

Research Article

Lyndall Hendrickson's pedagogy: A learner-centred, multi-sensory violin teaching approach

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This study explores the integration of sensory-based materials designed for the students of Australian violin pedagogue Lyndall Hendrickson, whose experimental teaching ideas were developed from the 1960s. This research examines principles that influenced her multi-sensory teaching approach to violin instruction. Investigated are Hendrickson's use of elements from Dalcroze Eurhythmics, her training of Ševčík's exercises, knowledge from polio recovery, and the ways this informed her pedagogy. Hendrickson engineered combinations of vision-, auditory-, and proprioception-guided materials to engage the young violinist's sensory perception in their learning process. Investigations from her archival material are personal letters, transcriptions of teaching diary notes, collated files of handwritten drills, and previously unknown transcripts of lectures she delivered between 1960 and 2010. They reveal her use of educational psychology and principles for using structures of the Human Performance Theory. Also discussed are the applications of student-centred approaches for her understanding of pupils' sensory needs, as well as her investigations to determine differences in their thinking behaviours. This examination of Hendrickson's pedagogical methods may benefit teachers of students who struggle to grasp the perception of patterns or haptic associations.

Keywords: Lyndall Hendrickson's pedagogy, Learner-centred, Multi-sensory violin, Teaching approach, Dalcroze eurhythmics, Haptic associations

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1. Introduction

Australian violinist Lyndall Hendrickson (1917-2017) had an amazing career in which she had to overcome many obstacles. At the age of ten, she was performing regularly, accompanied by her sister for the Australian Broadcasting Commission's radio program in Adelaide (Alberti, 1995). From 1939, she performed as a soloist with renowned conductors including Sir Malcolm Sargent, Sir Thomas Beecham, Sir Bernard Heinze, Joseph Post, William Cade, and Percy Code. When she was 33 years old, she contracted poliomyelitis from one of her husband's patients and was totally paralysed on her left side. Remarkably, she rehabilitated herself and developed her own style of exercises to play the violin again.

By 1975, Hendrickson's success as a teacher was such that she was the only Australian to present her violin pedagogical work at the prestigious Tennent Caledonian International Seminars on Violin Teaching chaired by Yfrah Neaman, Max Rostal, and Yehudi Menuhin. Hendrickson's biography in the Tennant Programme Souvenir stated that she devised finger drills, which led to her full recovery as a violinist after her battle with polio (Neaman, 1975). At the end of the Cultural Revolution in the People's Republic of China, Hendrickson was the first Western violinist and Australian woman to lecture on her method at the official re-opening of the Conservatories of Music in Beijing, Shanghai, and Guangzhou. These lectures

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revealed a wealth of information on her philosophy and methods of integrating a multi-sensory approach into the pedagogy of learning the violin (Hendrickson, 1978b). Hendrickson maintained correspondence and connections with many violinists, some of whom included Henry Roth, Louis Kauffman, Eduard Melkus, Jascha Heifetz, and Nathan Milstein. For such an important violinist, her pedagogical contribution is yet to be fully recognised.

2. Method

The method for this research involved a review of Hendrickson's teaching files, written materials, lecture notes, audio recordings, letters and her statements. The focus was to outline and interpret Hendrickson's approaches to violin pedagogy and reflect on the impact of her multi-sensory teaching methods on current understandings of learning violin techniques. The hypothesis is that Hendrickson's teaching reflected early experimentation with multi-sensory learning and an approach that emphasised students' individual learning styles over other methodologies.

2.1. Participant and Data Collection Process

For this study, the candidate digitized and transcribed 40–50-year-old cassettes to sort and preserve data. Reviewed from the estate collection, named the 'Hendrickson Archives', were 3000 cassette recordings of excerpts of teaching, rehearsals, lectures between 1960 and 2010. Also sourced were physical teaching files made for individual students, as well as published and unpublished writings. In the collection of materials were the Chinese transcribed lectures given in the People's Republic of China in 1977-78. Translations were kindly provided in 2019 and 2020 by Western Australian Symphony Orchestra cellist Xiaole Wu, and Jane [from Professional Chinese Translation Services c/- Fiverr International Ltd]. Other sources included the Australian Strings' Association [AUSTA] files and videos, and a review of class lecture notes presented at The University of Adelaide from 1978-2010.

2.2. Data Collection Tool/s

Three audio and video cassette players connected to computers were used to digitize and collect data. Physical folders and digitized files were catalogued into the Hendrickson Archives from boxes of unsorted materials from the Hendrickson estate. Themes and ideas from articles written by Hendrickson were also sought by examining files of AUSTA Conferences, *The Strad Magazine* articles, Gifted and Talented Children Association Conferences, *Australian Journal of Music Education*, International Society of Music Education Conferences, and the International Conference on Thinking. Materials were analysed thematically using a combination of deductive and inductive approaches, such as factoring the knowledge imparted from lectures and private correspondence from Hendrickson herself, in order to ascertain her teaching thought processes.

2.3. Data / Thematic Analysis Used by the Study

The framework to conduct this research was devised using a Thematic Analysis approach, as outlined by Braun and Clarke (2006). The choice to use this approach was based on an in-depth examination of the primary source materials in the Hendrickson Archives that related to the following research statements.

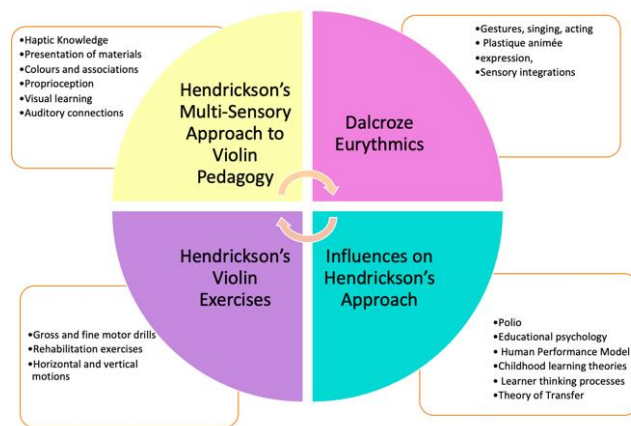
1. Who was Lyndall Hendrickson and how did she make an impact in her career.
2. What methods did Hendrickson use to deliver content in her teaching.
3. How did Hendrickson formulate her materials and exercises for learning the violin.
4. What influences, educational or psychological principles are evident in Hendrickson's approaches to encourage information processing for young violin students.

Frequent discussions in Hendrickson's writings and created materials related to learning and pedagogical elements, such as the examples of haptic learning, use of colours, the theory of transfer et al, were coded and then clustered together to form the central themes that relate to her pedagogy, as shown in Figure 1.

The analysis of Hendrickson's work is interpreted from her information on exercises, and philosophies for teaching young children. Their evaluation is interpreted against historical learning practices as well as research on other sensory-based approaches. Her techniques warrant attention because she integrated elements of multi-sensory learning for students as young as four years old to attain violin playing skills in unique ways.

Figure 1

The inner circle represents inter-related themes from coded materials



3. Influences on Hendrickson's teaching approach

An understanding of Hendrickson's research, and how she developed her philosophies of pedagogy, is partly connected to her past study of historical methods of violin instruction. Hendrickson gave a lecture in the People's Republic of China about her own historical research on the traditions of violin teaching. She stated:

In the early period of violin teaching, people used the C major scale as the basis of elementary fingering. They thought this was an appropriate scale to start learning the foundations of fingering. In 1831 there was a famous early period violin teacher called Louis Spohr. He had great influence as a teacher and used the C major scale as the basis of elementary fingering. Spohr found that there were some problems with the flattened first finger on the E string when playing the scale. He asked the student to rest the lower joint of the forefinger against the nut on the fingerboard on E string and keep it in position. He explained in shifting the first finger back that the student should press the finger down like a hook shape playing the note F. The second finger falling naturally can play the note G, the third finger stretched out a little bit can then play the A. This was considered as the correct left-hand position form on the violin for the notes (Hendrickson, 1978 Spring, p. 1).

A study of around 300 manuals of elementary instruction from 1650-1920 included in *The Influence of the Scale of C on Elementary Violin Instruction*, confirmed that there was indeed a long tradition of starting violin training exercises in the key of C major (Mikajlo, 1994). Hendrickson (1978 Spring,) explained that Francesco Geminiani illustrated a chord for the placement of the left-hand fingers and hand hold on the strings in his treatise, *The Art of Playing on the Violin* (Geminiani, 1751). These fingers when all held down on the fingerboard would show their first position placement on the strings in the key of C. His held-down, left-hand shape became known as the 'Geminiani Grip,' (Joachim & Moser, 1905, p. 10) and was subsequently included in many elementary instruction manuals as a means of setting up the natural position of the left hand and fingers on the violin until the early 20th century (Mikajlo, 1994). Whilst Geminiani's indication for the left-hand hold and fingering may have suited a person with long fingers, the position of holding these notes may have been very difficult for others with shorter left-hand fingers. Hendrickson pointed out that 'Learning is a process ... we need to make sure that these masters had taken the physiological functions of the body into consideration when they were writing fingerings and bowings' (Hendrickson, April 1978 p. 24).

