22 Dalcrozian Piano Pedagogy and Cognitive Motor Learning Theory

By Thomas Brotz

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Abstract:
Dalcroze-based piano pedagogy is considered in relation to four topics in cognitive psychology of motor learning: transfer of learning, variable practice, prepractice reference of correctness, and focus of attention. Dalcrozian techniques and practices are linked to these topics in motor learning theory. There is a concluding example of how to reference these topics to an experimental design in which subjects learn to play a single piano piece. In this experiment, treatment arms are defined by activities carefully chosen to enable measurement of the effects of Dalcrozian solfège, rhythmic movement (Eurhythmics), and improvisation activities away from and at the piano.

Keywords: Dalcroze, piano pedagogy, cognitive psychology, motor learning, transfer learning, variable practice, prepractice reference of correctness, attentional focus, ideomotor theory

Introduction

There have been only two studies of the Dalcroze approach to music education applied to piano pedagogy. Dalcroze described an experiment conducted sometime before 1912 (Jaques-Dalcroze E. , 1921/1967, p. 53). Melville-Clark contributed the second empirical study (Melville-Clark, 2000). The purpose of this article is to provide ideas which might spark further research in Dalcrozian piano pedagogy.

The article is organized in four sections, each devoted to a research topic in cognitive psychology of motor learning relevant to basic techniques and practices of the Dalcroze approach. The four research topics are: Transfer of Learning, Variable Practice, Prepractice Reference of Correctness, and Focus of Attention. The Dalcrozian techniques and practices are "Quick Reaction" and "Follow" exercises as applied in Dalcrozian Solfège, Rhythmic Movement (Eurhythmics), and Improvisation. A final section presents an experimental design devised to test the effectiveness of Dalcrozian activities applied to piano pedagogy.

A newcomer to the world of research in cognitive psychology may find theory of motor learning to be frustratingly complex and irrelevant to the real work of teaching. Indeed the number of competing theories and models of motor learning is quite staggering. Rosenbaum provides a good introduction to the field (Rosenbaum, 2010). His text includes references to some studies in music performance. It may be heartening to note that Dalcroze did not find it necessary to refer in his writings to research in the psychology of rhythm. Bachman comments, "Dalcroze seems to have been unaware of the discoveries of German and English-speaking researchers, despite their relevance to his own" (Bachman, 1991, p. 17). It is known that Dalcroze and the Swiss psychologist, Edouard Claparède, were interested in each other's work but not much has been written about their exchange of ideas (Schnebly-Black & Moore, 1997; Lee J. W., 2003; Bachman, 1991, p. 16)[1].

Transfer of Learning

A basic tenet of transfer of learning theory is that transfer is more likely between similar tasks. Since gross motor skills developed by Eurhythmic activities away from the piano are very dissimilar to the fine motor skills needed for performance at the piano, it is important in research of Dalcrozian piano pedagogy to investigate the transfer of gross motor rhythmic skill to piano performance.

Schmidt and Wrisberg give a simple example of experimental design in the study of transfer of learning.

> In experiments on transfer of learning, researchers attempt to determine the influence of prior experiences on people's performance (or learning) of a new task. Researchers do this by using an

1 Editors note: For more information on Claparède, see Kristin Benson's article, "The Intellects of Switzerland: Influences on the Dalcroze Approach to Music Education", *American Dalcroze Journal*, Volume 41, No. 1.

> experimental design in which some participants practice an initial task before attempting a second task. A control group receives no experience on the initial task and attempts only the second task. When prior experience on the initial task is beneficial (compared with the control group) for second-task performance, positive transfer is assumed to have occurred. If the prior experience is detrimental or has no influence, negative or no transfer, respectively, is assumed. (Schmidt & Wrisberg, 2008, p. 193)

Schmidt and Lee define motor learning as "a set of processes associated with practice or experience leading to relatively permanent changes in the capability for skilled movement" (Schmidt & Lee, 2011, p. 327). During practice, which is the acquisition phase of memory, there may be improved performance, but performance at a later time may show that the improvement has not been retained; a relatively permanent change in the capability for skilled movement has not occurred; the initial improvement was merely a temporary effect of intensive practice.

In a study of transfer, if a Dalcrozian gross motor rhythmic movement activity is used as the initial task and a fine motor piano performance task as the second task, a finding of positive transfer would be especially interesting because the tasks are quite dissimilar.

