individual organizes previous auditory and visual perceptions of given stimuli in order to react to these same, or similar, stimuli as they appear in new learning situations (26, p. 5).

Petzold's analysis of responses of children of ages 6 to 12 to visual and aural (auditory) stimuli presented to them as part of a study done in 1969 indicated that the major source of music reading difficulty might be traced to an inadequate aural understanding of the musical sounds represented by the symbols (25, p. 5).

A study done by King of children in grades five and six dealt with certain aspects of aural and visual responses of good and poor music readers. He investigated five aspects of musical hearing: feeling for tonal movement, tonal memory, pitch discrimination, time discrimination, and rhythmic discrimination of the Kwalwasser-Dykema Music Tests. The visual traits studied were near and far acuity, visual perception, near and distant fusion, astigmatism, stereopsis, vertical imbalance, and lateral imbalance. Imagery for pitch and rhythm, both auditory and visual, were also measured (13, pp. 93-97).

Differences between the goups were very small in most of the visual tests, and visual anomalies were not contributing to any reliable extent to disabilities in music reading. Both groups seemed to have a limited knowledge of musical symbols, but in the music tests the control group registered a consistent superiority. The critical ratios that were significant were found in tonal memory, feeling for tonal movement, pitch discrimination, and time discrimination (13, pp. 93-97). These aspects of musical hearing, in Kwalwasser's opinion, seem to be directly related to skill in music reading. He believed that it is doubtful that the good reader matches a symbol with a sound; rather, he matches a sound with a symbol. He hears first, just as the composer did, and his is likely to use notation to confirm what he hears (18, p. 158).

King said that when mistakes are made they are much more likely to be the result of error due to unmusical hearing than errors in seeing. The ability to reconstruct the sounds that the composer imagined when he wrote the melody is conducive to good reading. However, errors in reading result when the player deviates from the tonal, rhythmic, and harmonic intent of the composer (13, pp. 93-97). Kwalwasser said that there are patent weaknesses in this explanation, but that the emphasis is placed where it belongs, on the auditory skills (18, p. 160).

Whether the musician be composer or performer, his artistic behavior may be directed in part by an internal representation of musical sound, that is by imagery, according to Bergan. The sound of the music is the factor most intimately related to the behavior involved in the act of performing. When a child plays he is not attempting to reproduce the printed page, the finger numbers, or verbalizations of the letter names of the notes; these are only symbols of his real goal. Reliance on these music symbols alone would imply no direct knowledge of the music until it was actually heard, and performance could not be related to the factors directing it. That is, auditory feedback from the sound of the music would have no meaning. For example, a "sour" note doesn't convey information about letter names of notes or finger numbers; it simply points out the fact that the music sounds wrong (2, pp. 108-109).

In order for such information to have meaning to the child, it must be related to a system designed to judge sound. Bergan claimed that adequate auditory imagery could provide a basis for such a system. Such feedback would provide needed information both in the form of cues calling forth new images to direct future behavior and in the form of cues describing the adequacy of ongoing performance (2, p. 109).

Even if imagery is not involved in the process it seems that an individual's ability to make corrective or anticipatory adjustments to the pitches involved in a musical performance would depend on his ability to identify pitch in some way (2, pp. 108-109).

As in all learning, memory plays a part in music learning. The performer utilizes auditory imagery to direct his movements, but as soon as he presses a key and actually hears the sound he must also remember that sound.

Carlsen, Divenyi, and Taylor said that "Because music is a temporal phenomenon as well as an aural one, it is necessary for the listener to remember what he has heard as a referent for what he is hearing at the moment" (4, p. 8). The mind must further organize what is heard into auditory patterns or relationships between sounds. Lundin described this process as being an integration function (22, p. 5).

According to Rogan, memory seems to be a constant that persists over all, and in certain areas it may be stronger than in others. In every task involved in playing the piano memory serves as an essential component which stores the learning (16, p. 42).

Comparison to Reading of Language

Shepard (29, p. 79), in reviewing Christ's study (6), stated that Christ believed that language reading and music reading are analogous, despite many dissimilarities, in that both depend on the grouping of symbols into distinct perceptual units. Wildman explained this further when he said:

> When we read a book, magazine, or newspaper, we do not laboriously look at each of the letters which spell out a single word, and at length piece a number of words into a phrase. At a glance we take in the whole phrase, and in two or three glances a whole sentence or more. This is possible for us because of the time we have put in dealing with the letter groupings which form words, and with the relationships which words assume in phrases and sentences. The individual letters are comparable to individual notes in printed music; . . . we take in easily a whole series of these notes in vertical and horizontal groupings by seeing the musical relationships which they present (31, p. 12).

By the musical relationships Wildman meant that to a pianist certain groups of notes mean certain kinds of melodies, such as scalewise melodies, or melodies with many notes adjacent to each other in the form of a scale, or certain types of chords. Rather than thinking the names of the separate notes he thinks of the notes together as being a certain chord.

Young reported (32, p. 57) the finding of Monroe (23) that in both music reading and language reading there is a need to develop a "sight vocabulary"; in music this would consist of tonal and rhythm patterns; in language, of words. Identification of the symbolic language in both areas is done through perception of visual configuration within a context (32, p. 57). In language reading the student is dealing with one line of print which is read from left to right; in music reading the student must deal with symbols printed on two sets of staves having five lines each and vertical eye movement is necessary in addition to left-right movement. The amount of vertical paper space which music utilizes in one "line" is considerably more than the amount printed in language material in one line. There are therefore many more spatial relationships between symbols that the eye and brain must perceive.

The symbol system in music indicates more than which keys to press down; it also indicates the speed, volume (loudness or softness), the proper length keys should be held down, and any special treatments such as accents. Printed words do not impart stress and inflection to the extent that music symbols do (16, p. 57). Kovitz suggested during the summer 1971 workshop that perhaps rhythm and stress could somehow be marked in language reading material.

Rogan, who served as consultant for the workshop, expressed the opinion that this might be unnecessary. Both language reading and music reading are decoding processes, but the decoding process in reading language is being attached to or related to an already well-established language system, an automatic verbal system. So that when some clues appear in the printed page they trigger the word which the child already knows from his oral language. The words are all familiar and are the basis for the selection of words in the graded textbooks. As soon as the child grasps part of the decoding he will be able to say the word with the correct stress. This occurs because the word existed in his oral vocabulary. The problem with music is that these rhythmic patterns do not exist with the same degree of clarity as do the speech patterns (16, pp. 57-58). In early piano study the child has not ye· hr.d sufficient experience for these auditory rhythmic patterns to be automatic.

The rhythmic patterns printed in the music are attached to different melodic patterns. The equivalent of a simpler vocabulary like that in the beginner's language reader would be the simpler melodic patterns in a limited pitch range, such as in a five-tone range (16, p. 58).

According to Rogan, perhaps a parallel would be a case in which a child had had a great deal of experience with rhythmic patterns so that they were very automatic. He could at will clap out the rhythm of a familiar tune such as "Shave and a hair cut, . . ." Then the teacher could show him the visual note symbols and relate that visual pattern to the auditory rhythmic pattern that he already has (16, p. 58).

The music language develops mostly through formal lessons as the child becomes familiar with the whole repertoire of possible patterns. To beome adept at this skill one needs years of experience (16, p. 58).

In speaking of verbal language, Bruner said:

> The symbolic system of representation is based on the translation of experience into language. But it is obviously not language per se that makes the difference; rather, it seems to be the use of language as an instrument of thinking that matters, its internalization, to use an apt but puzzling word (3, p. 14).

Bruner said further that certain features of symbolic systems are only now coming to be understood, that they are arbitrary, remote in reference, almost always highly productive or generative, and that they are compact (3, p. 14).

Music, in this broad definition, is a form of language, not that it creates "words" that relate to literal objects, but in that it translates experience into communicable ideas, that is, music ideas; music is "an instrument for thinking" (15, p. 61). Written music is similar to written language particularly because it represents auditory experience which must be translated back into auditory experience, the actual hearing of what is played or sung (15, p. 64). In reading language orally a person hears himself speak the words, and in reading language silently he mentally says the words to himself.

According to Johnson and Myklebust, "reading is a visual symbol system superimposed on previously acquired auditory language" (12, p. 79). Music notation appears to be structured in a similar manner.

Motor, Tactile, and Kinesthetic Problems

Areas of potential problems in piano playing are those of motor skill and tactile and kinesthetic senses. In Schumann's opinion the one basic skill that any instrumentalist must possess is the ability to locate keys on his instrument without having to look at his hands. This is essential to good sightreading, to secure performing, and to playing easily by ear. The mere location of keys must be second nature to the player in order to free him to concentrate on the sounds that he is producing (28, p. 38).

In the beginning lessons a student learns to "read" notes, to relate two or three ink spots on a staff to two or three keys on the piano, and it is possible to play simple pieces at first without knowing the instrument "by feel" (28, p. 38). But as the pieces become more complex and greater speed is required, it is crucial to be able to locate keys instantly.

Fortunately, the piano has visual landmarks to initially orient the beginning student, the groups of two and three black keys. Also, on the piano every "g" for example, is in exactly the same place as related to every "a." All of the "g's" not only sound alike (because they are an octave apart from each other), but they look and feel the same as each other (28, p. 38). In other words, the keys have been cut at the piano factory so that all "c's" are the same length and width, all "b's" are the same length and width, and all black keys have the same dimensions.

Unfortunately this is where the similarities end. While all "c's" resemble each other they do not have the same dimensions as all "b's" or all "e's." The child learns by trial and error exactly how far his fingers must reach to accomodate these physical differences.

When the child first begins to play the piano the keyboard may be visually confusing to him (16, p. 61). He may not use the grouping of black keys as cues. As he has more experience he becomes visually oriented to the keyboard, and is also slowly building a kind of kinesthetic and tactile vocabulary of where certain keys are located.

He is also learning how much energy he must use to achieve an exact degree of volume (loudness or softness). The latter process can be complicated by the fact that there is a wide variation between pianos in the action of the keys. The keys of some piano keyboards are very easy to depress or have a "light" action; others are quite difficult and have a "heavy" action. If a child plays one type of piano at his lesson and another in his home he must make delicate motor adjustments to achieve the degree of volume indicated in the music.

A more serious situation occurs when the individual keys of a piano differ in heaviness of action, for this gives a child an incorrect kinesthetic message. To attain an even level of volume he might have to use more energy in depressing one key than he needs to depress another. If he subsequently plays a piano which has an even action he must readjust all over again. It is unfortunately true that the pianos on which beginners learn to play are perhaps some of the most poorly constructed and maintained instruments. In addition to the problem of uneven action the piano may be considerably out of tune, giving the child a poor auditory model. Some keys may not go down; others may stay down.

One must consider the structure of the human hand when discussing the physical problems of playing the piano. The fingers are of different length, meaning that some of the fingers must be curved more than others in order to maintain a comfortable hand position which will also allow for rapid playing.

Petri pointed out that the keys are much longer than they are wide, and they become narrower where the black keys begin. Also, all keys become heavier and slightly harder to push down the further you go forward (24, p. 5). The child learning to play must make adjustments to these differences.

Even in small finger movements there is a great difference between going from white to white key, black to black key, white to black key and black to white key. In the first three groups one must lift his finger from the bottom of the depressed key to the top of the next one, more so from the white to white key than from the black to black key. This is because there is no sharp edge of the next key which bars his way. One must move more forward than sideways when he moves from white key to black key. But when one goes from black to white key there is no lifting at all because he is on a higher level at first (the black key) than that of the key which he wants to depress (24, p. 5).

Finger span, the distance between the thumb and index finger, is often a source of information concerning the dimension of small objects. The angular position of the finger bones also helps to determine geometrical information such as the shape of surfaces and the arrangement of objects in space (5, p. 44).

Spatial orientation on the keyboard, as stated before, is very important. Now an additional reason for having this type of skill can be seen. When two notes are a certain number of scale tones away from each other they have a certain name depending on the number of scale tones between them. For example, from "e-flat" to "a-flat" there are four scale tones; thus the name given to the distance between these tones is the "interval of a fourth." Intervals are far more complex, but for the purposes of this illustration it is not necessary to explain these further. When a pianist plays this "fourth," his fingers automatically (with experience) shape the correct distance between the two keys (in this case between two black keys), and he depresses both keys simultaneously with the most comfortable choice of fingers.

If the pianist must play another "fourth" immediately after this one, but in a different location, such as two white keys, he must readjust his fingers to a slightly different distance apart from each other. This is necessary because, due to the construction of the keyboard, the distance between "e-flat" and "a-flat" is not the same as the distance between "e-natural" (white key) and "a-natural" (white key), even though they are both "fourths." This concept may be extended even further to include all intervals, all chords, all scales; none of them is exactly like the other.