Hendrickson was familiar with the written exercises of 20th-century violinists such as Yampolsky (1967) and Ševčík (1901), noting the importance of their exercises assigned to hand and finger strengthening through specific patterns and qualities of motion. She stated:

Yampolsky believed that fingering will in most times affect the precision of pitch, and this is true especially with beginners. So, fingering is very important. If your fingers press the strings too firmly, it is likely to be very hard to play in tune or adjust. If the fingers are not naturally balanced with the right amount of weight and finger position on the string it will be difficult for even an advanced violinist to play in tune (Hendrickson, 1978 Spring, p. 4).

The first texts discussing the impact of physiology and integration of the sensory system in violin playing, such as the *Senso-Motor Study and Its Application to Violin Playing* by Frederick Polnauer and Morton Marks (1964) and *The physiology of violin playing* by Ottó Szende and Mihaly Nemessuri (1971) were

distributed in Australia in the 1970s. Hendrickson noted that Szende and Nemessuri's pioneering research signalled a significant change in thinking about the acquisition of skill, which was explained through their studies of the physiological impacts of violin performance on the human body, the effect of oxygen and respiratory consumption, and the nervous system (Szende & Nemessuri, 1971).

3.1 Influences of Other Multi-sensory Violin Teaching in Australia

In the 1960s, Hendrickson's violin pedagogical approaches in Australia were unfamiliar, as she designed and experimented with her own integrations of multi-sensory materials. She attended conferences and was aware of new developments in teaching. For example, Zoltan Kodály, Émile Jaques-Dalcroze, and Carl Orff developed ground-breaking educational programs that offered supplementary materials for music teachers, employing new techniques to link visual, aural and proprioceptive processes in learning. These alternative programs offered a wide range of new ways to train students to connect aural sounds of pitch with written notations (Kodály et al., 1974). In c.1925 Hendrickson was trained by Heather Gell in Dalcroze Eurhythmics. Gell had trained at the London School of Dalcroze Eurhythmics and in 1924 established the Dalcroze Society of South Australia (Nash, 2014). Hendrickson stated that these classes greatly impacted her performance and teaching techniques by giving her a sense of freedom of movement in violin playing (Cox, 1995).

In the mid-1970s, Hendrickson became friends with Adelaide Suzuki violin teachers Peter Komlos and his wife Maxime, who adapted their violin programs to include elementary forms of notation, singing, and music games (Hendrickson, personal communication, May 14, 2009). Hendrickson borrowed a few ideas from the Suzuki teachers, such as using a metal whiteboard with a single line or five stave lines on it, to teach young children to place the notes on a space or a line with the tactile aid of magnets. She had read of these ideas from Suzuki teachers Mills and Mills in their chapter *Practical Suggestions for Teachers on Reading* (Mills & Mills, 1973).

Paul Rolland came to Australia in May 1977, to attend the AUSTA National Conference held in Brisbane at the University of Queensland (Pierotti, 2022). Hendrickson did not meet him at the time, as she was then travelling to the People's Republic of China. As she regularly travelled to overseas seminars and conferences, it is presumed that she was aware of his teaching, as she later mentioned his work to students at the University of Adelaide when teaching pedagogy classes in 1986. Rolland's *The Teaching of Actions in String Playing* came into circulation in the mid 1970s (Rolland & Mutschler, 1974). His program was based on his research on the fundamentals of motion techniques in stringed instrument performance. Rolland collaborated with composer Stanley Fletcher to publish *New Tunes for Strings*, which included a movement-centred approach to training in pieces aimed for use in a classroom and an ensemble setting (Fanelli, 2021). The repertoire included practicing elements of bow motions, rhythm training, left-hand patterning for finger placements, shifting exercises, harmonics, and many other motions to develop technical flexibility (Rolland, 1985).

In the early 1980s, child-friendly visual materials began to appear in violin instruction manuals, such as those by Shirley Givens, who embraced visual, aural, and kinaesthetic approaches in her teaching. Givens included instructions to sing notation through solfège, providing enlarged symbols of notation, images of finger measurement between notes, and pictures suggesting ideas to assist with the perceptual processes of learning. Students could colour materials, interact with stories and improvise in the creative exercises provided (Givens, 1981). Several ideas in her presentation contain elements that are comparable to Hendrickson's collection of materials that were written for students from the 1960s to c.2010. These similarities include singing, drawings, enlarged notation, storytelling, traditional tunes, vibrato exercises, and imagery to explain fingering techniques.

Géza Szilvay and Csaba Szilvay developed the Colourstrings method, contributing significantly to developments in string teaching in the 20th century by being the first known pedagogues to have notations in their violin and cello manual published in colour (Szilvay, 1980). From the 1980s to c.2020, the Szilvay brothers attended AUSTA Conferences and workshops to share their knowledge of sensory integrations. Their instructional materials were based on the Kodály Method, teaching children to sing and connect this with their kinaesthetic senses in performing on the violin and cello. They worked with childhood educators to include sets of Hungarian and Finnish song repertoire in kindergarten education, which they then included in the first sets of elementary violin repertoire as the basis for skill acquisition. The Colourstrings elementary material includes singing, enlarged notations, pictures, storytelling, early introductions of harmonic shifts, and other techniques. Included in the Colourstrings program is a commissioned repertoire of solo, chamber, and orchestral works by composers such as László Rossa and Ilkka Kuusisto (Rossa & Kuusisto, 1990). These compositions and arrangements were designed and written to encourage the

development of motor skills through new designs of elementary chamber music, and were tailored to also include repertoire for diverse levels of technical abilities (Rossa & Szilvay, 2020). Though Hendrickson and the Szilvay brothers never met in Australia, their pedagogical approach had similarities in teaching nursery rhymes and songs to young children that were directly related to beginner violin repertoire. Although their materials and exercises were different, they both encouraged early forms of shifting techniques and exercises for students to grasp the sensations of bow movement and left-hand finger patterns, and applied enlarged notation sizes and different colours to represent each string, in their materials for working with young students.

Sheila Nelson and Lyndall Hendrickson met at an AUSTA National Conference in c.1984 (Hendrickson, personal communication, July 1, 2009), and the two remained friends for many years. Hendrickson included the traditional tune *Cowboys Chorus* from Nelson's *Tetratunes* (Nelson, 1980) in her collation of elementary teaching materials as a dedication to her friend by re-naming it *Sheila's tune* (personal communication, 2009). Nelson was renowned for her pioneering string teaching work to thousands of students in London via *The Tower Hamlets Project* (Nelson, 1985). Nelson composed ensemble repertoire and encouraged students to move through positions in duet pieces such as *Ghosts*, found in her string ensemble books named *Technitunes* (Nelson, 1982). Her programs, written for every stringed instrument, had analogies, stories, games, chamber music for young string players, sight reading, and songs to assist in the learning of string techniques.

Renowned Russian violinist Yuri Yankelevich was a student of Abraham Yampolsky. Between 1930 and 1937, he was the assistant concertmaster for the Moscow Philharmonic Orchestra and began teaching at the Moscow Conservatory in 1934 (Lankovsky, 2016). Although it was not readily available in Australia, Hendrickson was gifted Yuri Yankelevich's book *Pedagogical Heritage* (1983), a compilation of his research, writings and lectures, when she visited Moscow in 1986 to see her student Jane Peters perform in the finals of the Tchaikovsky Violin Competition. Like Yankelevich, Hendrickson researched historical methods of instruction in the set-up of the hand, position work, and the teaching of techniques (Lankovsky, 2016). Yankelevich's pedagogical texts have some similarities to Hendrickson's teaching philosophies in that he recommended that it was important to link auditory connections with physical motions when playing the violin, and to learn appropriate left-hand and thumb motions when playing in different positions along the fingerboard as early as possible (Yankelevich, 1993).

As described by Marsha Lankovsky (2016) concerning Yankelevich's legacy and texts, Hendrickson's philosophy and approaches also do not follow a known methodology or specific school of playing. Hendrickson relied instead on preparing information for students' perceptual processes that enabled her to put forward tailored drills for pupils, designed to record transferrable motions and elements that would be recognised when encountered again in other passages of music. She advocated that structured exercises that enabled the transfer of elements would increase the speed of reaction time and assist students to recall a store of measured physical motions. These recalled motions are often referred to as 'muscle memory' (Johnstone, 2017).

4. Experimental Violin Exercises

In preparation for her career as a concert violinist, Hendrickson benefitted from the study of Otakar Ševčík's patterns of finger exercises passed on by his pupil Ludwig Schwab. Ševčík analysed many different finger motions in violin performance and configured them into short exercises in his *School of Violin Technique* (1881). Hendrickson explained that Ševčík developed technique by contracting and relaxing finger muscles and focusing on the hand shapes in different patterned positions. Although Schwab had passed down valuable insight into how to use Ševčík's exercises, Hendrickson advised student teachers at the University of Adelaide that the huge number of drills, and comprehensive presentation of Ševčík's manual could be perceived as overwhelming for young students. She explained that their attention may be divided, when a single activity or stimulus demanded more than one reaction (Hendrickson, personal communication, 1993). Hendrickson used her intimate knowledge of developing the capacity for muscle contraction and expansion, gained in her own experience recovering from polio, to manipulate the forms of Ševčík exercises into short drills. These drills differentiated left- and right-hand skills that integrated visual, auditory, tactile, and proprioceptive elements.