Variable Practice

Variable practice is characteristic of many Dalcroze activities. Frequently the plan of Dalcroze classes is to take a musical topic and present it to students in different guises. Schmidt's schema theory of discrete motor skill learning (Schmidt R. A., 1975) predicts that measures of performance on a transfer task will be better for variable practice than for constant practice. Measures of performance during acquisition are predicted to be better for constant practice. As an example of variable and constant practice, consider a five-finger exercise on the piano. The task is to play five white keys from C up to G and back to C. In constant practice the ascending-descending task is practiced identically a number of times, say 30. In variable practice the task is not practiced the same way each time; for example, the 30 trials might be performed 10 times at a forte dynamic level four tones per beat, 10 times at a fortissimo dynamic level two tones per beat, and 10 times at a pianissimo dynamic level four tones per beat. In studies of constant and variable practice, both retention and transfer are generally tested because Schmidt's theory makes different predictions for retention and transfer after constant practice or variable practice. Variable practice in Dalcrozian activities can be exemplified (1) by "Follow" exercises in which the same rhythmic pattern is performed at various tempi and dynamic levels in quick reaction to changes of tempo and dynamics of the leader and (2) in piano improvisation where melodic and harmonic variation might be applied to the same rhythmic pattern.

Research findings for the prediction that variable practice facilitates transfer have been mixed. (Van Rossum, 1990) A study of learning rhythm sticking technique (Rose, 2006) did not find that variable practice enhanced transfer to novel tasks. In her study college students practiced 10 rhythmic sticking patterns. She compared three kinds of practice: **Blocked (constant) Practice** (8 consecutive trials of the same pattern then the next pattern), **Random (variable) Practice** (one trial of each of 10 patterns, 8 times through the set), and **Free Practice** (control group, 12 minutes to practice ad lib.).

In Schmidt's theory, the process of motor learning is represented as a generalized motor program and two memory functions, a recall schema and a recognition schema, defined as "positive functions of the number of practice trials and the variability of practice" (Schmidt R. A., 1982, p. 117). Both schemata are functions of response-produced information (kinesthetic, visual, auditory and other sensory information obtained during motor activity). This means that Schmidt's theory cannot explain how motor performance of a melody on a musical instrument is facilitated by just listening to the melody. Auditory information can only be linked to motor information by hearing the melody during motor performance of the melody.

Prepractice Reference of Correctness

Dalcroze wrote that "Pianoforte lessons, unless preceded by training of the ear and by rhythmic movement, frequently damage the aural and rhythmic faculties" (Jaques-Dalcroze, 1921/1967, p. 53). Furthermore, he claimed that a student 'musicalised' by such preliminary experiences "will make more rapid progress at his instrument" (Jaques-Dalcroze, Rhythm, Music, and Education, 1921/1967, p. 56). Preliminary 'musicalising' may be related to developing prepractice references of correctness. According to Schmidt's theory motor learning cannot be facilitated by developing a clear idea of correct performance prior to beginning motor practice because it is only during the motor activity of practicing piano that auditory response-produced feedback is stored in memory for subsequent use in controlling musical performance. Do Dalcroze's statements suggest that without 'musicalising' a student by preliminary aural and rhythmic training there is some adverse effect on the response-produced feedback which a student obtains during piano practice? Would such an adverse effect occur because haptic (touch) memories gained in practicing piano take precedence over auditory sensory memories in control of movement? Some researchers think the haptic system plays a constructive role in motor musical performance. Reubart concluded that, for performers without absolute pitch discrimination, "auditory perception defers to haptic mechanisms which are caused to act first" (Reubart, 1985, p. 73). Palmer cites studies which "suggest that sensory information that is available when musicians' limbs make contact with their instruments enhances the temporal accuracy of upcoming movements" (Palmer, 2013, p. 407).