The pianist must develop a kind of tactile-kinesthetic-motor vocabulary quickly and store it in his brain, so that when his brain is stimulated by a certain visual symbol on the paper, his motor apparatus obeys instantly and begins to shape the necessary finger position to play the keys accurately (14, p. 42).

Kochevitsky emphasized the view that the problem of velocity lies not in the speed of any individual finger, but in dexterity of the mind, the rapid perception of the printed page and the rapid transmission of volitional impulses from the central nervous system to the periphery, the playing apparatus. Disobedience in the fingers is caused by deficiency in the transmission or orders (14, p. 41).

Persistent concentration is needed to achieve the finest precision in timing successive finger movements. In fact, extremely precise timing in coordinating the work of all parts of the playing apparatus is indispensable (14, pp. 41, 43).

If both hands must play in the same direction (either upward or downward on the keyboard), this motion is called parallel motion. If a child were to play, for instance, the first five ascending tones of a scale (a pentachord) in parallel fashion upwards, this would necessitate his beginning with the smallest finger ("fifth" finger) of his left hand and the thumb ("first" finger) of his right hand.

During the piano workshop Rogan analyzed the mental processes of an ambidextrous child when he attempts to accomplish such a task. She said that if he is ambidextrous his tendency would be to mirror with both hands, that is to move both hands from the inward to the outward or from outward in. In this situation the child has to learn that the left hand duplicates what the right hand plays rather than mirrors, and this may cause a considerable amount of organizational difficulty in his mind. Whatever messages the mind is sending (and they may not be verbal messages at all), the other tendency to mirror may be stronger. It is so much more economical for the brain to select the same fingers of each hand to move as when playing from inward to outward (16, p. 14) (a sequence of both thumbs, both index fingers, both middle fingers, and so forth). For one hand to duplicate the direction of the other hand the brain must send out two different kinds of messages (16, p. 14).

A student must learn the finger numbers used in piano and associate them with the proper fingers. When he sees the finger numbers printed on the page he must instantly move the corresponding finger. This is not an easy, automatic process for some pupils. An example of this is a case in which a child reads "1" for the left hand and moves the smallest finger rather than the thumb.

Rogan explained this as being an associative kind of learning process, learning a name for the position of each one of the fingers and relating it to an individual kind of finger, as "the long one in the middle, the index finger, the thumb...". If a child mistakenly uses his smallest finger of the left hand when he reads "1" it may be that he is thinking in terms of a left-right progression as in a number series, such as in the number line (16, pp. 44, 46).

In his teaching experiences Deutsch found that some children though they read easily, lack motor coordination and kinesthetic memory for what positions their fingers have taken. They have a great deal of difficulty finding keys, establishing hand position, and returning to formerly used hand positions (6, p. 104).

To play rhythmically is to play with motor control, Shepard said. "Kinesthesis is a major factor in rhythmic perception and the teaching of rhythm is synonymous with the teaching of motor control" (29, p. 80).

Special Qualities of the Musical Language

As in every other field of knowledge, music has a technical vocabulary that is unique to that field. From early piano lessons on the young child is confronted with the need to understand and to assimilate a number of basic terms, some of which are very abstract. These become more meaningful to him with experience, but he must establish some basic concepts before he can progress successfully.

Andrews and Diehl found in a study of children's musical concepts that some children mistakenly interchange the three terms "high," "loud," and "fast," and "low," "soft," and "slow." In their opinion this may be due to the frequent occurrence of "high" music also being "loud" and "fast" and "low" music also being "soft" and "slow." Or perhaps the children are confusing labels. In their study some of their subjects possessed the concept but failed to apply the correct label (1, p. 221).

Rogan said that to some children the musical language must seem ambiguous and confusing "because most, or many, of the words which are used have common meanings for the child which are different from the specific musical meanings. . ." (16, p. 39).

Examples of such words are: "staff," "note," "rest," "scale," "interval," "measure," "step," "skip," "repeat," "sharp," "flat," "up," "down," "high," "low," "half," "eighth," "quarter," "move," "flag," "time." Each of these words has other meanings experienced prior to music study. Therefore, the child must understand the specific music meanings and the word must be empty of its common usage, unless there are enough parallels in both usages to be helpful (15, p. 65).

Rogan explained that the child is learning something with a new vocabulary and with new relationships, new associations, and the old associations are still there. At times the old associations come forward and are helpful because the child can then associate with something that is meaningful. But at other times the old associations interfere with the child's learning (16, p. 6).

In directing a child to write notes on an empty staff, it is common for piano teachers to say, "Write a note on the line." The note heads, if correctly written, are placed so that the line goes through the middle of the note head. Some children have a tendency to place the note head resting on the line, actually creating a space note rather than a line note. Rogan offered a reason for this inclination when she stated that this is the interference of an earlier learned habit pattern which will sometimes cause errors, not on the basis of confusion or lack of knowledge, but simply that the old habit pattern of "writing on the line" comes to the fore (16, p. 20).

Another potential problem is the symbol for an eighth note:  or  . Both versions occur in beginning piano music. The wavy line found at the end of the note stem is called a "flag." Rogan compared the two symbols and noted that when the "flag" is attached to the top of the stem, as in the first symbol, the wavy line resembles, to her, a real flag more than when it is attached to the bottom of the stem (16, p. 20). This suggests that perhaps "flag" is not the best designation for this part of the symbol because it could call to the child's mind a real flag which would not associate properly with the meaning of this special musical "flag." Kovitz suggested that maybe "wing" would be more meaningful since the line more closely resembles a wing of a bird than a flag (15, p. 57).

Another sign, the "sharp" (#) resembles so much the lines made for a tic-tac-toe game that it could interfere with the child's conceptualization of the specific musical meaning (to raise a pitch). Seeing the sharp symbol, the child may puzzle over what a tic-tac-toe game has to do with music and the label "sharp" (17, pp. 17-18). A common meaning of "sharp" to a child means having a fine edge or point, a meaning which in no way relates to what is occuring in the music.

To help a child to organize his approach to a piece of music, piano teachers often have the child verbalize about the direction of the melody (that is whether it has notes representing ascending pitches or descending pitches or even pitches that remain at the same level). The teacher may refer to an ascending series of notes as going "up" and a descending series as going "down." Or she may talk about a melody being "high" (meaning to be played on a part of the keyboard that sounds high pitches) or "low" (meaning to be played on a part of the keyboard that sounds low pitches). In actuality, of course, she is indirectly referring to different sound frequencies being produced by the hammers striking the piano string. The shorter the string is, the faster the frequency of vibration and thus the higher the pitch.

The child is often encouraged to examine each note, compare its position (on the staff) to the adjacent note. If one note occupies a line and another note occupies the space just above or just below it these notes are said to be a "step" apart. The same label is used when one note in a space is next to a note on a line. If there is a greater distance between the notes the term "skip" is used to described the relationship between the notes. If two or more notes appear successively on the same line or space, the note, or notes, following the initial note is called a "repeat" note.

The child must internalize these labels and their meanings, special meanings which do not relate to common, speech meanings. He must also absorb the language that is used to describe rhythm: "quarter," "eighth," "half note," "whole note," and so forth. Sometimes he is asked to look at the note symbols and chant or sing them in proper rhythm using the rhythm names.

Many children's piano pieces also have lyrics that may be sung by the teacher and/or by the child; thus this is another set of words that are attached to the melody, words with common meanings (because of being verbal language words).

During the workshop, these multiple applications of words to note symbols were pointed out, and Rogan acting as consultant provided an insight into the mental processes which probably occur when the child hears and uses these words (17, p. 18). As she analyzed the concepts of "up" and "down," she revealed the complexity of associations to those words. She said:

> I don't think it's a difficulty of the child understanding what the parent means when she says, "Oh, it fell down." . . . It's falling that's being talked about, and "down" is kind of redundant. You could say, "Oh, it fell," and this would tell you what happens because it never falls up. So "down" is redundant in that language expression, but we use it all the time. But this may

mean that the child doesn't really have to think about "down," because "falling" is the concept (16, p. 55).

She gave some examples of the ways that "up" is used: ". . . 'look up' and 'pick you up' and 'See the birds fly up.' . . ." To her it seemed that the "up-down" becomes confused in music, because the child begins to relate this symbolically to the horizontal paper in school (16, p. 55).

For writing on the top of a page lying flat on the desk you go up, which is away from you; "down" on the paper is towards you. At the keyboard "up" and "down" take on another meaning and dimension, equated with left-right direction (16, p. 55). (To the left is "down" on the piano, and to the right is "up.")

Confusion exists with "up" and "down" in music because of the many ways in which the word is used in the child's daily experience, commented the consultant. An example she gave was a person bending down to pick something up. Another was a person taking curtains down: he climbs up to take them down. These are all physical, kinesthetic, experiential associations to the words "up" and "down." She explained that during a lesson the teacher does not know when she says any word, not just "up" and "down," what association out of a whole bed of associations may come out in response to that word (16, p. 55).

When a child uses the lyrics of a piece in imitation of his teacher, the words are an automatic sequence of syllables, like a rhyme. At this point, they are not conceptual. They can be made conceptual as the teacher talks about it and asks him to visualize the meaning (16, p. 33).

In explaining this Rogan said:

> . . . it's quite an automatic sort of thing, almost like a rhyme, "Humpty Dumpty sat on a wall. . . ." You can say this without any idea of what Humpty Dumty is, or what a wall is that you sit on, for that matter. Whereas, when you're asking him to say "start, repeat, repeat," or to give. . . the structure, . . . this is verbalization of an altogether different order. Because that means that in order to adequately verbalize this, there are two things he can do. One is he can remember by note what has been said before. This is almost an impossible task, because so many things have been going on at the same time that he doesn't remember whether you said "start, repeat, quarter. . . ." whatever. He can't remember this sequence, so . . . he must rely on something internal to which he's added these words . . . And this makes it a task of a different order. . . (16, p. 33).

Kovitz added:

> The words "step," "repeat," and so forth are important words because they're conceptualizing and verbalizing the language of the music. They're not incidental words. They're a product of his understanding the actual music itself. And the rhythm words, "quarter," "eighth," and so forth aren't incidental. They have to be thought through and are the response to the conceptualization of the music itself (16, p. 31).

At one point in the workshop the participants were trying to untangle the function of different vocabularies used to communicate and to clarify the rhythm of the piece for the pupil: the lyrics and the rhythm words of "quarter," "eighth," half note" (17, p. 14). Rogan said that to use "quarter" and the other rhythm words as language (by describing what is occurring rhythmically in the music), there is an integrative, thought-communicating process taking place in the child's mind. The child should have some ideational content to which to attach the words "quarter," "eighth" and so forth. She expressed concern that the words "quarter," "eighth," "half note" do not convey clearly the rhythmic pattern of the music. The child therefore lacks a solid ideational base which will serve him in learning another song at a later date (16, p. 36).

Discussion during the workshop revealed the fact that when a child looks at the symbols for a quarter note and a half note (♩, 𝅗𝅥) he sees one symbol for each, but if he says "quarter" or "half note" he is saying essentially two syllables which do not produce a speech rhythm that relates to the musical rhythm. Kovitz stated that "'quarter, eighth' language is symbolic language; it describes the rhythmic durations but doesn't fit the rhythmic pattern it describes" (17, p. 15). In music a half note is twice as long in duration of sound as a quarter note. There is little in the rhythmic chanting of the words "quarter" and "half note" that relates or demonstrates this ratio as it occurs in the music.

Lyrics fit the auditory rhythmic patterns, but they do not describe the rhythmic durations (17, pp. 14-15). Lyrics are part of a child's normal speech patterns that were established early in the child's life. Therefore, it may not be difficult to remember a verbal phrase in the lyrics; he is simply using what he already does very well. But to be asked to remember that a note of a certain shape and in a certain location on the staff has two names, a "d," and a "quarter," in a beginning stage of piano study when he has not learned them very well is difficult. The child is being asked to relate the names not only to a visual pattern of symbols on the page, but also to an auditory pattern of sound (16, p. 34).

To reiterate, piano playing utilizes simultaneously the visual, auditory, tactile, and kinesthetic senses. The information received through these senses is processed in the brain. This is called intersensory integration. One example of intersensory integration is that of matching information between auditory and visual sense modalities. Another is the task of matching visual to haptic information; another is matching auditory to haptic information (that received through the tactile and kinesthetic senses).

In explaining the various processing systems, Chalfant and Scheffelin said:

> The independent integrity of the auditory, visual and haptic processing systems is necessary for simple sensory functioning. There is clinical evidence, however, that the simple sensory functioning of one sensory system is affected or modified by the functioning of other sensory systems, both as they function independently and in coordination with other systems. As processing tasks become more complex, the number of sensory systems needed increases and their inter-relationships become more complex (5, p. 51).

The integration of the kinesthetic modality with the visual and haptic modalities may not take place until children are seven or eight years of age (5, p. 53).