In the fingers pressing the strings for two seconds down and one second to release, Hendrickson noted that the fine muscles on the left hand could be developed through constant contractions and relaxations. Her short drills included an open string in the pattern of the stopped fingers to relax the muscles. The sequence of fingering was then repeated in vertical motions ascending the string, which increased fine muscle strength and supported new learning connections acquired from various proprioceptive inputs. The samples in

Figure 2 became some of Hendrickson's drills that she herself used to regain strength in the fine muscles of her left hand. The G string was chosen deliberately for these types of drills, as the palm of the hand had to be turned further inwards to the fingerboard (Hendrickson, letter to Henry Roth, April 22, 1993). Hendrickson felt this could also assist young learners to negotiate appropriate hand postures and finger motions suitable to playing along the fingerboard, and was modelled in her four- to seven-year-old students (Hendrickson, personal communication, May 7, 2009). In the shorthand drill sample in Figure 2, the sequence of notes played with the first and second fingers need to be shaped to the altering widths of major and minor intervals as they ascend the G string.

Figure 2

Sample drills © 2022, reprint courtesy of the Hendrickson Archives. Note the instruction to the learner to discover 'Apple A' sitting on the second staff line.

In his book *The Art of Practising the Violin* published in 1983, violin teacher Robert Gerle also appears to have adopted Hendrickson's approach in writing similar shorthand exercises with an arrow indication to go up the string, for more advanced students (Gerle, 1983). The teaching of these types of exercises signalled a direct move away from traditional elementary violin teaching in the 19th and 20th centuries, where the focus was often on the fingers stopping the notes in the first position for the first year or so of training. Hendrickson advocated that leaving the hand in first position for a year or more could encourage perceptions of an undesirable left-hand grip and delay the learning and storing of other spatial motions, finger patterns, and transfer procedures. Similarly, Yankelevich also noted that many 19th-century violin methods followed the prerequisite for the beginner to have a lengthy amount of time only in the first position. Like Hendrickson, he noted that the time spent in first position encouraged a habit of holding the violin in a tight grip with the left hand that contributed to excessive finger pad pressure on the strings. He stated that these treatises developed a posture that 'fixates the left hand instead of ensuring its mobility' (Lankovsky, 2016).

In setting up left-hand finger motions, Hendrickson thought it was important to not limit left-hand finger work to one area of the instrument (personal communication, May 15, 1994). She thought of violin technique in forms and patterns and that the shape of both hands could greatly impact the performance of technique. In formulating finger work in combinations with appropriate postures, the student was encouraged to determine a comfortable arm motion and left-hand hold, where sensory information could be transferred to their fingertips. Hendrickson focused on the elements involved in arm and finger shifting motions and deemed that it was unnecessary for the student to learn set positions, such as recommended in *Introducing the Positions* by Harvey Whistler (1944), where the third and fifth position was introduced before the second and sixth position. Yankelevich also mentions similar principles when he stated that 'all systems of dividing the fingerboard to this day are relative and any search for new systems is counterproductive. This is especially so considering that actual musical performance is never tied to the necessity of classifying positions' (Lankovsky, 2016). He also clarifies that the whole arm is involved in carrying out musical functions 'and not the numerical delineation of positions' (Lankovsky, 2016).

In the 1960s, Hendrickson used a unique approach in teaching shifting actions to young violin students, training them to learn vertical and horizontal left-hand fingered motions along the fingerboard. Forming proprioceptive understandings of motions on strings can be complex, as the strings on the violin are stretched like a tight rope, with increments of different heights between the strings and fingerboard that extend from the nut to the bridge. The finger stopping of the notes shortens the strings, and the physical attributes of the hands and fingers for each student can vary greatly. Hendrickson's simplified forms of Ševčík exercises may have been a solution for the learner to access a greater range of proprioceptive feedback in early attention to movements of the left hand and fingers ascending the strings. It could also demonstrate to the student that the string tension of the stopped interval as well as the widths and shaping of each interval on the violin do not remain equally measured when ascending the strings, as is the case with equally measured pressed keys of a keyboard instrument.

5. Educational Psychology

In the 1980s, Hendrickson ran pedagogical classes for instrumental teachers at the University of Adelaide, where she spoke about the psychology of music learning through the theories of Gestalt psychology, Burrhus Frederic Skinner, and Jean Piaget (pedagogy class with author, May 10, 1984). Gestalt psychology involved the principles of proximity, similarity, continuation, closure, identifying elements of figure and ground, and symmetry and ordering of patterns (Sternberg & Sternberg, 2012). Hendrickson understood that perceptions of tasks involving these principles had to be prepared before lessons, so that the students' sensory and nervous system could register stimuli, structures of motions, and transfer patterns of physical motions. In these lectures, Hendrickson advocated that string teachers needed an understanding of the aim of techniques, as well as a breakdown of their individual components, so they could assist young players to perceive information, know how to integrate relevant knowledge, and execute relevant left- and right-hand tasks when playing the violin (personal communication, May 10, 1984).

In working with children as young as four years old, Hendrickson adopted an empathic approach that was similar to the one by psychologist Carl R. Rogers. Rogers stated that listening intently without prejudice and providing unconditional acceptance and understanding of others allowed them to become self-aware in their growth and learning (Rogers, 1975). Hendrickson advocated that it was important to create an environment where the child was not fearful to be themselves, where they could interact with a teacher who showed them unconditional positive acceptance and could react with empathy and understanding in the stages of their development. She further advised that it was important to have empathy, to listen, understand students' learning abilities, and assist their sensory awareness to build and promote self-directed learning (Hendrickson, personal communication, May 10, 1993).

Interested in the ways students rationalised, perceived, and understood learning processes, Hendrickson proposed that individuals be educated in styles that contributed to their thinking and pattern processing, reflecting traits of field independence [also referred to as divergent] or field dependence [also referred to as convergent] (Carrington, 1988). In 1977, American psychologists Witkin and Goodenough (1977) explained that field-dependent learners generally could have less ability in cognitive restructuring skills and be more advanced in their interpersonal competencies. The opposite was observed of field-independent learners. However, they also point out that there could be a crossover of high skills in interpersonal and cognitive restructuring areas. More recent medical researchers Ali Yazdanpanah Nozari and Hasan Siamian (2015) have explained that field-dependent learners tend to see a whole structure and view the concept of the whole idea, whereas field-independent learners may analyse each component of a structure separately without reference to the whole idea.

In her 1988 interview with AUSTA President Philip Carrington, Hendrickson discussed her research to diagnose field independence or field dependence tendencies. She conducted a drawing test involving over 2500 participants, aged 5-87 years, gathered over sixteen years from Australia, Russia, America, China, and Korea. They were drawn from the wider community and included conference delegates, musicians, 'students, bus drivers, street sweepers, conductors, scientists, poets, politicians, hotel chefs, and taxi drivers' (Carrington, 1988). The drawing test consisted of a simple line with a curve at one end. The participant was asked to use their imagination to complete a picture from the given shape within a few minutes. If the drawing became something unrelated to the original shape it was assumed that the participant was field independent (Carrington, 1988). Her influence in devising this test stemmed from the research of educational psychologist Ellis Paul Torrance's 'Tests of Creative Thinking' (Hendrickson, 1989). These tests were originally conducted with verbal or non-verbal instructions in tasks for students to complete a picture or to make their own association of elements in lines or circular shapes. They also needed to be simple enough and open-ended to cater to their subjects' abilities, knowledge, and background experience (Hebert et al., 2002). Hendrickson also used the drawings of her students to assess their spatial ability in associating elements to connect them with patterns and shapes (Hendrickson, 1986b).

In testing students, Hendrickson observed that those who were field dependent generally preferred addressing one skill at a time, understanding the structures and logical reasons for their activity. She noted that these students explored their musical tone by learning violin skill movements and working on their technique to improve the tone. This may involve using longer or shorter lengths of bow, applying less or more bow weight, bowing closer or further from the bridge, or the use of wider or narrower forms of vibrato in the left-hand. Hendrickson described that some students who showed traits of being field-independent would operate from hearing the sound to the instinctive touch in the example of using more vibration to express the sound. Others were intuitive in their approach to dealing with the whole structure of a musical passage rather than dealing with individual parts or components in order to understand their technique

(Carrington, 1988). Hendrickson stated that although field-dependent and field-independent thinking could sometimes overlap, it was important for teachers to understand these different processing behaviours in teaching students. Understanding such tendencies in her students' approaches to learning assisted Hendrickson to create learning environments, where she paired students to learn from each other, the elements from varied field-dependent and field-independent thinking styles (Hendrickson, personal communication, August 20, 1990).