Dalcroze seemed to be aware that musical performance requires a complex integration of many kinds of sensory information, auditory, kinesthetic, and haptic. He certainly recognized the positive contribution of the sense of touch in improvisation:

> …the tactile sense often has a marked influence on the musician… The hand is the most intelligent and sensitive of our organs. Its sensitivity is so refined that it often responds to flights of imagination more rapidly than the ear itself, which, more often than not, confines itself to controlling the dictates of musical gesture. (Jaques-Dalcroze, 1932, p. 8, quoted in Bachman, 1991)

Schmidt recognized that the design of his theory made it impossible for sensory information obtained separately from motor practice of a motor task to be available for motor control of that task (Schmidt R. A., Motor Schema Theory After 27 Years: Reflections and Implications for a New Theory, 2003), and he knew of research showing that learning occurs without response-produced feedback. He cited the Suzuki method of listening to pieces before beginning to learn to play them on an instrument as an example of developing a prepractice reference of correctness (Schmidt R. A., 1988, p. 383). Development of a prepractice reference of correctness involves observational learning, a kind of cognitive processing which facilitates learning without motor practice. In developing an auditory prepractice reference of correctness, a Suzuki student aurally observes a correct performance. The effectiveness of observational learning is assumed by music teachers whenever they demonstrate how a passage is to be performed. One explanation of the effectiveness of observational learning is that it elicits from students a beneficial cognitive effort (Lee, Swinnen, & Serrien, 1994). Many Dalcrozian "Quick Reaction" exercises require a special kind of cognitive effort from students by requiring immediate, spontaneous, unrehearsed movement responses to verbal commands such as "Hopp" and to musical changes of tempo, dynamics, durational or metric pattern, and tonality of music improvised by the teacher.

Focus of Attention

Dalcroze's emphasis on the importance of musical experiences before beginning study of an instrument may also be an example of training performers to use an external focus of attention. Experiences in solfège and rhythmic movement prior to beginning instrumental studies may predispose students to focus externally on the musical idea to be realized in performance rather than internally on the mechanics of motor performance.

Research findings show that focus of attention is an important factor in motor learning and that external focus of attention produces better motor learning (Wulf, 2007a, 2007b). In motor learning research, internal focus is defined as focusing attention on the performer's own body movements and external focus is focusing attention on the effects of movement on the environment (Wulf, Höß, & Prinz, 1998).

Though research frequently showed the effectiveness of external focus, some researchers felt the need for a theoretical explanation of the empirical findings and their efforts led to the Constrained Action Hypothesis, according to which

> …trying to consciously control one's movements constrains the motor system by interfering with automatic motor control processes that would 'normally' regulate the movement. Focusing on the movement effect, on the other hand, might allow the motor system to more naturally self-organize, unconstrained by the interference caused by conscious control attempts – resulting in more effective performance and learning. (Wulf, McNevin, & Shea, 2001, p. 1144)

Moreover, these researchers began to see a conceptual commonality between the Constrained Action Hypothesis and a much older theory of motor control, Ideomotor Theory:

> The idea that actions are controlled more effectively if attention is directed to the (intended) outcome of the action, or its remote effects rather than to the close effects that are directly associated with it (e.g., kinesthetic feedback) can be traced to Lotze (1852) and James (1890)…. links between motor acts and perceivable bodily and environmental events can be used and exploited in two ways. The first leads from actions to effects as, for example, in predicting or expecting an ongoing action's consequences. The second goes in the reverse direction from effects to actions, as for example, in selecting and initiating a certain act on the basis of an intention to achieve certain effects. This latter relationship – which leads from intended effects to acts – is considered the functional basis of the ideomotor principle. (Wulf & Prinz, 2001, p. 655)

So in searching for a theoretical rationale for the effectiveness of external focus, Wulf and Prinz found a connection between research in attentional focus and a much earlier theory of motor control which had mostly but not entirely fallen out of favor (Stock & Stock, 2004). However, when James discussed the ideomotor principle in the late 1800s he did not conclude that an external focus is always the most effective attentional focus. He suggested that the most effective practice strategy is to practice at first with an internal focus on proprioceptive feedback from movement and then gradually shift to an external focus on the effects of movement. James also suggested that, to some extent, learning to do something new requires trial and error and contributions from random experiences (James, 1890, p. 393).

Perhaps, in Dalcrozian quick reaction activities, the requirement of spontaneous movement responses to music throws students into situations where instinctive or random actions are teased out of them and provide the potential for learning new behaviors.

Ideomotor theory has been tested in a series of experiments investigating connections between auditory effects and key-tapping tasks (Keller & Koch, I., 2008). Young adults learned to tap one of four movement sequences on three vertically aligned keys when prompted by a color stimulus: top key-middle key-bottom key (pink), bottom-middle-top (yellow), top-bottom-middle (green), or bottom-top-middle (blue). Tapping a key triggered a compatible or incompatible auditory effect. A compatible effect was defined as the pitch height of the sound matching the relative spatial height of the key (A4, G4, and F4 for the top, middle, and low keys, respectively). Incompatible auditory effects included no sound for tapping a key, the same sound for each key, reversed relationships (A4, G4, and F4 for the low, middle, and high keys, respectively), and various scrambled relationships. Movement responses were generally faster when pitch height and spatial height matched and for persons with more musical experience. Though the tasks may seem trivial, the findings do support ideomotor theory which predicts that environmental effects influence motor action.