If multiple stimuli are being received through the same modality this is called intra-sensory integration. Relating the words "tap, tap, tap" to the equivalent sounds made by a hammer is one example of an intra-sensory task, because both stimuli have been received through the auditory modality (5, p. 51). The first stimulus is a verbal one while the latter is of the nonverbal type.

In music this would be comparable to merely listening to a person first sing "ha, ha, ha" on an "a" pitch and then hearing the person play "a" three times on the piano without being able to see either act take place (no visual cues). Intra-sensory learning is not purely intra-sensory; however, Johnson and Myklebust view them as being at times relatively independent (12, p. 27).

The reader should now understand the rationale behind the statement that "playing the piano is a complex task." It obviously demands the use of all the modalities. However, they may not all be called upon to an equal extent at any given moment. This idea was generated during the experimental workshop of the summer of 1971. The author had commented, "We are all combining modalities in different combinations all the time." Rogan added:

> There isn't any consistent reliance on one modality all the time. It depends on the task. . . . If the student is reading, he has a different task than if he's being asked to memorize. . . . In reading he will use certain modalities that he possibly doesn't have to use if you ask him to memorize. So then you can count on a completely different shift [of modalities]. . . (16, pp. 78-79).

A number of researchers have done a fairly thorough investigation of some of the processes and problems involved in piano study, but until very recently no one has suggested what special difficulties a child with a learning disability might encounter. However, there is considerable literature dealing with the learning disabled child's problems in non-music areas.

Before a relationship between piano skills and learning problems can be attempted, the definition of a learning disabled child and the nature of his problems must be explained.

The Child with Learning Problems

Characteristics of the Learning Disabled Child

A child with a learning disability probably has normal or better intelligence, yet, as Rogan defined him:

> . . . his nervous system does not receive, organize, store, and transmit information in quite the same way as does that of a normal child. . . . It is possible for a child to score within normal limits on tests yet have serious difficulty learning certain things. . . . Such a child may show a wide gap between his ability to understand events, experiences, and ideas and his ability to learn to read, spell, write, and compute numerically (21, p. 1).

There may be great inconsistency in performance; the child may be very adequate in math, for example, yet have difficulty learning to read, or vice versa. Clements also described this child as follows:

> Although achievement is variable depending on the nature of the task, the overall level of intellectual functioning is within normal limits and . . . we are not dealing with a child who is generally mentally retarded, that is, deficient in all areas of endeavor (7, p. 5).

Causes of the child's problem are numerous. It may result from injury to the tissue of the central nervous system such as might occur during a difficult delivery, or from a fall or an automobile accident. High fevers, encephalitis, or a lack of oxygen may damage tissue in a similar way so that it can no longer function as efficiently as it once did. Virus illness of the pregnant mother and blood incompatibility of mother and fetus may be damaging. Some authorities believe that the cause does not always lie in tissue damage, but that electro-chemical imbalance may be a factor. It is also possible that certain systems may lag behind others in their rate of maturity to such an extent that disparities in development result (21, p. 1).

Whatever the cause, the trauma or irregularity in development results in an alteration of the normal patterns of growth and development as they usually occur. Often the child's physical growth proceeds quite normally and he doesn't appear to be handicapped. His vision and hearing are functioning in a normal manner. The effects of the central nervous system dysfunction can be seen in the perceptual mistakes made by the child, his conceptual confusions, in his behavior difficulty, in his learning disorders, and in subtle motor incoordination (21, p. 1).

Some of the symptoms, according to Clements, that affect his academic performance are: inability to read at grade or age level, poor spelling, "difficulty with arithmetic, difficulty with abstractions and whole-part relationships, difficulty in mastering tasks which are dependent upon intact visual-motor-perceptual integration" (7, p. 5).

His printing, writing, and drawing may be poor; he may have difficulty copying geometric figures, letters, and numerals (7, p. 5). He may not be able to keep his place in the book either because he is distracted by something else or because he cannot pay attention to the most important part of the stimulus (the exact printed word which he must read). He cannot differentiate between relevant and nonrelevant stimuli. This inability to differentiate can cause difficulties in the ability to integrate (5, p. 51). He is overwhelmed by the mass of print before him and cannot concentrate on the single word.

Learning disabled children with a visual reception problem simply do not receive meaning from what they see. There are children with learning disabilities who cannot judge distance either in three dimensions, as in jumping from one place to another, or on paper (two dimensional). These children cannot perceive the difference between left and right, up and down, vertical and horizontal, over and under.

Situations that require differentiation of symmetrically opposite points are particularly difficult such as that in discriminating between a "b" and a "d" (5, p. 27). A basic problem in directionality can cause a child to confuse "b" and "d" and "p" and "q."

Some children have visual discrimination problems of a more gross nature. They cannot tell the difference between squares and rectangles or between larger and smaller symbols. Some cannot recognize a picture of an object if some of the parts are missing; they cannot mentally "fill in" the absent portions (visual closure problem).

Many are unable to remember what they have seen (visual memory) or to remember what has been seen in a specific order (visual sequential memory). Others cannot imagine or mentally picture what they have experienced and the places they have been (visual imagery).

A difficulty in coordinating eye and hand (visual-motor coordination) is common. This is a skill used when the child writes, colors within printed lines with a crayon, copies from the board or a book.

A portion of learning disabled children are unable to view things as a whole, as a "gestalt." They see parts of things but often do not comprehend the total mosaic.

A whole area of auditory problems exists. A child may not receive meaning from what he hears (auditory reception difficulty). He may not understand a teacher's question or be able to carry out verbal directions. He may have difficulty understanding only certain parts of speech, possibly the more abstract ones such as adverbs.

The child may not remember, in a general way, what has been said in class (auditory memory), or he may not remember in a specific order a series of events or instructions (auditory sequential memory). He may not be able to hear the differences between speech sounds such as "p" and "t" or the difference between "put" and "pet."

A deficiency might exist in auditorizing or in auditory imagery; the child may not be able to recall the actual sounds that made up part of an experience. Or he might understand and recognize words but be unable to remember or retrieve them for spontaneous usage (12, pp. 33, 114).

A child with a disturbance such as a problem in the perception of relationships cannot pay attention to the proper auditory stimulus; for example, when the teacher is explaining something he is distracted or irritated by noise from the playground. The term describing this inability is "auditory figure-ground" problem.

Johnson and Myklebust gave an example of one type of reading problem caused by a deficit in integration:

> The child learns the spoken word and what the letters look like, but he cannot associate these images with the way they sound. . . . The reverse can also occur. He learns what letters sound like but cannot make the normal association between these auditory images and their appearances (12, p. 28).

A learning disabled child is often described as awkward or clumsy; coordination deficits may appear in either fine muscle performance or in gross muscle performance or both. Some learning disabled children appear to be in constant motion, flitting from one object or activity to another, or they may be merely restless and fidgety. Clements said that the child's "drivenness" may also manifest itself as uninhibited speech or as disorganized thinking even in the absence of outward constant motion (or hyperactivity). Other learning disabled children are the opposite; they move, think, and talk at a very reduced rate (hypoactivity) (7, p. 5).

Some of these children cannot keep from touching and handling objects, may curse and be insulting, commit anti-social acts. Many are irritable, aggressive, or easily moved to tears; they may have quick changes of emotional behavior from high temper to easy manageability and remorse. They may be panicked by what would appear to others as a minimally stressful situation, but there are also some who are consistently even-tempered and cooperative, with a very high frustration tolerance. There are those who have a very short attention span (distractible) and fade out, especially when abstract material is being presented (7, pp. 5-6).

Some "soft" neurological signs are poor coordination of fingers, mixed and/or confused laterality (left and right-handedness), speech defect, or a history of slow speech development or irregularity (7, p. 6). Inability to discriminate tactilely (by touch) can also be a problem.

Temporal or time sense may be a deficit area. The child does not know the order of seasons, cannot judge how long it took to do something or how long it will take to do something. He cannot project into the future and know with certainty when "next week" is, for instance.

Verbal or written expression or both may be problem areas. The child might have defective syntax or be "unable to plan and organize words for the expression of ideas in complete sentences" (12, p. 114). The child may be able to express himself verbally but not be able to put the ideas into written form; he may have trouble forming the letters or he may form the letters correctly but be unable to produce complete, well-organized sentences on paper. These are expressive disorders.

Often a child has a deficit not in perception but in symbolic processes (handling of symbols) or in conceptualization. At the level of conception the percepts of the previous level (perceptual) become further refined, organized, and abstracted for greater ease and economy of manipulation. "The child's internal and external worlds become further ordered as he learns to think of them in terms of different systems of classification, categorization, and serial arrangement" (27, pp. 58-59). He is better equipped than ever before to explore and to practice the many ways in which an actual or vicarious experience can be expressed in action, in language, or in other abstract symbols (27, pp. 58-59).

The apex of development is reached when the child gains the skills and facilities of the integrative system's cognitive level. Here a single word can retrieve from the storehouse of memory all related pertinent information accrued by the child up to that moment in time, and can make that information available in the service of optimal performance (27, p. 59).

Each child with learning problems has an individual combination of deficits and strengths. According to Johnson and Myklebust, "a dysfunction in the brain can disturb auditory processes without fundamentally disturbing others. . . . The same can be said for disturbance of visual, tactile, and proprioceptive learning" (12, p. 27).

Johnson and Myklebust viewed learning disabilities in terms of three basic ways in which learning may be neurologically impeded: receptive, integrative, or expressive. In explaining an integrative type of disorder they said that "clinical experience, as well as research, has shown that input and output, reception and expression, can be intact in the presence of some of the most debilitating learning disabilities" (12, p. 21).

Further support for this finding came from Chalfant and Scheffelin:

> There is some evidence that individuals who function normally when receiving stimuli through a single sensory modality sometimes perform differently when the task

> involves the simultaneous or successive functioning of several modalities, or when several stimuli are received through the same modality.
>
> Higher mental functions may be disturbed by lesions affecting the parts of the cerebral cortex which make up the integrative system (5, pp. 54-55).

The functioning of higher mental systems requires interconnected, but highly differentiated cortical zones, and the integrity of the whole brain (5, p. 55).

The reader should be reminded at this point that problems in mental functioning may also be caused by chemical imbalance or by neurological immaturity.

Behavior of Selected Learning Disabled Children in Learning the Piano

In this section the behavior of some learning disabled children in learning the piano will be described. Explaining the source of this information seems to be important at this point.

Three piano teachers, S. Harris, V. Kovitz, and the investigator, had observed specific difficulties their piano students had had. Some of the children they had taught were students with diagnosed learning disabilities, and others were children having no learning problems. The teachers sought a better understanding of the mental processes involved in piano study and more complete information about the learning disabled child. They hoped, through an exchange of ideas, to develop new methods which could be used not only with learning disabled children but with others as well.

The idea of having a piano teaching workshop occurred to V. Kovitz. The format was to be lessons observed by a professional consultant in the field of learning disabilities and by participating teachers. The lessons were to be followed by discussions of the student's behavior, the mental tasks involved, and the methodology employed.

L. Rogan, Ph. D., internationally known learning disabilities specialist, agreed to serve as the consultant. She was a pioneer in the identification of learning disabilities, learning disabilities research, and the remediation of learning disabilities. She is Clinical Director of Cove School, a private school for learning disabled children, which she and Strauss co-founded (17, pp. 1-2).

Two of the children participating were students at Cove School; thus the consultant was thoroughly familiar with their individual abilities and learning styles. Harris's student was a nine-year-old boy; Kovitz's pupil was a twelve-year-old girl. The author's student was a twelve-year-old girl with suspected but undiagnosed learning problems.

Through her observations of the lessons the consultant could offer insights to the teachers into the specific learning situations involving the pupils, and she in turn would gain more information about piano study (17, p. 2).

The total program ran four weeks, with ten lessons given. The boy had two lessons with Harris; Kovitz gave four lessons to her student; the writer taught three lessons. The time period of the lessons was from thirty to forty-five minutes each, and they were given in the Kovitz home (17, pp. 2-3).

The consultant observed each lesson from a vantage point in the room; the other teachers could listen to the lessons from another room, unseen by the child though their presence was made known. The observing teacher, the participating teacher, and the consultant were the members of the discussion group following each lesson. All of the lessons and discussions were taped; a transcript was prepared by Kovitz after the workshop had ended (17, pp. 2-3). Specific problems that were discussed will now be presented.

In a paper which summarized and evaluated the workshop and also offered additional comments about learning disabled children and the piano, Kovitz discussed a problem of a particular learning disabled child whom she had once taught. The child, when reading notation, was misled by the position of the note stems. When asked in what direction a specific melody was going (an ascending melody), he answered "down" because he was attending to the stems which were hanging down from the note heads (17, p. 5).