A case example of a student having varied thinking styles was documented in Hendrickson's paper *Understanding diverse thinking behaviour in musically precocious children* presented at the eighteenth ISME Conference (Hendrickson, Autumn, 1989). Hendrickson mentioned that this student's performance of a work by Johann Sebastian Bach was acclaimed by experts as profound. She discussed that although the student displayed thinking tendencies that were predominantly field dependent, 'drawing and other tests indicated some degree of field independence overlap, and this was substantiated by some otherwise unexplained strengths in areas of musical thinking that demand flexibility and open-endedness' (Hendrickson, Autumn, 1989). Hendrickson linked some forms of non-verbal information with field-independent thinking. She related there was a diversity of information given with non-verbal visual representations and verbal forms that was still to be understood in education. Hendrickson stated that Albert Einstein had related that a great deal of his thinking occurred to him visually first and that in the second stage of his problem solving, 'conventional words or other signs have to be sought for laboriously' (Hendrickson, 1996).

6. Human Performance Model

Hendrickson followed Canadian kinesiologist Ronald Marteniuk's research from the time she read his book, *Information Processing in Motor Skills* (Marteniuk, 1976). He researched information processing through the model of Fitts's and Posner's Human Performance Theory that explained learning processes via perceptual, decision, and effector mechanisms. Hendrickson understood that reaction time did not include reference to muscular contraction time, and that if the mechanisms described in the Human Performance Model were working effectively, the feedback involved would reinforce effective perceptual learning processes. She stated that the principles of 'perceptual mechanisms' can only lead into 'decision mechanisms', if all the relevant information is present (Hendrickson, 2013). Marteniuk (1976) advocated that the teacher should control some of the sensory stimulations received by the student, and Hendrickson interpreted this by implementing controls to stimulate her teaching material structures through kinaesthetic, visual, aural, and proprioceptive combinations of multi-sensory communications. She stated that her methods aimed to use the senses to channel concepts and ideas of learning to her students and added that it was a 'hindrance to learning when the use of the senses was deprived' (Hendrickson, personal communication, 20 August 1990).

Hendrickson noted that the teacher must realise how their students can understand a task perceptually, assess if they understand its properties or analyse what they have gathered about the skill. In designing tasks, there may be variables in students' sensory perceptual processes, and differentiations in their capacity for dealing with the decision mechanisms when organising and classifying information (Marteniuk, 1976). Hendrickson observed that when her pupils were left to their own devices, their attention was less restricted to the dominant or salient dimensions of available information (personal communication, August 20, 1990). Recent studies such as that by Thomas Parr and Karl Friston, have studied similar roles of weighted attentiveness or salient information in the learning of new data and sensations (Parr & Friston, 2019). Hendrickson's philosophy that violin students should be trained in perception, to decipher relevant information and exclude irrelevant information, appears to have been paramount in her preparation of materials. Specified attentions could be required when a student was given an elementary étude. This involved their perception of information, how they decided to execute their motor movements, and put them into action. Hendrickson's concern when setting violin étude work for a student was that any omission in the teacher's analysis of their perceptual processes, in the way that they may individually attend to that task, could amount to a trial-and-error learning process (Hendrickson, personal communication, April 16, 2014).

Hendrickson created tests to identify ways her students used their vocal and motor abilities to imitate pitches and rhythms and categorise patterns or shapes. This testing included a check on the length of the left-hand little finger and to consider any difficulties that may occur in the reaching of motions across the fingerboard. The variations in the sensory learning abilities that Hendrickson's students may already have possessed are unknown. For example, in 1986, one of Hendrickson's students who had learning difficulties, particularly when looking at notation, had enlarged eyes drawn on their drill sheet (Hendrickson, 1986a).

7. Haptic Information and Physical Differences

Hendrickson designed communicative ways to integrate sensory connections, by arranging aural, visual, haptic, proprioceptive, gestural, and spatial information for children to learn the violin. She argued that a student's perception is subjective and referred to Ralph Pickford's explanation of haptic associations that students externalise experiences of what they feel in body sensations, muscular movement, responses to touch, vibration, and impulses (Pickford, 1972). Hendrickson asserted that visual perception of musical notations, instructions or finger movements alone may not give enough understanding for the comprehension of musical notations, gestural or proprioceptive motions. She stated that the calculations of what is seen via size, shapes or relative positions of these visual items may be further comprehended from the integration of multiple senses (Hendrickson, personal communication, May 14, 2009). Hendrickson's development of ways to assist children in processing sensory information paralleled the investigations of American occupational therapist and educational psychologist Dr. Jean Ayres, who proposed in the 1960s that perception, body awareness, and motor learning was dependent on integrated forms of sensory inputs (Roley et al., 2007). In 2008, this notion was investigated by neuroscientists Gori et al. (2008), who examined sensory thresholds and found in their research that children did not integrate visual and haptic spatial information fully until they were 8-10 years of age.

In designing exercises to strengthen the fingers and motor actions, Hendrickson advised against long hours of practice for young children. In pedagogy classes at The University of Adelaide, she stated that care had to be taken to not overload physical demands of the young child, noting that the bone structures in the hands of a five-year-old may not be sufficiently developed in joint formation via articular surfaces (Hendrickson, 1993). Articular cartilage is the connective tissue that encases the diarthrodial joints [movable joints] and children accrue variations of articular cartilage in their developmental years (Jones et al., 2003). In 2022, kinesiologists (Garnett et al., 2022) reported that age and exposure to time practising or performing on instruments, performance anxiety, and a lack of attention to individual body postures and balance in motions were factors contributing to the risks of injuries in musculoskeletal dysfunction in musicians. Musculoskeletal problems are linked to muscle, nerves, bone, joint, tendonitis, tenosynovitis, peripheral neuropathy and focal dystonia (Ranelli et al., 2011). Many important motor control procedures are interdependent on individualised adjustments of motions that are then tailored to the performer's anthropometry [physical dimensions of a performer's body] (Shan et al., 2012).

Most strikingly, Hendrickson presented a case for re-thinking the way technique is taught through commercially published manuals of instruction by contemplating a more tailor-made approach in teaching students that considers their individual anthropometry and perceptual learning needs. For example, her assessment of how gender may be related to students' physical needs in pedagogy was pointed out in her classes. Hendrickson said that 'almost without exception, the entire violin literature has been male edited. The smaller female hand had never been accounted for' (Hendrickson, 1993). Her observations may relate to recent studies by Ranelli et al., who reported that females learning instrumental performance tended to be more at risk in developing musculoskeletal problems when actively participating in repetitive non-symmetrical postures such as in performing on a violin, cello or bass (Ranelli et al., 2011). Hendrickson stated that the practice of many tertiary teachers and individual instructors was to enforce the use of editions of repertoire purely on a basis of personal preference. Those with smaller hands could, therefore, lose valuable time in 'attempting to master inappropriate fingerings' that were written based on a larger physical size of hands and fingers (Hendrickson, 2003). She further pointed out that 'Learning is a process ... we need to make sure that these violin masters had taken the physiological functions of the body into consideration when they were writing fingerings and bowings' (Hendrickson, personal communication, May 14, 1993).

As no two students are the same physically or develop the input of sensory information equally, Hendrickson suggested teachers could prepare materials by observing their student's physical abilities in the lengths and shape of their fingers, hands, and arm movements. She recommended the collection of data on how students learn and record observations of sensory information through their interaction and feedback. For example, this could be done through asking a student to sing back notation, their observance of fingering, bowing indicators or where a note is placed on the stave. Former student and Australian concert violinist, Jane Peters, reflected that Hendrickson's design in varying and rotating the tasks of techniques, pieces, patterns and tone production in lessons was emphasised to avoid over practice, injury, fatigue, and strain from aimless repetition (Peters, personal communication to author, August 11, 2023).

In lectures, Hendrickson referred to Marteniuk's discussion of 'knowledge of performance' from proprioceptive and kinaesthetic feedback (Marteniuk, 1976). Proprioceptive feedback from movement involves the full range of sensory receptors including touch, stretch, pressure, joints, muscle spindles and the

inner ear [vestibular apparatus] (Marteniuk, 1976). Muscle spindles are stretch responsive receptors operating in a network of motor nerves controlled by the brain (Burke, 2014). In Hendrickson's case, these surviving receptors likely assisted her recovery from polio, as the spindle nerve ending of spindle fibres have reflex connections along the spinal cord to the cerebellum and brain. Neuroscientist David Burke reported that these muscle spindles are also responsible for programming motion and providing spatial information of limb locations (Burke, 2014).

Excess contact of the skin on the instrument from areas of the left-hand, such as in the bending of the wrist under the neck or the gripping of the palm of the hand around the sides of the neck, may alter hand and finger shapes. This could send an unnecessary overload of proprioceptive information to the learner as the brain may associate their attentions to biomechanically inefficient hand postures or other areas of palm or skin contact when acquiring individual notations. This has been noted by some students with difficulties in negotiating their left-hand contact with the fingerboard. Yankelevich included discussions of similar principles where he wrote that for some students, the habitual holding of the violin with the left hand, the clamping of the neck, and pressing down with the fingers firmly on the strings impeded their natural movements of the left arm, hand and fingers (Yankelevich, 1993).