In a study of piano performance and focus of attention (Duke, Allen, & Cash, 2011), external focus was found to improve accuracy of timing in piano performance. College music majors performed a simple alternating piano figure on two keys (A4-F4) with focus of attention on fingers, piano keys, piano hammers, or sound. For each focus, each subject did 4 practice blocks of 10 trials each, took a 5 minute break, then 10 more retest trials (retention), a 2 minute break, and then the transfer task (same alternating figure but starting on F4). The journal article mainly discusses the nonpianist data and for these there were

no statistically significant differences at retest. For the transfer task, performance with internal focus on fingers and keys was statistically significantly less accurate than performance with external focus on hammers and sound. External validity of this study may be weak because the task (alternating two keys) is rather trivial. Weak external validity means that the behaviors observed in the experiment have little relevance to the behaviors of interest outside the experiment (performance of the much more complicated fingering and key-finding tasks required by the piano repertory).

Application

To illustrate how hypothesized connections between concepts in cognitive psychology and Dalcroze exercises might be tested, a research design is sketched out here. The title of this imaginary research project is: Four Approaches to Teaching Kabalevsky's Op. 39, No. 18, Effects of Incorporating Elements of the Dalcroze Method in Piano Lessons of Eleven-Year-Old Early Intermediate Piano Students. The design has four treatment groups linked to key elements of the Dalcroze approach to music education and to the issues of transfer learning, variable practice, prepractice reference of correctness, and focus of attention. Hypotheses are formulated for the four treatment groups.

For such an experiment, many other important matters would need to be planned in great detail. Before describing the four treatment groups, a few of these other matters are listed.

Qualified teachers must be found and eleven-year-old early intermediate piano students must be randomly selected and assigned to treatment groups from a pool of piano students who live in close proximity to participating teacher sites. Background information for each child should be collected including years of piano study and exposure to other musical educational experiences, especially any Dalcroze experiences. This information may be used as supplementary data for analysis (covariates) (Melville-Clark, 2000, p. 77). The number and duration of practice sessions must be determined; for example, 8 hour-long private lessons taken 8 weeks in succession with practice of the Kabalevsky piece between lessons disallowed in order to control for unequal practice effects across treatment groups. Lesson plans must be scripted for each of the treatment groups. The success of the experiment depends very much on the quality of the lesson plans and the teachers' consistent implementation of the lessons. For recordings of tasks selected from each lesson as criterion measures, a choice of statistical methodology must be made for the analysis of judges' grades (Melville-Clark, 2000) and/or objective measures of timing (Brotz T. , 1990).

Treatment Group 1 is a control group representing a stereotype of traditional approaches to piano pedagogy. The Kabalevsky piece is taught by rote without reading musical notation. Though this is not typical traditional practice, it provides a control group with internal attentional focus on practice of fine motor pianistic tasks. There is no variable practice except perhaps in the sense that traditional methods have students practice initially at a slow tempo and gradually increase the tempo. A prepractice reference of correctness for the Kabalevsky piece is not provided via listening to a professional performance of the piece nor by preliminary teaching of the melody in solfège exercises or of the rhythm in preliminary rhythmic movement activities. There are no improvisation activities.

Treatment Group 2 represents the application of Dalcrozian "Quick Reaction" and "Follow" exercises in Dalcrozian Solfège, Rhythmic Movement (Eurhythmics), and Improvisation activities away from the piano. Minimal attention is given to piano technique. Activities are designed to develop a strong prepractice reference of correctness and external focus of attention by including listening to a professional recording of the piece at the beginning of each lesson followed by variable practice of the piece away from the piano including ear-training exercises and rhythmic movement activities related to the melodic, harmonic, rhythmic and metric content of the piece. After these activities, the Kabalevsky piece is practiced at the piano. Students must find by ear the sequence of piano keys to be played but the teacher may point to the correct keys if necessary. Choice of fingering is left to the student. Improvisation using tonal-rhythmic patterns of the piece and other contrasting material is to be included but not at the piano (this is reserved for Treatment Groups 3 and 4). Improvisation of a freer nature should also be included, activities which appeal to the imagination of the student (Jaques-Dalcroze E. , La rhythmique, l'enseignement du piano et de l'improvisation, 1945).