A child might be "too aware of all the cues and stimuli coming at him, and he has difficulty in discriminating those most useful to him for the situation" (17, p. 5). When the teacher introduces a new song to the child, sings it with lyrics, and claps the basic pulse, the learning disabled child might be attending only to the melody or the rhythm or the lyrics, or perhaps only to the clapping or her facial expression or to the necklace the teacher is wearing, or maybe to all of these stimuli. Because the necklace might be the most appealing of the stimuli, that might be the one that he watches (17, p. 5).

During a lesson that was part of the workshop described above, Kovitz asked her student, a learning disabled girl, to observe some repeated notes (notes of the same pitch) and to describe the "movement" of the notes. The student was confused. Rogan explained that the teacher had been looking for movement up or down on the staff, or a repetition of notes. The student saw the visual movement laterally across the page and said, "Yes, they do move." The consultant felt that this indicated the ambiguity of the language which is used in music; "many of the words which are used have common meanings for the child which are different from the specific musical meanings" (16, p. 39).

Another confusion in the word "move" was illustrated during one of the boy student's lessons. His teacher was helping him to find a minor pentachord when his fingers were at that moment in the position to play a major pentachord. (In other words, his fingers might have been on the keys C-D-E-F-G; to make this a minor pentachord he would have to play C-D-E-flat-F-G.) The boy was told to move his middle finger, meaning to move it laterally from an E to an E-flat. The confusion in thinking could occur when the child might also think, "But all of my fingers move," having in mind up and down movement (16, p. 40).

The name "flat" can also cause confusion for a child with a learning disability, and perhaps for other children, too. In the course of one of the lessons Kovitz's girl student was asked if a certain note was "plain b" or "b-flat" and was confused. Having observed this event, the consultant wondered if the confusion might come from the fact that the flat symbol looks like the letter "b" (16, p. 40). She commented further:

> . . . since "b-flat" is the first flat tone to be introduced in music, quite accidentally, since it is the first, it relates to the "b." And why flat, then? It seems, . . . "Oh, aren't they very nice! They're putting the letter "b" here so I don't have to think and remember it's a "b." They're making it "b" for me. And this could be part of the child's thinking (16, pp. 40-41).

Then when the child sees the same symbol next to another note such as an "e," in his thinking it becomes "b-flat e". . . . and what is the "b" doing next to an "e"? (16, p. 41)

While learning a particular piece, the writer's student was able to clap the rhythm, walk the rhythm in steps across the floor, but was unable to play the piece using the score (even though she knew the names of the notes and the keys). The consultant explained that it might have been simply a matter of the complexity of the task. The girl had been able to do the other tasks before the visual notation was added, along with the requirement of playing the keys. She had trouble integrating all of the information and subsequently performing (16, p. 76).

The student seemed to be bothered by a quarter note and when to start an eighth note pattern following the quarter note. She asked questions like "Do I wait?" She was sensing that she should wait, yet not knowing how much, or what value to give the quarter note. This was not the result of not knowing the rhythmic value, in Rogan's opinion. In viewing it visually the girl did not know how to translate that visual quarter note symbol "into the pulse that she could maintain without looking at it visually" (16, p. 76).

As was mentioned before, there are various ways of talking about the notation. A child might be asked to verbalize the names of the note values as he reads, such as "quarter, two-eighths, quarter, quarter," or he might be asked to say, "step, skip, repeat," etc. He might be asked to count aloud, "one, two, three" etc.

Following the lesson above, Rogan and the writer considered if the girl had been internally vocalizing to herself as she was playing and what she might have been saying mentally. The consultant thought that if the girl had been singing to herself "step, step, skip" etc. it might have been difficult for her to count "one, two, three" because this would interfere with whatever other vocalizations she may have needed to do. The writer offered the idea that the young lady might have been relying just on the kinesthetic-motor pattern, the way it feels. Rogan thought she had used the kinesthetic supported by the visual, because she glanced down to see the keys and her hands, and she was probably supporting this kinesthetic-motor effort by the visual effort, and occasionally she may have been saying "quarter, two-eighths" to herself. So if she were even occasionally saying these things to herself, counting "one, two, three, four" would be difficult, except for the purposes of analyzing the rhythm (16, p. 77).

In presenting a new song to children, piano teachers often sing it first, then move rhythmically with the student while singing it, and then perhaps have the student show the direction of the melody (up or down) with his hand. Sometimes the child is asked to point with a finger of one hand to the fingers of the other hand which will begin to play the piece. Harris had asked her student to do this. His left hand was to do the pointing on his right hand which was held with thumb up, palm facing his body (16, p. 11).

The boy had heard the teacher sing the tune and had done rhythmic body movements to it. But when he had to relate the direction of the melody to his body this seemed to Rogan to require a shift from his melodic memory for where the tune went after the first note (16, p. 11).

The teacher commented that she had asked the boy to hold his hand in the position described above to give the feeling of up and down. The child had then been asked to play on the keyboard. Kovitz pointed out that a transfer of the feeling of up and down to the keyboard should then have occurred. Rogan agreed: "I think it's the kinesthetic as much as the visual. And then he can deal with the rotation of the visual form from this [] to this [] when he has the kinesthesis, the tactile impression" (16, p. 12).

Sometimes teachers ask children to play and sing simultaneously. The consultant discussed what is involved in such a task: the child has to hear his own voice and also hear the instrument. He is actually initiating his voice in his brain; the brain is also directing and instructing his voice concerning where to sing, which way the melody is going. In addition, the brain is instructing his fingers where to play. This may be the cause of a problem in accomplishing this task; the difficulty might arise centrally more than in the listening to his own voice (16, p. 81).

In examining published literature, the investigator encountered a statement of relevance to the learning disabled child and his study of music but not in specific reference to piano lessons: A child who has difficulty processing auditory stimuli may be observed to perform poorly in an effort to reproduce pitch, rhythm, and melody (in imitation of the examiner) (5, p. 9).

So that the reader may relate readily the literature to the author's findings, to be presented in Chapter Three, a summary of the present chapter follows.

Summary of Chapter II

A review of the literature has shown that the act of playing the piano is a most complex behavior dependent upon efficient functioning of the central nervous system. Many delicate processes must interact to produce a smooth, comprehensible performance.

Kochevitsky stated that the brain must control very exact motor movements based on proprioceptive, tactile, and kinesthetic sensations relayed back to it from the motor apparatus. The brain must remember those sensations. The musical "guide" in this process is the ear; perhaps an auditory image serves as a stimulus for the anticipation of the motor act. The motor act takes place and sound is produced. The sound is heard, judged as to quality, and probably compared to the auditory image, remembered and organized into relationships and patterns.

As the neurological processes become more concentrated and directed into a specific neural pathway, more differentiated, independent movements are possible between hands, in muscles of one arm, and finally in the muscles of adjoining fingers.

If the performer is using the music, the symbols serve as a stimulus to the auditory area of the brain, causing it to create the auditory image, and so on through the sequence stated above. Visual processes involved in score reading include: binocular vision with adequate acuity, visual discrimination (the ability to see the difference in physical appearance between symbols), visual figure-ground (the ability to pay attention to notes rather than to the background), visuo-spatial ability (capability of perceiving that a particular note is printed higher on the staff than another, for example), the ability to see more than one note symbol at a time and to organize note symbols into perceptual units or "gestalts," the ability to follow or "track" both left-right and vertically, (for speed) the ability to read ahead of the notes being played and reading with few eye movement pauses and short pauses and few regressive movements, visual memory for what has been seen (so that it can be related later to what is <u>being</u> seen at the moment).

Auditory processes examined were: auditory imagery (an internalized sound) and auditory memory (remembering what has been heard).

If music reading is a sound to symbol relationship, then relating an auditory image to the visual symbol on the page (sound to symbol), listening to what is played, remembering, and comparing it to the auditory image, organizing the sound into patterns, and correcting what is unsatisfactory by redirecting movements are probably all integration functions.

While all of these functions are taking place, the pianist is making hundreds of fine adjustments to the unique topography of keyboard, directed by tactile (skin), kinesthetic (movement) and proprioceptive sensations as well as memory of both of these. He is also judging distances (spatial orientation) between keys based on these sensations and his memory of them, but directed, according to Kochevitsky, by the inner sound of the tones he is to produce before he plays them. This is a complex process involving kinesthetic, tactile, and auditory modalities.

If he is using a score visual processes are involved, and whether he looks at the score or at his hands while playing he must coordinate not only motor movements of his arms, hand, and fingers, but must coordinate and integrate visual and motor functions.

Suggested similarities between language and music reading were mentioned: both seem to depend upon the grouping of symbols into perceptual units; both seem to require the development of a "sight vocabulary"; identification of symbolic language in both areas is done through perception of visual configuration within a context; both processes are a kind of decoding process; both represent auditory experience which must be translated back into auditory experience.

The differences appear to be that music is printed over a greater vertical spatial area and is read not only left to right, but vertically, also; music symbols impart more specific indications for rhythm and stress than verbal language; the decoding process in reading language is being attached to an automatic verbal system while the decoding process in reading music is being attached to auditory patterns which have not yet had a chance to become automatic.

The vocabulary of music is technical and abstract, yet contains many words that have common, nonmusical meanings which could either aid or confuse a young student. The child must learn the new music associations to the words and new relationships, but he also must learn to organize his thinking so that he can use the new vocabulary with meaning. He must be able to conceptualize and perhaps verbalize the abstract nature of the musical events which he is studying and experiencing.

Learning to play the piano utilizes simultaneously the visual, auditory, tactile, and kinesthetic senses. Information received through these senses is transmitted to the brain where it is processed.

There are various types of integrative tasks involved in piano playing. Simple sensory functioning of one sensory system is affected or modified by the functioning of other sensory systems. Although piano playing is a complex task involving the modalities listed above, not all of the modalities may be called upon to an equal extent at any given moment. Modalities are being combined in different ways for each learning task, and there is no reliance on just one modality.

The author found a conspicuous absence of published material on the relationship of piano skills to the problems of learning disabled children. However, information was available on the difficulties of learning disabled children in non-music areas.

The child with learning problems was seen to perform in an inconsistent manner, sometimes showing ability in one subject area and a deficiency in another. The child was seen to have individual combinations of deficits and strengths. Brain dysfunction may occur in one modality without disturbing others; input and output may be intact while integrative functioning is weak. Disturbances in functions may be caused by brain lesions, chemical imbalance in the brain, or neurological developmental lag.

Visual problems identified were: reception, discrimination, memory, imagery, sequential memory, figure-ground, closure, spatial relationships, directionality, and visual-motor coordination.

Auditory problems found were: reception, discrimination, memory, sequential memory, imagery, and figure-ground relationships. Some of the types of reading difficulties were listed along with other possible deficit areas such as coordination of gross and/or small muscles, hyperactivity, impulsivity, distractibility, confused laterality, poor spatial judgment in three dimensions, tactile discrimination, verbal expression, written expression, weak temporal sense, and finally poorly developed conceptual, integrative, and cognitive skills.

A workshop having three students, three piano teachers, and a professional consultant-observer was described as a source of information concerning possible difficulties of learning disabled children in piano study. A detailed account of the learning behavior of the students was given.

Problem areas were the following: being confused by the use of the words "move," and "flat," being unable to handle the demands of using notation and subsequently playing rhythmically, and attending to a nonrelevant aspect of the stimulus.

Mental processes discussed were: shifting melodic memory of the shape of the tune to a relationship of the direction of the melody to the body, acquiring a kinesthetic feeling of up and down and rotating the hand from a vertical position to a keyboard position, and the brain's dual directing task involved in playing and singing simultaneously.

Information found in the literature stressed the importance of efficient processing of auditory stimuli as a prerequisite to imitation of pitch, rhythm, and melody.

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CHAPTER III

DESCRIPTION OF PROCEDURES AND PRESENTATION OF FINDINGS

Sources of information for this paper consisted of published and unpublished material concerning mental processes in piano playing, problems and confusions in reading the score and in the motor, tactile, kinesthetic areas, and the special qualities of the music vocabulary.

Literature in the field of learning disabilities provided a description of the characteristics of learning disabled children. As stated before, there was a great lack of information on the learning disabled child and music, and in particular in relation to piano study.

The author had had experience in teaching keyboard skills to both learning disabled children and "normal" children who had exhibited similar difficulties to those of the learning disabled children. However, the writer sought further understanding of the causes of the problems that had been observed. Two other teachers expressed similar interest; thus the workshop described earlier was organized.

In spite of the fact that the workshop did not have a chance to mature and gain its full momentum, an impressive amount of information was generated, both about learning processes and perception, and about musical pedagogy. According to Kovitz, ". . . new questions were raised; many are still open for answers" (11, p. 3). Much of the information developed was pertinent and immediately applicable to the teachers' students, both those with learning disabilities and those without (11, pp. 3, 20).