Hendrickson also recommended that the shoulder rest or pad may need to be adjusted or replaced with an item that allowed the shoulder and the left-hand fingers more freedom in fine muscle work when playing in higher positions (Hendrickson, personal communication to author, 1983). She factored in that it is important to acquire information on an individual's physical capabilities or the difficulties that they may display in processing muscle contractions or relaxations. Students who have longer fingers or hypermobile joints [double jointedness] may have differently patterned associations of hand motions and positions of the hand. Hendrickson considered that variations in physical size of the shoulders, neck, arms, hand, fingers or fingertips should be considered when assessment is made regarding the best teaching program and instrument suitability for the individual student. These observations are supported by a recent study by Shan et al., who write that 'violin performance should be thought of as a process, not as a kinematic reconstruction of instructions on a printed page of music,' and advised that motor control is influenced by proportions of the anthropometry (Shan et al., 2018).

8. Auditory Connections and Pitch

Music educator Edwin Gordon studied short and long-term exposure to auditory stimulus and its impact on babies from birth. Gordon noted that if children did not have appropriate auditory exposure before the critical age of up to 18 months or in the sensitive period of up to five years, the effect on communication and recognition in the relationships of tonal sounds could be severely compromised (Gordon, 2011). The implication in teaching language or intonation to a violinist with no exposure to training in auditory sound patterns or an extended range of pitches may mean that there are no reliable recognised perceptual auditory mechanisms in memory to rely on in the teaching of violin technique. Hendrickson also questioned how such students acquired their auditory connections to patterns of sounds during their formative years. For such students, she argued that the perceptual mechanism may be dysfunctional from the start, 'because before you can develop the cognitive ability of the brain, you must have something there for it to act upon and data that is not misleading' (Hendrickson, 2013).

In the late 1980s, Hendrickson researched microtonal musical instruments made by Jonathan Glazier displayed at San Diego's Exploratorium, as she speculated that micro sounds between Western notational intervals could also assist students to connect with associated sound frequencies (Hendrickson, 1993). In lessons, she would on occasion improvise microtonally or play dissonant chords whilst a student would be practicing minor sixths ascending in chromatic motions on two strings (personal communication, May 20, 1990). Musician Gabi Lanyi noted that whilst individuals were educated to see the whole spectrum of colours from violet to red and identify them through repetition, they were not educated to identify their exposure to a variety of environmental frequencies in sound that could range from 'about sixteen to twenty thousand Hertz' (Beato, 2016).

Evidence from the Archive shows that Hendrickson may have attempted to fill in the gaps when recognising these auditory frequencies by exploring with her students some of the microtonal modulations of sounds needed to fine tune their pitch. Describing ambient environmental sounds as part of the pitch continuum, she stated it was 'possible to have a sense of a mental photograph of their frequencies that are related to pitches' (Hendrickson, 1999b). Hendrickson suggested that some forms of absolute pitch could be colour related or constellation-bound [in pattern clusters] or be identified by 'its frequency rate along a

horizontal spatially-visualised continuum without reference to any learnt musical notation' (Hendrickson, 1999b).

In controlling pitch, the violinist must constantly adapt to frequencies from variations in bowing frictions and pitch variations on stopped notes. Violinists also temper their pitch microtonally to play any note in tune with other instruments. The individual strings have tensions that vary with every sound actioned by left-hand fingering. The addition of right-arm bow pressure and bow weight on the strings to achieve dynamic variation must also be adjusted to the fundamental frequency through natural harmonics and overtones to assist the violinist to tune and control their pitch. Micro-alterations of pitch can occur due to variations in the overtone spectrum of sounds produced through adjustments in the friction of faster or weighted bow motions on the strings. To address some of these physical tension changes to pitch, Hendrickson introduced variations of left-hand finger patterns on one string that were slurred in one bow, and advised beginning with less weighted, controlled, even bow strokes. She advised that this could enable students' ears to hear and attend to the intonation precision of the left-hand (Hendrickson, personal communication July 10, 1983).

Further ideas were given in a worksheet for a string pedagogy class at The University of Adelaide, where Hendrickson wrote that within a 'single semitone it is possible to produce seven microtones' (Hendrickson, 2000). To establish the concept of microtonal motions involved in intonation perception, and to develop an auditory sensitivity to the slightest finger pad motion on the string, Hendrickson introduced a 'Kite Procedure.' This involved the fingertip tension being released enough to allow the chosen left-hand finger pad to slide smoothly along the string from first position to the edge of the fingerboard near the bridge (Hendrickson, 2000). The Kite Procedure had elements that could lead into mastering shifts and the early teaching of vibrato. In teaching vibrato, Hendrickson noted that the technique shared some identical movements associated with chromatic fingering where a semitone move involves the same finger. She stated that 'if focus is placed on the fingertip cushion there is a sensory perception of a fine oscillating or wavering movement in the action, producing an effect described by Henry Roth as impulse vibrato' (Hendrickson, 1999a, p. 4). She also noted that the 'degree of fingertip pressure involved in the vibrato movement indicates possible changing neuron frequencies, as the information relayed to the brain by the fingertip receptors accounts for the oscillations and their effect' (Hendrickson, 1999a). Hendrickson explained that, when she was first experimenting with a lubricant (e.g., mixture of lanolin and bees wax) applied to the fingertips and fingerboard to encourage oscillating movements of vibrato, it was 'only a step away from the wavering motion of the finger cushion in natural vibrato' (Hendrickson, 1999a). The application of the lubricant also provided an unstable surface upon which the fingertip could oscillate at various speeds and assist the learner to be aware of the release of fingertip tension that is required in the vibrato motion.

9. Dalcroze Eurhythmics

Hendrickson studied Dalcroze Eurhythmics with Heather Gell when she was a child in the mid-1920s (Hendrickson, personal communication, August 1989). Eurhythmics encouraged the engagement of the entire body in listening and moving in a physically balanced way, and to express musical sound through gestures and motions. These classes taught Hendrickson to discern between motor movements and physical gestures that may need excitement and those that needed calming (Cox et al., 1995). Translated into action, which parts of the body were needed to create tension or release it, and how did the transition of gestures and emotion progress from one expression to another?

The founder of Eurhythmics training in the early twentieth century Émile Henri Jaques-Dalcroze, stated that when children were not able to sing, beat or walk in time or have the ability to control the rapidity of their movements, there was 'insufficient coordination between the mental picture of a movement and its performance by the body' (Jaques-Dalcroze, 1920). This linking of emotion and sensory experience to gestures became an important part of Hendrickson's teaching resources when explaining instrumental techniques to the learner, as well as in understanding the links from cognitive processes to muscular motions. Violin repertoire has instruction for the coordination of different arm and hand motions, as well as notations, rhythms, expressions, and articulations. In working with very young children, Hendrickson encouraged students to first sing notations, fingering, and bowing indications with Dalcroze-like imitative actions. This was a conscious decision aimed to assist the learner to visualise motor actions and connect with memory the perceived intonation and phrasing of imaged notes.

The Dalcroze Eurhythmics concept of 'plastique animée' is tied to interpreting and realising the elements of sounds and spaces of a piece of music, and expressing them through body movements and gestures (Daly, 2021). In 1921, Dalcroze advocated that the nervous system of the human body could 'be trained and

regulated so as to give the brain complete liberty of control over muscular movements,' and to be able to 'spontaneously transpose into attitude and gestures, all the aesthetic emotions provoked by sound rhythms' (Jaques-Dalcroze, 1921, pp. 202-203). He also applied these principles to his teaching of gestures for dancing, theatre, acting, cinema, and music (Rogers, 1966). In the 1970s, Hendrickson used these *plastique animée* principles to assist students to express emotion in their performance. The idea of a story to give an emotional voice to a passage of music is tied to Hendrickson's ideas of empowering young children to feel sensory elements and freedoms of motion when playing the violin. For example, she would encourage students to find several expressive ways to vocalise or express a simple phrase of words before trying to imitate those expressions on their instrument (Hendrickson, personal communication, August 1989).

To further encourage the pupil's motivation in learning a piece of music and producing musical expression, Hendrickson would weave into the violinist's study of the repertoire her ideas of theatre, storytelling, pictures, stories, and illustrations. In 1978, she wrote a story for a student about a lion named 'Crescendo' who lived at the Adelaide Zoo. With the help of the other zoo residents, he learns to play Felix Mendelssohn's *Violin Concerto in E minor, Op. 64* (Hendrickson, 1978). The story of Crescendo was composed with the aim to inspire this student to capture expressions in their study of *Mendelssohn's Violin Concerto*. Hendrickson also used various modulations of her own voice when reading stories to raise the attention and response of young students (Duffield, 1996). Interestingly, in 2021, violinist Diane Daly stated that she gained further articulations and expressions of the Ysaye's Violin Sonata by similarly applying *plastique animée* principles to explore 'the piece in full body movement away from the instrument' (Daly, 2021).