Treatment Group 3 includes the same Dalcroze Solfège, Eurhythmics, and Improvisation activities as in Treatment Group 2 but with added coaching for technical matters of fingering and orientation to the keyboard. Also Eurhythmic activities specific to key-finding and fingering aspects of the musical piece are included in accordance with indications Dalcroze provided for applying Eurhythmics to piano technique (Jaques-Dalcroze E. , The Jaques-Dalcroze Method of Eurhythmics, Rhythmic Movement, Vol II, 1921, pp. 79-96).

Treatment Group 4 is like Treatment Group 3 except that Dalcrozian solfège, rhythmic movement and improvisation are performed only at the piano – no activities are performed away from the piano. In reading the following hypotheses, note that each hypothesis deals with the integrated effect of variable practice, prepractice reference of correctness, and focus of attention on transfer of learning understood in the broadest sense: "Transfer of learning is our use of past learning when learning something new" (Haskell, 2001, p. xiii).

Hypothesis 1: Group 2 will perform better than Group 1

Rationale: Variable practice via Dalcrozian activities away from the piano develops a prepractice reference of correctness and an external focus of attention, and this Dalcrozian practice transfers and facilitates learning of pianistic tasks.

Hypothesis 2: Group 3 will perform better than Group 2

Rationale: Transfer of skill to piano performance from gross motor rhythmic movement and solfège activities away from the piano is more effective when such activities are combined with Dalcrozian activities at the piano and traditional exercises in pianistic technique because prepractice references of correctness need to include motor information about the pianistic task, and focus of attention is more effective if it includes focus on an aural image together with attention to fine motor components of the task.

Hypothesis 3: Group 4 will perform at least as well as Group 3

Rationale: Transfer from variable practice via Dalcrozian activities at the piano is sufficient by itself to develop a strong prepractice reference of correctness and an external focus of attention for facilitation of learning to perform a piano piece.

The first hypothesis tests transfer between highly dissimilar motor tasks. Dalcroze lamented that children are "taught at the piano before they have shown any musical propensities…. before their feeling for sounds and rhythmic movement is developed – before their whole being vibrates in response to artistic emotions…. if the whole system of rhythmic training is based on music, it is because music is a tremendous psychic force" (Jaques-Dalcroze E. , 1921/1967, p. 63). In writing these words in 1914 he seems confident that preliminary music and movement training away from the piano transfers to learning to play piano. If the hypothesis is not rejected a theoretical explanation could be that preliminary variable practice in Dalcrozian music and movement experiences away from the piano develops prepractice references of musicality and unconstrained action of external focus which facilitate learning of pianistic motor tasks better than traditional practice at the piano.

The typical expectation of transfer of learning theory is that positive transfer is stronger between similar tasks. The second hypothesis predicts superiority of Group 3 over Group 2 because it supposes that for Group 3 the addition of Dalcrozian fine motor exercises at the piano involving skills similar to those needed to perform the Kabalevsky piece will produce an intermediary bridging effect which increases transfer of preliminary musicalising activities away from the piano to the learning of pianistic motor tasks. The rationale of the second hypothesis seems consistent with what Dalcroze wrote in 1921. "Up to the present time there has been no bridge between the teaching of Eurhythmics and the teaching of instrumental technique…. It is more than likely that sooner or later some virtuoso will write a book of instrumental technique… in which each of the exercises destined for the whole body will be applied

to the movements of the hand and arm. Meanwhile we wish briefly to indicate how rhythmic exercises can be applied to pianoforte technique" (Jaques-Dalcroze E. , The Jaques-Dalcroze Method of Eurhythmics, Rhythmic Movement, Vol II, 1921). Now, almost 100 years after this was written, the closest any book has come to what Dalcroze predicted may be a book by Tova Berlin-Papish published only in Hebrew (Berlin-Papish, A Method of Teaching Piano, 1958).

The third hypothesis brings this article to a close with a hypothetical test which, if not rejected, is apt to be controversial among Dalcroze practitioners. This hypothesis supposes that it is possible to develop the musicality of students entirely at the piano—that Dalcrozian activities in solfège, rhythmic movement, and improvisation activities can be applied so effectively at the piano that students in Group 4 can achieve skill in performance equal to that of Group 3.

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