In evaluating the workshop, Kovitz wrote:

> Much of the value issuing from the workshop was due in great part to the special contributions Rogan, the consultant, offered. Again and again she was able to penetrate through a tangle of discussion about pedagogy, methodology, or student performance, to the underlying principles of learning or perception governing the child's observed responses. By drawing repeatedly upon the child's viewpoint, she underscored the necessity for teachers to refer to the child's experiences, his perception of the world, and his associations to words and concepts, in order to interpret how he responds in a given situation (11, pp. 12-13).

Thus it was from this workshop that the author gained possible explanations for some of the problems observed in her own teaching experience and additionally for problems which she had not previously encountered or considered. A careful study was made of the transcript of the workshop tapes. Material relevant to this paper was extracted and presented in Chapter Two.

As mentioned in Chapter One, the author, during the teaching of piano students at two private schools prior to the time of the workshop, made behavioral and learning observations which were notated after the lessons. Some of the verbal interactions between teacher and student were also recorded. At the same time, an analysis of the data was started.

In this chapter the investigator will present data from her teaching experience that is relevant to some of the topic areas of Chapter Two, will interpret the data and suggest relationships to the problems of learning disabled children.

The majority of problems seemed to occur when the students were using the printed score. Three children, D., female, seven years, ten months; V., female, eight years, four months; and C., male, seven years, seven months, nearly always lost their places in the score when a series of repeated notes occurred. As a result they produced an incorrect number of tones. The boy tried to help himself by playing with the right hand and pointing to each note with the left.

A girl, C., eight years, three months, was visually distracted, and even upset by the presence of note stems, slur marks, staccato marks, and so forth. Once she remarked that she wished that they were not there and that they bothered her. Perhaps there were too many stimuli for her to handle at once. She planned to pretend that they were not there by not looking at them.

The same child also confused "b" and "d" and "a" and "e" as shown in the following illustration:

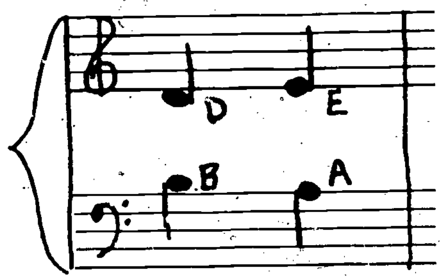

Fig. 1--Notes subject to confusion by rotation.

She reacted in her playing as if she thought that they were the same notes. She appeared to be having a kind of rotation problem, such as that identified by Chalfant and Scheffelin in speaking of a confusion between "d" and "p" as a rotation (3, p. 26).

When the writer referred to "lower," the same girl was unsure which direction was lower on the staff or the keyboard. Perhaps this was a directionality problem suggesting that she had not yet internalized the concept of a descending pattern of note symbols as indicating progressively lower pitches produced in a leftward direction on successively lower keys.

She also appeared to be miscued by seeing two "middle c's" in the situation illustrated below.
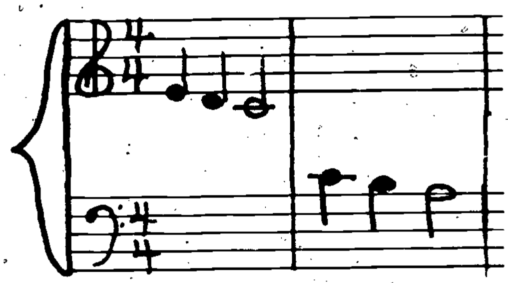
Fig. 2--Two positions for "middle c."

The child could not understand why the two "c's" were located in different places on the staff while referring to the same key, "middle c," one location on the keyboard. In some instances she had been asked to identify a "higher" note (as compared to the adjacent note). Apparently in this instance she was comparing the two "c's" as being one "higher" note and the next "lower" note. She had applied this technique at the wrong time, for the placement of the two "c's" as illustrated above is necessary to indicate the right hand playing the first "c" and the left hand playing the other. This is an exception to the rule that notes representing progressively lower pitches are placed in progressively lower locations on the staff.

Another "mixed message" which the staff gives to a child, especially a child who is easily miscued, as some learning disabled children are, is shown in the following illustration:
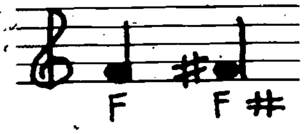
Fig. 3--Visual appearance of a natural note followed by the same note sharped.

Although the two notes appear in the same space and resemble each other they are not the same notes. Because of the sharp sign in front of the second note the child must play "f-sharp" rather than a plain "f." "F-sharp" is the black key immediately adjacent to "f" on the right side. Thus "f-sharp" sounds a pitch that is higher than "f" (called in musical terms a "half step" higher). What this may convey to the child is: "Forget what you have learned about notes that look the same being repeated notes. This is an exception. The second note here is higher." (Even though it does not occupy a higher location on the staff.) One wonders what the confrontation of these exceptions does to the thinking of a child who is weak in visuo-spatial relationships. It would seem to take much overlearning for the child to assimilate all of these associations and to use them appropriately.

The writer observed another confusion concerning the reading of note symbols. If a child learns what certain notes look like and stores a visual image of these notes in his brain, he can be easily confused if he forgets momentarily that the two clefs, treble and bass, use different names for their lines and spaces. For example, he might, upon learning a treble clef "e," say to himself as a memory aid, "E . . . that's the one on the bottom line." Later, when he is reading in the bass clef and sees a "g" on the bottom line he may say, "That's on the bottom line, so it must be 'e.'" But it is not "e" at all in the bass clef; it is called "g." The following illustration shows the similarity in appearance between these two notes:
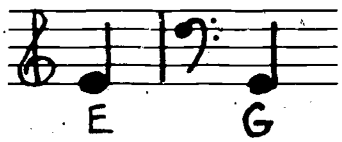
Fig. 4--Similar appearance of a treble clef "e" and a bass clef "g."

Another set of associations must be made, therefore, to the bass clef in addition to those made to the treble clef. The child must also be able to shift his thinking freely from one set of associations used for the treble clef to another set of associations used for the bass clef. If he cannot do this he cannot read easily in both clefs, either separately or at the same time.

The problem is further complicated by the fact that all "e's" and all "g's" do not look alike even in the same clef, nor do any of the "c's," "d's," and so forth. The child usually learns notes near "middle c" first, such as the "e" pictured in the treble clef above. Soon after this he may be asked to learn the next higher "e" which does not resemble the lower "e." The difference is shown in Figure 5.
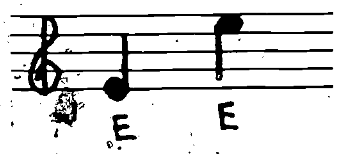
Fig. 5--Difference in appearance between two treble clef "e's."

The first note is a line note; the second, a space note. These new associations must be assimilated. This task could be difficult for a child with associative learning weaknesses.

Basically, what the child must be able to conceptualize is that the staff lines and spaces represent differences in pitch, a highly abstract concept. Every line and every space is used and given the names "a" through "g" of the alphabet. Usually the total concept is represented by the section of the total staff which appears in the next illustration.
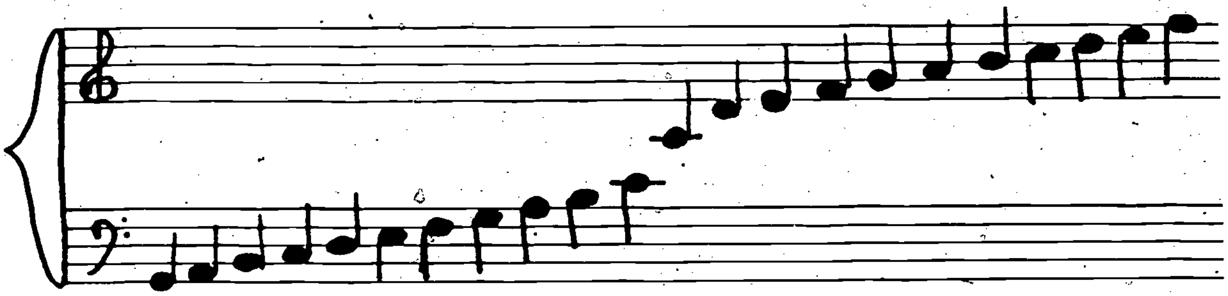
Fig. 6--Grand staff

The child usually learns the names of the notes pictured above before he learns the names of the notes using ledger lines (partial lines above and below the ten full lines of the staff).

In school the child has made associations to "up and down" as being, on notebook paper on his desk, away and toward the body. Now the child is asked to associate symbols printed on an angle toward the corner of the page with "up and down." The page itself is also on an angle because of resting on the piano's music rack. The following figure illustrates the angles created by ascending and descending note patterns.
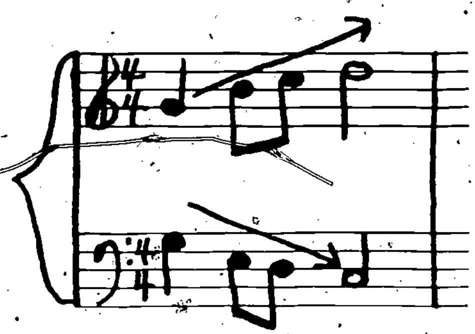
Fig. 7--Angles created by ascending and descending note patterns.

"High" and "low" in the music score do not relate to the child's notebook page. He must also associate each sound to a symbol, each one representing a different sound. The author thinks that he must be able to discriminate between pitches heard and remember the pitches before he can develop the ability to create an imagined pitch and then match it to its printed symbol. To be able to choose to which visual symbol he should match the imagined sound he must be able to visually discriminate between the line and space notes.

He must first be able to conceptualize the meaning of "higher" and "lower" in pitch imagery before he can associate this imagery with the appropriate symbols. If he can do this he can assimilate easily the new association of "higher" and "lower" being on an angle aimed toward the corners of the page rather than away from or toward his body in a directly horizontal manner, the notebook paper being parallel to the floor.

In addition the child must assimilate all of these concepts and then relate them to lateral movement on the keyboard. (As one moves left on the keyboard, the tones become lower in pitch; toward the right they become progressively higher.) Abilities which are vital are spatial orientation, being able to conceptualize spatial relationships, and the ability to perform the complex act of reading the score. The child also must have the motor control to act upon what has been conceptualized and integrated. An additional possible complication is that the child's eyes are tracking both from left to right and up and down to see all of the notes while his hands are often moving in a leftward direction.

To determine the names of notes children often name individually lines and spaces up or down from one note to another. This involves an internalization of concepts of higher and lower, memory for the names of the lines and spaces, the ability to say the alphabet from "a" to "g" forward or backward, among other skills. The child probably needs to have a visual image of the appearance of each of the missing notes as he counts up or down between the two printed notes, and the images of each note may need to be formed one by one as he counts and internally vocalizes, "This line is 'b.' This space is 'c.' This line is 'd,' and so on." He needs to conceptualize the idea that the notes that he is working with are only a part of the whole staff, the grand staff plus ledger lines.

If he uses any visual imagery of the whole grand staff and ledger lines perhaps they could be considered a visual "gestalt," or a puzzle that has already been assembled. The notes with which he is working are a part of the "gestalt" or whole puzzle. He must mentally conceive a part-whole relationship. If this analogy is correct, then it might follow that children who have problems in visual closure (inability to integrate parts into wholes), visual imagery, and part-whole relationships or solving puzzles (spatial and part-whole relationships) might encounter difficulty in the imagery and conceptualization of the structure of the grand staff. Many, but not all, learning disabled children have these difficulties.

Another girl, D., seven years, ten months, was confused by the author's writing numerals as counting aides in the blank area between the treble and bass clef. She confused them with finger numerals which are printed or written in the score by the teacher, usually above the note head.

The same girl was unable to recognize the second "e" as being the same "e" which she had just seen when she encountered the situation pictured below.

Fig. 8--Stepwise notes.

The writer interprets this to be a problem in visual memory for the appearance and exact location of the note "e." She was able to discriminate properly between the first "e" and the "d" which followed it because she had played these two notes correctly.

The skills involved in the tasks described earlier in this chapter (visual figure-ground, directionality, associative learning, pitch discrimination and tonal memory, seeing spatial relationships, visual memory, spatial orientation, ability to work with symbols, and integration of visual, auditory, kinesthetic, and tactile sense information) are all skills that may be weak areas for a learning disabled child. Few of them would have weaknesses in all of these skills, but probably all learning disabled children would have difficulty with some of them, at least in terms of academic school work, or they would not be considered learning disabled.

In the area of motor, tactile, and kinesthetic problems, three children, J., female, nine years; E., female, eight years; and D., female, seven years, ten months, were repeatedly unable to depress keys with fingers of both hands so that the sound produced by each hand began at the same instant.

When D. tried to play separate, clear tones with individual fingers she had a serious problem in maintaining motor control. She was unable to control the lifting of one finger while the next finger went down. At other times instead of just one finger coming up, both came up. When only one finger was to depress a key, two fingers attempted to move. This occurred more often in early lessons than in later ones. There was steady, but very slow improvement, and the problem never disappeared completely in eight months of study.