Hendrickson advocated that orally stating or singing the intent of a phrase of music using muscle contractions and breath in a vocal performance may help to transfer sensory impressions that connect to violinists' physical motions. Educators in the past have advocated singing before learning other technical skills. As far back as 1702 French educator Abbé François Ragueneau noted that the Italian emphasis on singing first was desirable. He stated 'Italians learn music as we do to read; they have schools among 'em where the children are taught to sing as ours learn their ABC' (Morgan, 1950). The practice of singing before reading notation and performing on the violin was also applied by Johann Adam Hiller in his *Anweisung Zum Violinspielen, Für Schulen, Und Zum Selbstunterrichte* written in 1792 (Hiller, 1792). In 2010, Géza Szilvay explained that together with his brother Csaba Szilvay, their foundations to base their Colourstrings program relied on Zoltan Kodály's philosophy, that the 'voice was everyone's first instrument' (Bruz, 14 January 2011). In 2017, Oksana Solovieva also examined benefits of singing to transfer the sensations of phrasing, resonance, intent, breathing, bow distribution, and articulations in her thesis, *Teaching Violin to Higher Level Students: The Analogy and Benefits of Vocal Approach* (Solovieva, 2017). Hendrickson was aware that singing was strongly connected to the cognitive processes involved in the transfer of motor movements to learn the violin. She stated that singing was the fastest way for students to correct problems of left-hand intonation, and to connect their sounds to notations, articulations, phrasings and expressions. (Hendrickson, personal communication, August 1989).

10. Violin Teaching Materials for Childhood Development

Whilst recovering from polio in the 1950s, Hendrickson enrolled in an art design course and became a commercial artist ("Paralysed violinist now cartoonist," 1953). Using images or colour for advertising and the highlighting of important information was transferred by Hendrickson into her teaching materials designed for four- to five-year olds. Background, luminous colours such as yellow are often used for signs and with other coloured objects may assist in spatial processing and recognition of outlines (De Valois et al., 1991). Hendrickson experimented with colours based on Ralph William Pickford's study of Hans Jürgen Eysenck's research on children's preferences and stimuli in their use of colour (Pickford, 1972). She indicated that yellow colours on her materials competed less for attention compared to the frequencies of other colours, such as the blue and red, and she illustrated this on her hand-drawn representations of repertoire and drills (Hendrickson, personal communication to author, July 10, 2009).

At the University of Adelaide in the mid 1980s, Hendrickson lectured on the influence of Swiss psychologist Piaget's work on child development and theory of the various stages in cognitive learning (Waite-Stupiansky, 2017). She referred to Piaget's description of childhood schemas, in which children may construct new information built on their own experiences and knowledge from the environment (Cherry, 2022). Building on what students had previously experienced, Hendrickson introduced new ideas for students to assimilate information that could contribute to their structured gestures, expression, and rhythmic motions on the violin. She worked with stories, pictures, songs, and colours, and used sad or

happy songs, role play, and other visualisations to create understandings of notations, finger actions, motions in bowing or associate meanings to sounds created in playing the violin. Her use of emotion in materials relates to work by the neuroscientist, Antonio Damasio, that 'we came to life with a pre-organised mechanism to give us the experiences of pain and of pleasure,' and that these feelings arise from emotions experienced through perception (Damasio, 1994).

Hendrickson referred in her lectures to the research of another neuroscientist, Eric Kandel, where he discovered that 'cellular changes accompanying long-term sensitization in *Aplysia* were similar to changes underlying long-term memory in the mammalian brain' (Kandel et al., 2014). Hendrickson clearly understood that behaviour was modified by learning and experimented with her arrangement of teaching material to encourage her students to perceive sensations related to stories, pictures, and subjects they contained (Hendrickson, personal communication, August 20, 1990).

From the 1970s, Hendrickson noted the public decline of teaching songs to Australian infants (Griffen-Foley, 2020), so she collated repertoire from radio programs that she had known in her youth as well as tunes from the *Oxford Book of Nursery Rhymes* (Buck, 1933) to source pieces she could use in her pedagogy. She sang songs with her students and gave them recordings to ensure that they were exposed to a range of songs and repertoire (Hendrickson, personal communication August 20, 1983). Hendrickson drew pieces from commonly known nursery rhyme tunes recognized by parents and four-year-old children, such as *Twinkle Twinkle Little Star*, *Mary had a Little Lamb*, *Old MacDonald*, *Sing a song of sixpence*, *Oh where, oh where has my little dog gone*, and other traditional songs (personal communication, May 15, 1994).

Introducing enlarged coloured notations to symbolise the differentiation of strings is also used in the Colourstrings method (Szilvay, 1980). As may be the case with pioneering ideas and leaders in their field, it appears some similar ideas of pedagogy were developed around the same time. Although Hendrickson's work for teaching young children was presented at seminars and conferences, her work was unpublished. She was not aware that the Szilvays were developing similar work with colour, note enlargement and folk songs until their work was published and marketed in Australia in the mid 1980s. Géza Szilvay was also not aware of similarities with her work until he came to Australia for a four-day Colourstrings workshop in Perth in 2010, where Hendrickson's work supervising the thesis *The Influence of the Scale of C on Elementary Violin Instruction* was discussed (Géza Szilvay, personal communication to author, October 15, 2010). Hendrickson's colours for teaching young students the notation of strings differed in being black for G string, blue for D string, red for A string, and green for E string. She also added her own individual drawings, recycled pictures, and other visual stimuli to enhance the student's perception when encoding tasks for the engagement of motor skills.

For example, in Figure 3 the tune *Yankee Doodle* was written out on a two-metre roll of paper and Hendrickson demonstrates her understanding of Piaget's schemas by using elements familiar to a four-year-old child. Rather than relying on the symbolic language of musical notation, a flower replaces C sharp as the key signature. Cut-out, recycled pictures tell the story of *Yankee Doodle*, and stick men figures hold up flags with sharps in front of the note G on the second stave line. To avoid overloading the child learner with too many cognitive elements, the clef, key signature, and bar lines were omitted as redundant information for the student who was at an early stage of development. Such information was learnt later, in subsequent lessons.

In the first fifteen to twenty lessons with her students, Hendrickson's full set of nursery rhymes used in her pedagogy was closely related to the different finger patterns illustrated in the *Boosey and Hawkes Instrumental Course for Strings* by Joseph Skornika and Roland Moehlmann, published in 1952 (Skornika & Moehlmann, 1952). These examples show that Hendrickson was aware of, and drew from, contemporary pedagogies, transforming them to produce multi-sensory materials that were individually tailored for her students' age and learning needs.

Figure 3

Yankee Doodle, 1973. © 2022, reprint courtesy of the Hendrickson Archives.



10.1 Spatial Frequency Applied to Music Notation

Another consideration Hendrickson used to assist her young students in learning to read music was to use visual materials in her set-up of nursery rhymes with lower spatial frequencies, relying on enlarged notes and visual contrasts (Hendrickson, 1993). Spatial frequency is explained as the time, distance and amounts of measured light and dark wave propagations on an image (Gioux et al., 2019). As mentioned previously, the practice of enlarging note sizes was a pedagogical strategy Hendrickson shared with the Colourstrings Method of the Szilvay brothers, as they both presented elementary materials with larger notational sizes than in other known violin manuals for younger students at the time. Significantly lower spatial frequencies may be advantageous in determining image shapes and their locations. When reading music notation, young children must distinguish note positions and shapes between lines and spaces of the musical staff (Jordan et al., 2016). Peripheral vision has also been found to be less developed in children than in adults (David et al., 1986). The crowding of information, sometimes referred to as visual “clutter,” is also linked to visual-cortex processes for dealing with different spatial frequencies (Doron et al., 2020). To try and overcome these clutter difficulties, Hendrickson’s addition of colour contrasts on the page as well as the size of notation, were ways that assisted the very young learner to differentiate notation, patterns, and shapes.

11. Mirror Work, Muscle Memory and the Idea of Speed

Since the physical attributes of no two students are equal or identical, perceptions arising from sensing and observing physical motions may influence the performance of violin technique through eliciting knowledge associated with muscle memory (Johnstone, 2017). Hendrickson suggested that perceptions of sensory data, such as proprioceptive information, could be engaged by using a mirror to observe physical motions or by analysing the contraction or expansion of the muscles involved in performing measured, spatial tasks. Further discussions on boosting motor skill with mirrors, and comparison of effective feedback techniques are found in discussions by Florian Bähr et al., in *Boosting the Motor Outcome of the Untrained Hand by Action Observation: Mirror Visual Feedback, Video Therapy, or Both Combined – What Is More Effective?* (Bähr et al., 2018). In using mirrors for students, Hendrickson also referred to the balances involved in visual feedback, kinaesthetic cues and spatial awareness stating:

I practiced in front of a mirror looking over their shoulders [students] ... at the hand vision on the violin and all aspects of bowing by looking on the other side... By looking over their shoulders at their left-hand, this increases the amount of visual information ... I point out that reaching in the dark is also of great importance because there is less visual information about the target, the string finger is targeting (Hendrickson, c. 2011, pp. 9-10).

When students were performing motor actions in slow speeds on the violin, Hendrickson noted that left-hand placements did not always reflect the posture of hand positions needed for fast speeds or for motions in different areas of the fingerboard. She also noticed that her students gained a perception of fluency by observing more amenable hand positions whilst practising and implementing pacing techniques to master scales accurately through varied tempi, from slow to fast (Hendrickson, 1978). Hendrickson used the principles of positive or negative feedback of American psychologist Burrhus Frederic Skinner in teaching control of speed acquisition in scales and drills for certain violin techniques (Skinner, 1938). For learning scales, she isolated small, drilled sections to learn motions of fingering and shifting, such as exercises using only two fingers when ascending the strings, and a range of other finger patterns. When the student could play the scale slowly and perform the scale starting from different notes, she would ask them to fluctuate through controlled doubling of speeds in repeated sequences. Hendrickson had first been trained herself to double speeds in Ševčík’s exercises during her training with Schwab in the 1930s. These ideas of doubling speeds are also discussed by Anton Mingotti in *How to Practice Ševčík’s Masterworks* (Mingotti, 1957). To further the idea of speed whilst the student was repeating the scale motion, Hendrickson would use a castanet to beat to regulate the tempo. In repeats, she offered feedback to encourage the students to speed up their reaction time in correcting any errors or faults (Hendrickson, 1978).

12. Visualisation Cards to Enhance Auditory and Memory Processing

Hendrickson also devised experimental visualization cards for students as a challenge to develop their abilities to associate seeing and hearing music. After a period of training, she sometimes asked students to sing and read a passage of notation on a memory card before bedtime without playing it on their instrument. Hendrickson was experimenting with the idea that students could be unconsciously rehearsing, and memorising information received from memory cards whilst resting (personal communication, July 5, 1983).

In the following lesson, the student would be asked to sing the notation and rhythm or play it on their instrument without having practiced it at home.

Researchers in cognitive neuroscience, Simon Ruch and Katharina Henke from the University of Bern, Switzerland, suggest that some information 'acquired during wakefulness is subsequently strengthened in neural replay during sleep' (Ruch & Henke, 2020). In the study *Reactivating memories during sleep: Memory rehearsal during sleep can make a difference in remembering later*, researchers Delphine Oudiette and Ken Paller from the department of psychology at the Northwestern University examined experiments to test how subjects remembered information rehearsed during sleep. Paller also assessed that 'critical memory reactivation transpires during sleep' (Northwestern-University, 2013). It is unknown which texts Hendrickson may have read regarding learning consolidation that occurs in sleep memory, but clearly, she experimented with its principles in giving memory cards to her pupils to rehearse mentally just before going to sleep.

13. Limiting Principles, Reaction Time, and Bowing

Hendrickson held the view that practising is not learning if the student repeatedly goes over the task to master a concept without analysing each component of the motions: where to place the arm, hand, fingers, and how to lift or place the bow, etc. Tasks involve understanding the workings of each element associated with performing *detaché*, *staccato*, *spiccato* or *sautillé* to be able to present the appropriate material to engage perceptual mechanisms. The discussion of perception, decision, and effector mechanisms are also related to reaction time, defined as the time between a given stimulus and response (*Cognitive Ability - Neuropsychology, What is reaction time or response time?*, 2023).

Hendrickson questioned how sensory motivation and perceptually relevant teaching materials impact the student's attention and reaction time, noting that techniques such as adding an intensity of attentional colour or image to chosen materials for a young learner may activate faster motor responses to tasks (personal communication, May 2014). This correlates with Hendrickson's idea that if learning items are in an array that is easier to discriminate and classify, a faster response time may be achieved. She inferred that teaching materials prepare the student to improve or automatise their reaction times so that they become as close as possible to instantaneous. Her focus on engaging the perceptual elements in the elementary stages of learning was purposefully aimed to accelerate reaction times when performing more advanced violin skills such as *sautillé*, *spiccato* or *staccato* or left-hand configurations required in a sequence of double-stopped chords. Violinist and colleague Josef Aronoff recalled that, when teaching a skill such as *spiccato*, Hendrickson strove to create an image in the brain of recalled motions. He stated that when the balance and association of the movement was recorded by brain, 'you feel and have the impression of that and don't have to waste time re-learning the movement all over again' (Aronoff, 1978). Hendrickson encouraged students to experiment with all types of bow strokes, both on and off the strings, so that they would engage with the idea that there is a spring in the bow-hair tension that creates its own bounce. She stated that even in lessons with beginners, her objective was to discourage 'a single concept of bow weight being formed' (Hendrickson, July 9th-13th, 2009).

Hendrickson also stated that learning 'is faster and less likely to lead to errors when the first attempts to learn a fine muscle movement are made only with the gross outline of the total movement preceding it' (Hendrickson, 1999a). She wrote that there is a tendency for beginners to 'stiffen the forearm muscle when initially learning to draw the bow down. The muscle tension quickly becomes associated with the downstroke (personal communication, April 1989). To avoid this instinctive muscle response, Hendrickson advised introducing the first bowing stroke by lifting the bow first from an overhead position and allowing the bow to drop down to the strings without any forearm tension to draw the bow. Similarly, Rolland encouraged students to use rebound bows of circular motions from a lifted position to learn the natural weight of the arm into the string via bow placement, bow speed, and bow pressure (Rolland & Mutschler, 1974). Hendrickson noted that controlling the overhead position of the bow also strengthens muscles involved in precise bowing skills. Hendrickson explained that it was important to focus on specific body movements before isolating the smaller precise motions. The observance of co-dependence and interaction of gross and fine muscles involved in motor skills has also been reported by Shan et al., who wrote that postures and gross motor control functions provide a 'stabilising foundation' for smaller muscle functions (Shan et al., 2018, pp. 1803-1807). They report that precise 'control is needed in violin performance because the precision of fine motor control governing bowing and fingering is contingent on the predictability of arm and body movement' (Shan et al., 2018, pp. 1805-1806).

Depending on the student, from about the sixth lesson, Hendrickson introduced a double-stopped melody that incorporated perfect fifths, octaves, and major sixths for young learners. She then introduced examples of rhythms, timings and bowing variations to create right-hand and arm motions that students had to negotiate with their sensations of balance, direction, position, angle, weight and bow speed. The perfect fifths trained the learner to hear sounds to tune the violin as well as to recognize the interval. Hendrickson had borrowed this bowing idea from Ševčík, who also introduced short eight- or sixteen-bar melodies upon which he based variations with 'every possible aspect of bowing' (Hendrickson, 2003). Introducing these elements such as two-string and three-string chorded drills in the elementary stage of learning was also to encourage students to recall and recognise muscle motions and proprioceptive sensations when encountering these elements in their repertoire. After observing and attending Hendrickson's talks at the AUSTA National Conference in 1987, former AUSTA National President and violin pedagogue from Melbourne, John Quaine, stated that he included similar themes and bowing variation drill ideas in some exercises of the *Series 9, Violin Technical Workbook* for the Australian Music Examinations Board (Quaine, personal communication, May 30, 2023).

14. Redundancy and Attention

Marteniuk wrote that 'information whether it resides in the environment or arises from the proprioceptive system, must be transformed into a code that can be used by the performer's central nervous system' (Marteniuk, 1976, p. 14). These codes can be recorded in patterns, words, pictures, sounds, and other information from multi-sensory sources. The optimal organisation of perceptual information assists the learner in gathering a memory store of cues and sensory information to anticipate, recognize and categorise a series of appropriate motor actions. Proprioceptive information can be obtained on string instruments through contraction or expansion of muscles connected through pattern work of finger motions. The motions involved in performing pieces are linked to a range of multi-dimensional patterns and shapes perceived via visual, auditory or proprioceptive senses.

Hendrickson advocated that memorising and storing forms of this information, depended on careful planning in drills. She noted individual differences in sensory perceptions and warned of information overloading in teaching materials because of its impact on divided attentions. In university lectures, Hendrickson referred to Christopher Wickens's term, 'information loading' in *Engineering Psychology and Human Performance* (Wickens, 1992, pp. 3, 47, 89). Wickens described that stress or visual clutter could impede the learning of information and that redundancy (i.e. lessening the amount of additional or superfluous information to assist focus) in forms of presentation was necessary to avoid information loss (Wickens, 1992).

Hendrickson applied this principle of redundancy to simplify information for four-year-old students. For example, when violin learners are exposed to an elementary Kayser study or a new piece of repertoire, there may be several types of information processing need to be processed together. She underlined and drew attention to Wickens's explanation, that in some situations, the information provided for a learner can divide their attention so that it is 'impossible to narrow the focus of attention when needed and shut out unwanted inputs' (Wickens, 1992). In noticing the focus of attention, Hendrickson communicated that when a right-handed learner becomes fixated with the movements of left-hand actions, focus on the right hand usually decreases and that there may be a need to monitor the balancing/feedback of energies in attention (personal communication, May 2009). In right-hand movements, some learners mirror image the motor skill from the left hand and communicate short movements to match the left-hand finger motions. The results may show that the learner is lacking spatial awareness in bowing movements. In violin lessons, some attentions for the student can be divided between visual reading of notation, posture concerns, right-arm bowing motions, left-hand fingering choices, calculating intervals, and measuring distances and volumes of space between arm and finger motions. Hendrickson's approach illustrates that she set out to pre-empt how student attention may be directed when interacting with her teaching materials, and demonstrates a sophisticated understanding of this process. She stated that it was important for teachers to prepare and control students' attention in the study materials they created, so they would optimally engage their perceptual mechanisms (personal communication, August 20, 1990).