The large hand of a fifteen year old boy, D., was a control problem for him. It appeared to be stiff and unable to bend enough to accomodate comfortably the topography of the keyboard. This young man knew the names of the keys and note symbols, understood the printed finger numerals and remembered to which finger each numeral referred, yet he could not manage to complete the motor act of playing those keys with the correct fingers. He was unable to handle the integration and the fine motor coordination.

He also found it difficult to strike all of the keys in a chord at the same moment. This, however, is a common occurrence with beginners of all ages, including adults, but it usually improves rapidly with practice.

D. was able to handle the less complex motoric demands of playing the autoharp. Performance on this instrument requires only one finger of one hand to press a chord bar and the other hand to stroke the strings. Independent finger action is thus not required except for the pressing of the chord bars by different fingers. It is possible to simplify this motor task even further, though, by using only one finger, moving it from chord bar to chord bar.

D. also exhibited an excellent tonal memory by playing new songs "by ear" almost instantly with one or two fingers after hearing and seeing them played once by the writer. He could also transpose instantly (play the song in a different key). He sang new songs rhythmically and on pitch after hearing the song sung to him. Usually he tried to avoid using notation, but when he did use it he read by patterns of steps and skips rather than by letter names. This is an efficient way to read. However, he was unable to perform satisfactorily because his fingers could not follow through with the proper motor sequence. Intellectually he probably knew how the piece should sound but he could not accomplish a performance that met his intellectualized standard.

This boy had been diagnosed as learning disabled, with poor body image and "trouble with visual and auditory short term memory," but was reported to have "good auditory discrimination" ability. Notice should be taken that a deficit area was reported to be <u>short</u> term auditory memory. Perhaps his long term auditory memory was intact. The type of auditory memory required for playing "by ear," as he was most capable of doing, is long term. Another qualification should be made; when he played "by ear" he demonstrated intact long term memory for musical tones; this may not necessarily mean that he would be equally skillful in retaining a sequence of verbal material such as words. At any rate he was capable of receiving the sequence of tones he heard and remembering the sequence. He then integrated the auditory information with his knowledge of which key produces which exact pitch and successfully sent the message to his finger to press the keys which would produce the pitches he wanted. But, as stated before, he was able to use only one or two fingers to play the tune. He could handle all of the complex integration up to the point of managing independent finger action between several fingers.

All of the students who were strong auditorially and could play readily "by ear" tried to avoid reading the score except for one child. This finding agrees with that of Curwen and Kovitz and perhaps of many other piano teachers.

Another motor coordination difficulty was experienced by E., the eight-year-old girl, when she attempted to perform the rhythms shown in the following illustration.
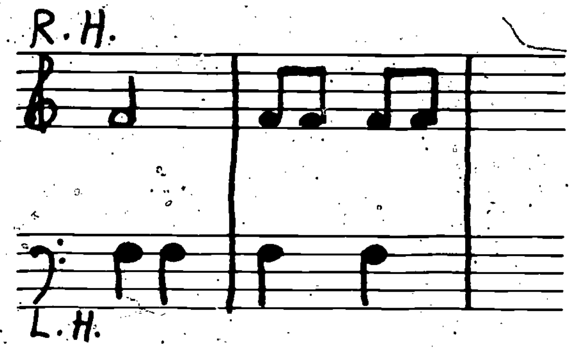
Fig. 9--Opposing rhythms

She was unable to accomplish the performance of these rhythms. The movement pattern in number of finger movements was as follows:

R.H.	1	2	2
L.H.	2	1	1

Fig. 10--Finger movement pattern

Probably the changeover from one to two movements from hand to hand was too rapid or too complex for her to manage. This little girl performed well as a tap dancer. In tap dancing she moved her feet, but did not have to achieve individual toe action.

Three students, J., female, nine years; N., male, eleven years; and E., female, eight years, seemed unable to choose fingers appropriate to the type of movement and direction required on the keyboard. Of course, all beginners have some fingering problems, but these three applied some of the most jumbled fingerings the author had ever seen. This occurred in spite of indication in the score of some of the finger numerals. Perhaps they could not plan ahead and prepare the proper finger. It seemed to be a motor and an integration problem because they all knew the numerals in the music and knew to which finger each numeral referred.

Another problem which E. experienced was the inability to adjust her hand position from a close five-finger position (in which each finger plays the first five tones of a scale) to an extended hand position (in which the fingers must extend out of the five-finger position). She seemed disoriented and was unable to find a comfortable choice of fingerings. This was apparently a problem in motor and kinesthetic processing.

N. (diagnosed as having a visual perceptual problem and considered a learning disabled child) "lost his way" in finding the proper keys. To find a certain key he had to look down at the keyboard, find an "a" and count forward "a," "b," "c," and so on until he found the key he needed. He knew the letter names of the notes and the keys and had integrated this information but he could not manage the motor act, the output, unless he supported it with a visual clue of visually searching for the proper key. He did not trust his kinesthetic memory and his tactile skill to find the key by kinesthesis and touch.

He may have had a visual memory problem for the appearance of the exact key which he needed and thus needed to use a frame of reference. His reference point was a key that he was sure of and remembered visually. He then counted in a rather rote manner up to the key which he was supposed to play. He also may have been experiencing difficulty integrating all of the modalities needed (visual, auditory, kinesthetic, and tactile) and had to stop to take a section out of the ongoing mental processes and isolate it, somewhat like "making the clock stand still for a moment" while he tried to re-orient and clarify his thinking.

Other motor problems were found in D., a seven year, ten month girl, in the task of writing notes. She was unable to align them properly with the scale number printed on a worksheet. An example is shown in the following illustration:
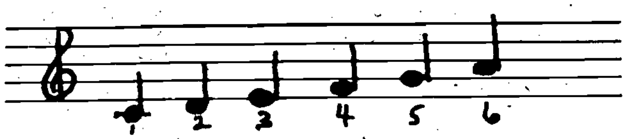
Fig. 11--Portion of the C major scale

The numbers were already printed on the sheet; she was to fill in the missing notes. This task and the one to be described next are visual-motor tasks requiring spatial judgment (for alignment and position) and fine motor control. The other task which she was unable to do correctly was placing notes on lines and spaces of the staff. Space notes should be placed so that they are actually between lines, and line notes should be placed so that the staff line bisects the note head. Examples appear in Figure 12.

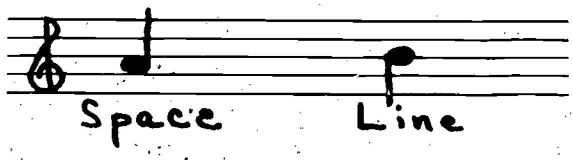

Fig. 12--Space note and line note

When D. placed notes she misjudged where to begin her pencil mark, and her line notes were positioned so that the staff line did not go through the middle of the notes. Her space notes extended beyond the lines; she had difficulty confining the oval shape to the area between the lines. Fine visual-motor tasks such as these are tasks that may be difficult for a learning disabled child who happens to be weak in this area.

A possible reason for some of the spatially-caused problems could be that certain spatial relationship skills develop, according to Piaget (12, pp. 422-429) later than other spatial relationship skills. Piaget listed, as the last three spatial skills to develop: concepts of up, down, forward, backward, left, right; ability to measure and compare distance and dimension; and recognition that position and direction can be represented graphically.

The concepts of up and down and left and right have been discussed already in terms of their particular relevance to music learning. The skill of comparing distance is constantly being used. A child must see which note is higher or lower than the next and not just in a general way, but exactly how much higher or lower so that he knows where to play. As explained in Chapter Two, efficient reading is visually taking in patterns, seeing instantly the "gestalt" of a series of notes. To do this one must see the distances between notes.

The last skill of recognizing that position and direction can be represented graphically is, in effect, a description of the function of the music score. The score in two dimensions on paper and graphically, through symbols, tells the player which keys to play, how they relate to each other in distance between them, and what direction to move his fingers on the keyboard.

It probably is difficult for the teacher to know if she is working with a child with a disability in spatial relationship skills or a child who has not yet reached a particular level of spatial development, whose "timetable" of development happens to be different than that of the "average" child.

A cluster of attentional difficulties was seen in V., female, eight years, four months. She perseverated (inability to shift to a new activity) by continuing to play the piece after the writer had started to introduce the next piece to be studied. Compulsive behavior was shown when she lined up her gummed stars (used as rewards) repeatedly in a rigid, equidistant type of arrangement on the music rack.

During the beginning lessons she would not stay seated for more than a few minutes and tried to crawl under the piano. She was distracted and unhappy about eraser shavings from the pencil eraser; at times she paid more attention to the author's jewelry than to the score.

Teachers on the staff of the school reported to the writer that the girl was having emotional difficulties. If true, this could have accounted for most of her behavior, except that she also lost her place in reading repeated notes. The difficulty she had in keeping her place and her attention to the nonrelevant aspects of the stimulus (the jewelry and the stars) seemed to resemble the behavior of some learning disabled children with whom the author had worked.

Another child, C., male, seven years, seven months, exhibited similar behavior to V. but not to such a marked degree. He was auditorially strong and often tried to avoid reading the score.

E., a girl, consistently confused her left and right hands and also could not relate each hand to the proper part of the keyboard until she was asked to verbalize which hand she was supposed to use and where. This appeared to be a laterality problem, one which a neurologically immature child may have.

When trying to determine the name of a note by counting lines and spaces backwards (in a downward direction), D., female, was unable to reverse the alphabet by saying "g," "f," "e," and so on. She was not able to reverse the sequence of "a" through "g." Apparently, this was not the best technique for her to determine the name of a note. Most of the time she identified the note names by using the forward alphabet, but at least once per lesson she was asked to use the reverse alphabet approach. At the end of seven months she was able to do this comfortably; perhaps by then she had merely memorized the sequence and was not really thinking it through.

In viewing each child's individual collection of problems it appeared that E. had kinesthetic and motor problems; D., female, seemed to have a visual problem in keeping her place, fine motor and visual-motor weaknesses, and an inability to reverse the alphabet. Perhaps this was a manifestation of her not having reached the stage of reversibility (defined in Chapter One). C., female, seemed to have a group of visual problems: distractibility (score was too stimulating), directionality problem which manifested itself as a visuo-spatial problem, and perhaps a motor and integration problem in fingering.

V. seemed to have the same visual problem as D., losing her place when reading repeated notes, was hyperactive, distractible, and perseverated. J. may have had a motor and integration problem with fingering, and she tried to avoid reading (she was strong auditorially and could play "by ear" and transpose).

In considering the boys, it seemed that C. had a repeated note problem, was distractible and hyperactive, and he tried to avoid reading. (He also was able to play "by ear" and to transpose.) N's problems appeared to be in the motor and kinesthetic areas, as were those of D.

Two of the boys, N. and D., had been diagnosed as learning disabled children. Because it was impossible to study in detail their performances on the diagnostic tests which had been administered, specific deficit areas could not be determined. Both boys appeared to be motivated, and D. gave definite indications of being "musical." Since their problems were predominantly motor ones, perhaps they merely needed more experience to develop coordination and kinesthetic memory for movements.

Before considering the possible explanations for the other students' problems some very vital questions should be contemplated.

One relevant question, and one that has not been answered definitely by research, is whether or not music is processed differently than language.

In the area of visual perception there are two viewpoints concerning perception of verbal and nonverbal stimuli. One point of view is that visual perception for words is quite different from the ability to perceive numbers or geometric figures. The other point of view is that there is no difference between the two kinds of perception (3, p. 95). Would it follow then that the two viewpoints could be held in relation to auditory perception and integration?

Johnson and Myklebust said:

> Verbal abilities are of utmost consequence to human behavior, but it is of singular importance to both normal and abnormal behavior that nonverbal symbolic functions not be overlooked. Symbolization as it appears in art, music, religion, and patriotism may be equally significant. Illustrative are the cross in religion and flags, the Statue of Liberty, and the hammer and sickle in patriotism. This type of symbolic behavior, the nonverbal, often is disturbed by dysfunctions in the brain (7, p. 35).

If music learning, at least in part, is a nonverbal function, and if nonverbal functions are routed differently through the brain than verbal functions, why would it not be possible to have processing difficulties in only the verbal functions and not the nonverbal, or vice versa? If music functioning is not the same as language functioning, a logical hypothesis could be that a child with language problems might be adequate, perhaps even gifted, in music, at least in its nonverbal aspects.

This also raises the question of whether mathematics, being a nonverbal function to a great degree, is the same as music functioning. Or are math functions different than either music or language? It could be conceivable that for each separate task there is a unique circuitry in the brain.