15. Muscle Memory and Identical Elements

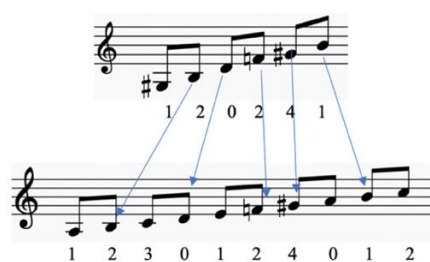
In her approach to setting up drills, Hendrickson used her understanding of how one element of a function could be used to assist in another function, as described in their well-known theory of learning by Edward Thorndike and Robert Woodworth (Woodworth & Thorndike, 1901). Their research discusses the detection

of similar or identical elements that could be transferred from one situation to another situation. Hendrickson also researched how positive and negative transfers impacted her teaching of violin technique. Negative transfer is when the state of a task cannot transfer any of its elements to another task or when the original task is obstructive or inferior in the succeeding task (Frensch & Haider, 2008). Positive transfer is when a skill in a task has an element that can be applied to assist in performing another task. Hendrickson stated that the ability to use previous learning and transfer it to another situation 'depends on the learner being able to generalise from experience and extract common features from similar situations' (Hendrickson, July 9th-13th, 2009). For example, she noted that there was negative transfer from the stopped finger on the string to the function of *glissando* (sliding on the string), whereas elements in *glissando* had positive transfer elements that could be applied to position changing in the left hand.

Hendrickson further stated that a violinist who has previously experienced a learning stimulus is more apt to recognize that same stimulus on a future occasion, and may become aware of the relationships of similar patterns and associations involved with hand and finger placements (Hendrickson, 1987). For example, the idea of finger substitution developed by Hendrickson, also illustrated in Francesco Geminiani's treatise, involves a light finger slide so that different fingers are able to play the same note (Geminiani, 1751). Double stopping is usually considered an advanced element of violin techniques for the violinist's left hand. However, Hendrickson established that, if the elements of finger substitution were identified and introduced in the first lessons, it would be advantageous for the learner to later identify these motions in other techniques. For example, finger substitution can positively transfer elements for notations that require fingers to do identical motions across two strings, such as double-stopped finger work to perform thirds. Thirds, sixths or other chords on the violin involve two fingers on adjacent strings that have to be accurately judged in motions to match intonation. This can involve the learner being aware of micro-slide motions for one or two of the fingers to correct just intonation when playing chords or with other instruments.

In devising materials for children, Hendrickson used analogies, such as trilling on the half position note of G sharp on the G string to create a 'buzzing bee' sound. She highlighted the G sharp in an orange to yellow colour to indicate to the student that there was a change to the note of G and to draw attention to the sharp placed before the note. Through the analogy, imagery, and sound of the trill noise, that she described as 'bee notes' in half position, she thereby assisted the student to feel the transfers from changing the hand position to and from half position (Hendrickson, 1986). In Figure 4, Hendrickson illustrates the intervals of the diminished seventh arpeggiated chord on G sharp and draws attention to the transfer of identical notes that are structured within the A harmonic minor scale.

Figure 4
(AUSTA) workshop display, 1989. © 2022 Hendrickson Archives.



16. Learning Difficulties in the Twenty-first Century

In 2016, Royal Northern College of Music senior lecturer in education, Philippa Bunting, stated that it was not easy to work with talented children, and that it is more of a responsibility for the teacher to ensure that these students know that they are valued with or without a violin in their hands. Bunting recognised that some talented children are divergent thinkers with their own special needs when she wrote, 'This rare tribe doesn't develop in nice straight lines – instead, students tend to leap disconcertingly from crag to crag like intrepid, and somewhat unpredictable, mountain goats. They also question just about everything.' Bunting further wrote that 'being different is no light burden for a child' (Bunting, 2016). Her statements are reminiscent of Hendrickson's own descriptions of talented, divergent learners who like herself, 'were prone to make rapid changes in orientation' when problem solving and could 'jump from one subject to another and see connections that were not clear to others' (Hendrickson, 1997).

Whilst studies by Marion-St-Onge et al. detail the superior performance working abilities of children identified as 'child prodigies' or talented children (Marion-St-Onge et al., 2020), attention is also drawn to

the fact that there are students who struggle in the processing of information to learn violin performance skills. In the last few years there has been extensive research in how music teachers can assist these 'different children' by the use of multi-sensory techniques in music therapy and social integrative pedagogy. Various techniques from Orff-Schulwerk pedagogies, (Schumacher, 2013), the Kodály Method (Tiszai, 2015), and Dalcroze Eurhythmics techniques (Habron, 2016) have been used to assist students with learning difficulties to experience music through transdisciplinary techniques. Many pedagogues, including Hendrickson, have drawn on such techniques to extend their teachings of rhythm, singing, movement and to integrate forms of multi-sensory techniques. Similar to the discussion above on Hendrickson's use of transfer theory in her pedagogy, Lara Mitofsky Neuss suggests that elements of the Orton-Gillingham approach through visual, auditory and kinaesthetic pathways of learning could be a suitable structure for teaching multi-sensory forms of music to dyslexic students (Neuss, 2021). The Orton-Gillingham Method was devised in the 1930s to break down elements of grammar into smaller parts, verbalising sounds, tracing letters, and by using phonology (how words are pronounced), grapheme (symbol sound), morphology (how words formed), syllabification (breakdown of syllables), encoding (transform information into a form) and decoding (analyse and convert signals or letters to a usable form) (Neuss, 2021). As seen in Hendrickson's application of a multi-sensory approach in teaching violin, Neuss notes that there are extra demands on the learner in reading music to 'handle multiple elements at once' (Neuss, 2021, p. 9) and suggests techniques to simplify materials as she had noted with the use of colour, enlarged notes, singing, humming, whistling, using body movements, and creating art works for students to express their emotion (Neuss, 2021). She discusses that elements of Dalcroze Eurhythmics, Kodály and Suzuki methods may be of benefit to dyslexic students (Neuss, 2021). Currently, due to an absence of prior research the detail of Hendrickson's work is relatively unknown outside of Australia, so it is likely that researchers such as Neuss and others may be unfamiliar with her multi-sensory teaching approaches and their effectiveness.

Jane Peters, a former Hendrickson pupil and currently professor of violin at the Conservatoire of Rouen in Normandy, stated that the weekly handwritten drill sheets Hendrickson created for her began with the sequence of short-finger patterns that were transferred in motions ascending the strings. These assisted her in forming concepts of 'spatial pitch locations along the string, rather than having to identify each of the positions as such.' The drills addressed the technical needs of both hands and arms and were linked to the study of her repertoire. She added, 'these drills saved hours of work – how lucky I was' (Jane Peters, personal communication, August 11, 2023). Hendrickson's former student, violin teacher and conductor of the Streichhölzer Ensemble at Musikschule in Luzern, Switzerland. Elisabetta Luis-Parrella related that the inspirations in stories, integrations of sensory elements, and exercises from Hendrickson's creative materials were greatly valued in her violin lessons as a four-year-old and she benefitted in access to time-efficient methods to learn violin performance skills. About Lyndall Hendrickson she stated that 'I still vividly remember her stories, and how she interacted with them to accomplish various violin techniques and achieve playing in high positions on the violin at a very young age. She was a very creative and passionate teacher' (Elisabetta Luis-Parrella, personal communication, August 17, 2023).

17. Conclusion

The evidence from the Hendrickson archive presented here shows her remarkable ability to diversify and synthesise a broad range of pedagogical techniques. She engaged with theories from scientific and educational research, tailoring exercises to individual students' physical and sensory needs, and drawing on rehabilitation learning experiences into a highly focused student-centred approach to violin teaching. This approach proved to be highly effective for her students. Her combinations of multi-sensory materials directly impacted the effectiveness of their working memory, as well as their long-term memory in the learning of patterns and skills. From the 1960s, Hendrickson had been developing materials to connect with her knowledge and understanding of cognitive learning processes. She had taken further into consideration that students individually have varied thinking patterns, and acquire different levels of perception and sensory inputs from their growth, training or environmental exposure. Hendrickson was clearly working at a level that put her decades ahead of her time, and recent research has helped to explain the effectiveness of her teaching approaches. Her multi-sensory approach to the integration of materials could be a model that can benefit both talented string players and those with disabilities, such as perceptual limitations or problems in the identification of components, categorisations of patterns or associations. Music is a complex form of pattern study, and the transfer of multi-sensory skills, and the balance of verbal or non-verbal information in music teaching, is a focus of my current research. Whilst Hendrickson's methods of teaching

may not suit every teaching studio, future studies applying her approach with students in modern times are needed to test the effectiveness of her approach.

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