Information about the students' classroom performance was not available, so a comparison between skills in the "academic" area and music skills could not be made. Having contemplated the ideas about music being a separate function, the writer decided that the following possibilities existed as reasons for the children (other than the boys N. and D.) having difficulties: 1) They could be undiagnosed learning disabled children with a) neurological lag in development, a) neurological lag in development, b) brain damage or dysfunction that could be circumvented through special instruction, c) need for more experience, d) little musical ability, 3) nonverbal problems that caused a deficit in music skills, f) verbal difficulties that caused a weakness in music (particularly in the understanding of the vocabulary), g) both verbal and nonverbal problems affecting musical success; 2) They could be normal children but a) were slow in general mental development or just in musical development, b) needed more experience at the keyboard, c) should have had experience with pre-instrumental training such as body movement, small mallet instruments, rote singing, d) lacked motivation, e) had an individual style of learning in music (such as preferring to play "by ear" and never becoming a good score reader), f) had deficits in the nonverbal aspects of music (and perhaps not in other nonverbal functions such as the nonverbal facets of mathematics or perhaps also had difficulty in mathematics).

Obviously there would be no one explanation that would fit all of the children since each child is an individual with a unique collection of abilities and experiences. Formal evaluation for a learning disability could not be made, but in the writer's opinion there were sufficient indications to warrant the administration of psycho-educational tests, had it been possible. However, even if tests had been given they would not have examined the processes involved in music learning. The only formal assessment that could have been done in music skills would have been to administer commonly used musical aptitude tests, which do not test all of the specific abilities involved in music performance. The children could have done well on the usual tests used to diagnose learning problems and still experience difficulty in learning to play the piano.

In spite of their problems the students appeared to enjoy, generally speaking, their piano lessons. Each child was definitely more adequate in certain tasks than in others. Those with score reading difficulties (except for one child) seemed to be strong auditorially; they all possessed enough skill to enjoy playing in their own way. Perhaps this reflected a style of learning, a preferred modality in respect to piano playing. The concept of a preferred modality has been offered in respect to general academic learning, so perhaps the same phenomenon could occur in music. However, the modality preferred could differ from task to task both in academic subjects and in music. Perhaps the weaknesses observed in score reading reflected an inability to deal with nonverbal symbols, or at least the nonverbal symbols used in music.

The statement can probably be safely made that none of these children would become, at least in the near future, outstanding score readers. Perhaps this was not a realistic goal for them at that point in their lives. Maybe they simply were not ready for the complexity of the task. Other instruments could have been studied which are less demanding motorically and which use music in one clef rather than two (eliminating the vertical reading demands). In spite of motor problems at the piano keyboard some of the children could handle the coordinative requirements of playing other instruments and tap dancing. Thus they still had an expressive outlet in music, or at least in an activity related to music.

Discussion of the Literature and Implications for the Learning Disabled Child

In this section some of the skills and problems presented in Chapters Two and Three will be analyzed and additional deficit areas in piano study for some learning disabled children will be suggested.

Kochevitsky discussed the need for stable spatial relationships, the processing of proprioceptive, tactile, and kinesthetic sensations, accurate transmission of signals to the motor apparatus and subsequent efficient fine motor coordination (see Chapter Two). To re-state this in a gross way, one could say that he was describing input; analysis, synthesis; output; and feedback. Any of these areas can be deficit areas for learning disabled children, but not necessarily all of the areas are affected in each child.

He then proceeded to explain the role of auditory imagery as an inwardly heard stimulus. He discussed the need for processing and evaluation of the sound of the music being played so that the brain can then send signals for the next movement to be made, directed by the auditory imagery of the sound. The speed with which this occurs must be incredible; the sound must be sent to the brain and evaluated and the signal for the next motor act must be sent before the next sound is returned to the brain and evaluated, and so forth. To evaluate what he hears, the pianist must be sensitive to pitch, volume (loudness or softness) of the tone, and rhythm (which requires a temporal sense and discrimination between various durations of sound). Accomplishing this requires complex integration processes.

He made clear that these are, in his opinion, the events that occur when an accomplished pianist plays. Thus, all of these events may not occur or may not occur smoothly when a beginner performs. In learning to play the piano, the child is practicing the use of whatever mental processes are involved in the various tasks; he is probably establishing new neural pathways that may be unique for music learning.

He is repeatedly hearing certain patterns of tones and seeing them represented symbolically on the page, integrating sound with symbol, building a vocabulary of auditory and visual patterns. He is also gaining and storing kinesthetic information which he connects to auditory information. In other words, probably unconsciously, he is associating certain movements with certain length sounds, and sounds of a certain volume and pitch. He learns from experience what changes he must make in his movements to achieve the exact type of sound that he wants. This requires intact kinesthetic and tactile perception and conceptualization and memory. A child with a learning problem in these areas would probably encounter difficulty with these tasks.

The growing familiarity with patterns occurs through the lessons, as Kovitz said (Chapter Two) and through hearing music at times other than the piano lesson, and, obviously through practicing. The growth process may take years of experience.

One can readily accept the concept that the music symbol system is a visual representation of sound and musical ideas and structures. The sound occurs in a linear fashion; it is ongoing and often disappears in a matter of seconds. The printed word is a symbolic representation of speech sounds and verbal meanings. Speech also is linear and on-going. The reading of printed verbal material is a "visual symbol system superimposed on an auditory system (7, p. 79). Then would it not follow that music reading is also a visual system superimposed upon the auditory, or visual patterns connected mentally to auditory patterns?

The importance of a young child's hearing speech for years and acquiring spoken language before he attempts to read is universally accepted. Why should it not be equally important that auditory experience with music (listening) precede an attempt to read the music score?

A parallel to the acquisition of verbal spoken language would be the act of modeling or imitating an adult's musical performance. The young child imitates an adult's speech; the young child could, and often does, in some methods, imitate an adult musical performance. (The

Suzuki method of teaching stringed instruments and the Kodaly and Orff philosophies of music education give extensive auditory experiences through imitative activities before notation is introduced.)

The child can, in the initial stages of some teaching methods, play with the instrument and explore its sound possibilities much in the manner that a very young child explores his speech mechanism through babbling. Kovitz pointed out that a piano student arriving for his first lesson usually has not had a chance to explore the piano sounds in the way that he has explored speech sounds (9, p. 26). Perhaps this kind of exposure to sound patterns, by building a solid auditory foundation, would prevent score reading problems in most children.

At any rate, the importance of the auditory sense in playing the piano is clear. If verbal and musical (or tonal) auditory functions are the same it would follow that a child with auditory verbal learning problems would also have difficulty in the auditory (tonal) aspects of music learning. The writer believes that they are, however, separate functions.

When a child hears music he needs to be able to "make sense" out of it if he is going to perceive it rather than merely letting it "fall on his ears" as he does with noise. He probably initially must have the ability to discriminate between the pitches of sounds, not in the sense of being able to name the pitches heard, but to hear the difference between them. He must also be able to differentiate between the various lengths of sound, to hear that one tone lasts longer than another. As his listening skill develops he becomes able to discern differences in volume between tones, and, usually much later, he is able to identify a sound as coming from a certain instrument.

The child must organize what he hears into patterns, a conceptual task. He needs to remember enough of each pattern to be able to recognize it if it occurs again later in a piece to which he is listening. To accomplish this he must remember a sequence of pitches having a certain rhythm, volume, and timbre (tone quality). This is a tonal memory task. The conceptualization process is actually far more complex than this and too lengthy to be discussed here. As the child gains in auditory skill he becomes increasingly aware of the total structure of a composition; he hears more than just a melody. However, the influence of training must be kept in mind. The child would be unable to reach this level of auditory skill without training involving a great deal of guided listening. This means that someone with more knowledge and experience than he has verbalizes some of the basic concepts to him and helps him to discover more about them.

The ambiguity of the musical language and other language problems were discussed in Chapter Two. Several additional ambiguities will now be considered.

There are many uses for digits in music. When a teacher writes in the beats in a measure she uses the numerals one, two, three, four, and so on, depending upon the number of beats per measure. Scale tones are called "one, two, three, four," and so forth through seven. Lines of the staff are named by the digits one through five; spaces of the staff are called "one, two, three, four." The numerals one through five are printed in the score to indicate which finger to use, and the fingers of the hand therefore are referred to as "finger one" or the "first finger" and so on through five.

The word "time" has several meanings: time signature, "keeping time" (playing in the correct rhythm), and the common use referring to clock time. There are also multiple uses of the word "key": key signature, key on the piano keyboard, and the key in which the piece is written.

The above examples represent multiple meanings of words. Some learning disabled children have difficulty making, differentiating between and remembering numerous word associations.

Another ambiguity may be found in the use of the word "move." When a piano teacher asks the student about r tes "moving" across the page she really does not mean "move" in the literal sense. The notes do not move at all; they take up space on the page and are permanently printed in one location. What moves are the eyes of the player.

"Step" as used in music fails to relate in a mental image to the familiar stairstep or to taking a step in walking. "Skip," to a young child, may mean skipping down the street, while its musical meaning refers to skipping mentally over the lines and spaces not used or to the keys not played. However, the child might see an association between skipping a line on the staff and skipping a line on his notebook paper (as in numbering a column of problems in school). A similarity could be observed even though the staff lines are much closer together than those of the notebook paper.

These ambiguities and the others pointed out in the second chapter may seem like an exaggeration of the problems with the music language. Children having no learning problems probably make and categorize the necessary associations more readily than could some learning disabled children. The latter children often fail to understand abstract language; they often forget word associations. Some cannot assimilate multiple meanings; others take only very literal meanings of the words used.

This whole area of the assimilation and use of language is a verbal function. The child must understand his teacher's speech, and usually needs to express himself in language during lessons. Some authorities would add that he needs language skills in order to use the inner language of thought. Thus even if a child were quite efficient in the nonverbal aspects of music learning and performance, he would still need certain language skills to comprehend the language of music. But this is not to say that a child needs <u>all</u> language skills to succeed in music. For instance, he could be a poor speller and still perform very well at the piano.

In reviewing the score reading difficulties presented in Chapter Two the reader may find a resemblance between some of the problems found by Lawrence and Deutsch and those of children with learning disabilities. One weakness mentioned was that of children who were unable to recognize the relationship between two adjacent notes, not seeing whether they were alike or different or which one was higher. This seems to be an indication of a nonverbal visual perceptual problem in the areas of visual discrimination and visuo-spatial relationships. At the time Lawrence and Deutsch wrote their books the field of learning disabilities was still relatively new and information had not been widely disseminated.

Examples of children who were confused about up and down and left and right were given both in reference to school tasks and to piano playing. Hermann has said that children who have disturbed directional function have difficulty principally with the comprehension of symbols. He indicated the kinds of symbols as being letters, numbers, Morse code, and music notes (6, p. 140).

Other difficulties that some learning disabled children might have in relation to playing from a musical score are basically special spatial orientation problems that might occur because of the physical structure of the piano. When the score is placed on an almost vertical music rack the child must transfer from reading the music in left to right horizontal and simultaneously vertical directions to a motor act accomplished on a horizontal plane with movements that are both lateral and vertical. In addition, the child, if he looks at his hands, must change his eye focus from one distance (the eyes to the rack) to another (the eyes to the keyboard).

Playing on the keyboard involves activity which crosses the midline of the child's body. Some children with learning disabilities have difficulty doing this in other motor activities, so the possibility exists that they might find this midline crossing a problem also.

When a young child is experimenting with basic movement patterns he refers all movement to the center of his body as the zero point of origin. Thus, the young infant first moves his arms in a bilaterally symmetrical fashion toward the center of his body and away from it in circular motions. As one arm moves in (toward the center), the other arm moves in, too, and he learns that this bilateral pattern is an "outside in" movement (8, pp. 47-48).

But with his left hand it is objectively a left-to-right movement, and with his right hand it is a right-to-left movement. So one basic symmetrical movement pattern has two opposed objective directions. Later, when he first moves his hand across the midline of his body, he must learn that the movement remains constant even though it has crossed the midline and is now compared with the pattern on the opposite side (8, p. 48).

So, subjectively, the movement is first on "outside-in" pattern and when it crosses the midline becomes an "inside-out" pattern. The child learns that the objective movement remains "right-to-left" even though it may have begun as an "outside-in" type movement and, on crossing the midline, become an "inside-out" movement. Kephart said, "The subjective direction must be reversed when the midline is crossed in order to maintain the constancy of the objective movement" (8, p. 48).

Visual processes required for reading language seem to be very similar to those used in music reading. They include: receptive ability (the basic ability to perceive or to get meaning from the symbols), visual discrimination, visual pursuit (left to right tracking), visual figure-ground discrimination, and directionality. However, because of utilizing more vertical space per line than the printed word uses, the music score demands more from the reader; it requires more visuo-spatial skill.

In view of the complex visual skills required in reading music it might be likely that a child who has a language reading problem would also have difficulty with the musical score. To the author's knowledge no one has shown definitely that this is true, but Bowren apparently made some observations and analysis in this area. She offered the following ideas:

> The pupil with a poor memory for the sight configuration of words may encounter the same difficulties when reading the notes written on a staff; the reader who fails to notice the differences in letters such as "n" and "m" may be the music student who tends to read the third line on the treble staff as G rather than B; a strong reversal tendency in reading could conceivably cause some confusion between the symbols for crescendo and decrescendo (1, p. 56).

(The sign for crescendo is <, and it means "to get louder." The sign for decrescendo is > and it means "to get softer.")

Nevertheless, other possibilities exist. Although both words and music are visual symbol systems representing sound patterns, the sound patterns which words represent are a verbal means of representing ideas, while the sound patterns of music are a nonverbal means of representing musical ideas.

Although no professional has proven so, it is conceivable that verbal and nonverbal learning functions are separate. Might it not be possible then that a child, in spite of having certain verbal learning difficulties, including reading language, could read music? Or, to reverse the situation, could he not be adequate in reading language but be unable to read music well? Another set of circumstances might be that he would show ability to read music and language but be deficient in another symbol system, for instance, mathematics.

The possible combinations would be endless _if_ each separate learning skill is indeed unique. If every learning experience actually creates new neural pathways it would be conceivable that therefore each learning skill draws upon its own unique set of pathways or circuitry.

No scientist has defined the exact mechanisms involved in any specific skill or type of thinking or learning; no one can state with certainty what neural pathways various types of learning follow. It may not even be possible to accomplish this.

The only practical way to approach such a task is to study the behavior of brain-damaged patients and to attempt to find causation for their behavior in the particular lesions they have suffered. This is an incredibly complex task, though, for most brain lesions are apt to involve densely crowded fibers and centers which may or may not belong to identical or functionally related systems (13, p. 376).

Schlesinger said:

> It stands to reason that damage to identical points of macroscopically identical cortices of two hypothetical individuals would not necessarily produce identical effects unless the two cortices were also histologically identical. In fact, one might go further and assume that even under these "ideal" conditions, the effects of the lesions may be different because of the potentially different functional history of the two cortices or the fact that the way in which seemingly identical performances are integrated may vary with different individuals. At the same time we would assume that lesions involving different sites of the brain may cause identical clinical symptoms because of the identity of the ultimate effect upon a "target organ," say, the diencephalon [midbrain] (13, pp. 376, 377).

In discussing the process of localization, Gross and Zeigler said:

> Although specific lesions often have highly specific behavioral effects, it may be misleading to try to "localize" psychological functions such as learning or memory in particular parts of the brain. . . . a lesion may interfere with two or more independent mechanisms rather than produce a single dysfunction (5, p. 111).

Even if a child had a brain lesion (as some learning disabled children may have) that is not absolute proof that a certain function is permanently gone. According to Sperry, each hemisphere of the brain is capable of perceiving, learning, and controlling instrumental responses independently of the other. In fact, the two hemispheres can be trained, one at a time or even simultaneously, to solve different discrimination problems. Each half of the brain can control the lower centers and the motor system, but when two conflicting responses are called for simultaneously by the two hemispheres, there is no confusion; one or the other hemisphere becomes dominant and prevents the output from the other hemisphere from having any effect at all (14, p. 112).

Schlesinger (13, p. 494) reported that Falret (4, pp. 227, 241, 273) had found musical aptitude to be preserved in the presence of the most severe language disturbances. A neurologically immature child having no brain lesion may develop abilities by virtue of maturation, sometimes even without special training. Some of these abilities could conceivably be in music.

The fact that music learning is quite demanding and complex need not deter a piano teacher from working with a learning disabled child. As Rogan said during the piano workshop, one never knows how much more growth can still occur unless it is "absolutely and definably clear that growth has stopped. Then it is a question of having to bypass or circumvent a given learning disability" (10, p. 51).

But one does not know until and unless one keeps searching for what has been only temporarily stunted and what can still develop (10, p. 51). Rogan also said:

> During the maturational processes, for instance, a child might have had one faculty stunted at one point, just as the use of an arm, perhaps, might be temporarily impaired. The person learns to do without the use of that limb, compensates by becoming more skillful in the use of his remaining intact faculties, and essentially forgets about the possibility of using the impaired arm. If, however, functioning capacity returns to the impaired arm, the child might not be aware of it and because of the habit of not using it, continue to function without it. The same can happen with certain learning faculties. By working with those faculties which were once impaired but have since resumed growth, the child finds out that the faculty is actually there, and has a very rapid rate of growth with that faculty, which is then usable and serviceable to him (10, pp. 51, 52).

In regard to piano lessons and the learning disabled child, Rogan said that "there is every reason to continue to work with good faith to develop as many perceptual and conceptual skills as possible, to have patience with the technical, coordinative skills. Since music study is many-faceted it may well sensitize a child to an awareness of a capacity of which he was ignorant and enable him to start using it" (10, p. 52).

Music can be a means to learning. It can be used successfully to explore necessary concepts which a child with limited abilities might otherwise not have the opportunity to practice. Some of the concepts were listed by Cameron as follows (2, p. 59):

up-down	contrary-parallel
long-short	now-later
high-low	repeat-continue
first-last	early-late
over-under	curve-straight
slow-fast	single-double (triple)
top-bottom	same-other
alike-different	left-right
beginning-end	lower-upper
shorten-lengthen	open-close
omit-add	hold-release
weak-strong	connect-separate
step-skip	lift up-put down

However, as in all truly professional pedagogy the teacher must understand the nature of the child's problems through careful observation and analysis. She should try to discover his learning patterns, if he prefers a certain modality and in which situations he prefers it. The teacher must clarify confusions to prevent the development of long range problems. She must, through carefully chosen activities, insure enough success experiences for the child to enable him to cope with the frustrations of working in his weaker areas.

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CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary

The purposes of this paper have been to investigate the perceptual and cognitive processes involved in learning to play the piano, to examine sources of confusion and problems which might be encountered by a young piano student, particularly a child with learning disabilities.

The study was undertaken because the writer sought to understand more precisely the demands that formal piano lessons make on children, and the possible causes of problems and confusions. Through her own teaching the author had become aware that piano study can be at times a frustrating experience for some children. The writer recorded observations of her students and began to analyze them.

The difficulties found strongly resembled those of some of the learning disabled children with whom the author had worked previously. Finding these similarities stimulated the questions of whether or not the troubled piano students could have undiagnosed learning disabilities or were not sufficiently neurologically mature to handle the abstract nature of formal piano lessons, particularly the symbolic system of notation. There was a need to discover if learning disabled children could have special difficulties and what their nature might be.

Not only would information of this kind be valuable to the writer for application to her teaching; perhaps it could increase other teachers' awareness and empathy toward their students' difficulties.

The investigation involved reading of published and unpublished literature in the fields of piano study, music perception, and learning disabilities, and participation in an experimental piano workshop designed to explore possible explanations for the problems the writer and the other participating piano teachers had observed in their teaching. Another source of data was the recorded observations and analysis of specific personal teaching experience.

Before a review of the literature was presented, pertinent terms were defined. The literature revealed that piano playing is indeed a most complex act dependent upon efficient functioning of the central nervous system. Published and unpublished sources provided in some detail an explanation of what processes are utilized in playing the piano and some of the confusions and problems that can occur in performing various kinds of tasks.

In order to relate the processes to learning disabled children's difficulties, the characteristics of children with learning disabilities were presented. They were found to have various combinations of learning strengths and weaknesses unique to the individual.

Published material specifically relating the intellectual processes of learning disabled children to piano study was not found; however, the piano workshop and an unpublished paper summarizing and evaluating it provided much information. Specific examples of the behavior of selected learning disabled children were given, the source of which was mostly the workshop lessons and discussions.

A statement and analysis of personal findings gathered during piano teaching revealed some problems similar to those of the learning disabled children who participated in the workshop, and additional difficulties were also seen. It was not possible to ascertain through testing whether the author's private piano students have learning disabilities, but the need for testing seemed to be indicated.

The possibility was suggested that current instruments used in the diagnosis of learning disabilities do not evaluate functions needed in music learning, nor do music aptitude tests assess these skills thoroughly. A child could perform quite adequately on psycho-educational tests and still experience difficulty at the keyboard, if music and language functions are different. Or, on the other hand, a learning disabled child could be deficient in language skills but adequate or even gifted in music.

In spite of the difficulties exhibited, each child possessed enough skill in some aspects of playing that the writer was led to assume that the children generally enjoyed their piano study. In fact, there seemed to be evidence of a preferred style of learning in the children who were auditorially strong but visually weak.

Additional analysis of the skills and problems presented in Chapters Two and Three was done, and further possible deficit areas of learning disabled children in piano study were suggested.

The unanswered question of whether or not music is processed differently than language or even than other nonverbal symbolic systems such as mathematics was offered. If each kind of skill is a separate function it would be possible for a child with learning disabilities to be adequate or even gifted in music, at least in its nonverbal aspects.

Attempting to pinpoint the functions affected by brain lesions (which some learning disabled children may have) is nearly impossible because of the complexity of the intertwined nerve fibers and other factors such as the histology and functional history of the cortex.

Evidence was given that even in the presence of a loss of brain tissue or a brain lesion certain functions may continue to operate and may be capable of being trained, so that learning can continue to occur. Even if there is a brain lesion causing severe language disturbances musical aptitude may be preserved. A child without a brain lesion whose central nervous system is merely immature may exhibit previously latent abilities, some of which could be musical.

Therefore there is every reason for a piano teacher to be optimistic in teaching children with learning disabilities. One cannot be certain how much growth can still take place; the child can compensate for a temporarily stunted faculty and later rediscover it. Through music study he may become aware of a capacity of which he was previously ignorant. Music study can afford the child an opportunity to successfully explore necessary concepts, but the teacher must plan carefully to give the child sufficient success experiences to enable him to cope with the frustrations occurring when working in his weaker areas.

Conclusions

Investigation of this problem revealed that piano study is indeed an intellectually demanding activity, dependent upon the efficient functioning of the central nervous system. It could not be determined whether the writer's piano students are learning disabled children. The nature of their difficulties seemed to indicate the need for a formal evaluation.

It was found that some learning disabled children may have special problems in piano study. However, the generalization cannot be made that all learning disabled children will encounter difficulties.

The writer believes that the processing of the verbal language used in music probably is similar to that of verbal language processing in other subjects, but that the musical concepts expressed through the language refer to nonverbal events (sound) that are very abstract. Therefore to be successful in understanding and assimilating the musical language, the child probably would need language integrities.

Piano lessons and other types of music study probably are predominantly nonverbal activities, but, in the author's opinion, they require the use of functions that are separate from those needed in other nonverbal tasks such as mathematics. It seems quite possible that verbal and nonverbal functions are separate. If this is true a child with verbal deficits could still be successful in music, at least in its nonverbal aspects.

Each learning disabled child has his own pattern of strengths and weaknesses. If the various piano tasks draw upon those specific skills in which the child is weak it is likely that he will be momentarily, but not necessarily permanently frustrated. Parents and teachers should be optimistic and recognize the potential of music study for being a means to learning concepts and even a kind of therapy for an injured self-concept. It could provide the child with practice in using the very processes which he needs to develop further.

If the demands of piano playing prove to be too great there are many simpler ways of expressing oneself in music, such as the study of an instrument requiring the reading of one clef and less complex motor coordination. Whatever instrument the child decides upon the teacher should find his strong areas, preferred modality or style of learning for each task. She should use these to create success experiences which will support his ego and help him to meet frustrations with a minimum of anxiety.

Recommendations

Considerably more investigation is needed into the exact nature of visual and auditory perception, the processing of tactile and kinesthetic information, and intrasensory and intersensory integration not only in the a as that have begun to be researched but especially in music. There is need to explore in detail the processes involved in score reading, memorization, and performance of music, in discrimination and pitch matching, in the development of the ability to organize auditory patterns of sound, and in the growth of skill in judging various timbres.

Score reading readiness tests ought to be devised and employed to prevent a child who is not ready to handle the symbolic system of notation from being totally frustrated when he attempts the reading of music. Comparisons between language reading and score reading skills should be made in depth.

It should be ascertained whether extensive auditory experience prior to the learning of notation influences the degree of success in this task and to what extent it does so.

The question of the manner in which the developmental neurological level of a child's brain affects his ability to learn music should be pursued. Deficit areas which have been identified by professionals in the field of learning disabilities should be further examined for their possible influence on success in music. Would it be possible for a child to have diagnosed language difficulties and still understand the language of music? Could a child like this even be musically gifted? How does creative talent or giftedness in music in a learning disabled child help him to overcome musical problems which he may encounter?

How, precisely, could music training help a learning disabled child to cope with the academic demands in school? Could it be a means of remediation for his perceptual and conceptual difficulties? And through what techniques could this be accomplished?

The research area of music and the learning disabled child is nearly virtually untouched due to the recent establishment of the field of learning disabilities. It is an area rich with research possibilities and has a potential for becoming a subfield in the fields of learning disabilities and the psychology of music.

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