Musical Pathways in the Brain:

A Cognitive Look at Music Literacy for Pianists

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Author Note

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Introduction: A Path in the Forest

A glance into the forest can be intimidating, much like a peek into a book of Beethoven sonatas. Navigating through each will result in the building of a pathway—one through the trees, and the other through the brain. Step by step, this path is packed down with the frequency of travel. Becoming musically literate is a journey from symbol to sound and the ease you begin to experience while traversing the trail means that instead of needing to focus on the roots and rocks that might trip you up, you can turn your attention to the beauty of your surroundings. Music literacy, as an automated visuospatial experience, requires the development of actual pathways in the brain through a systematic process of incremental learning paired with repetition, using intentional patterns, creative play, and reading repertoire.

Music and the Brain

Dimensions of Music

Music is a language, a unique language, that not only reaches every corner of our globe, but every corner of the brain. Research has shown that "musical operations involve disparate regions of the brain, including all lobes of the brain, and both cortical and subcortical structures" (Levitin, 2009, p. 226). A musician can concurrently "activate the cognitive, visual, auditory, affective, and motor systems" (Curtis, 2014, p. 54). According to Levitin (2009), music throughout the world always has eight foundational dimensions: "pitch, rhythm, timbre, tempo, meter, contour, loudness, and spatial location" (p. 213). These "can be varied independently… [and] are subserved by distinct and separable neural processing units" (pp. 213, 226).

A Network of Neurons

Dendrites. Pathway building begins with dendrites, tree-like structures protruding from the neuron, or nerve cell. They are the little receivers that take in data from a new experience. In fact, Curtis (2014) explains that new dendrites actually sprout in order to handle the new input (p. 53). The brain must actually "chang[e] to accommodate new learning" (Sideroff, 2014, p. 5). These dendrites receive the information as a chemical, but draw it into the cell body as an electrical charge, sending it on its way to the axon.

Axons. Only one axon extends from the main body of the cell. However, it also has little branches that can meet the dendrites of the next nerve cell. To bridge the gap between itself and the adjacent dendrite, the axon returns the electricity to a chemical, known as a neurotransmitter. This tentative path can now be strengthened or weakened.

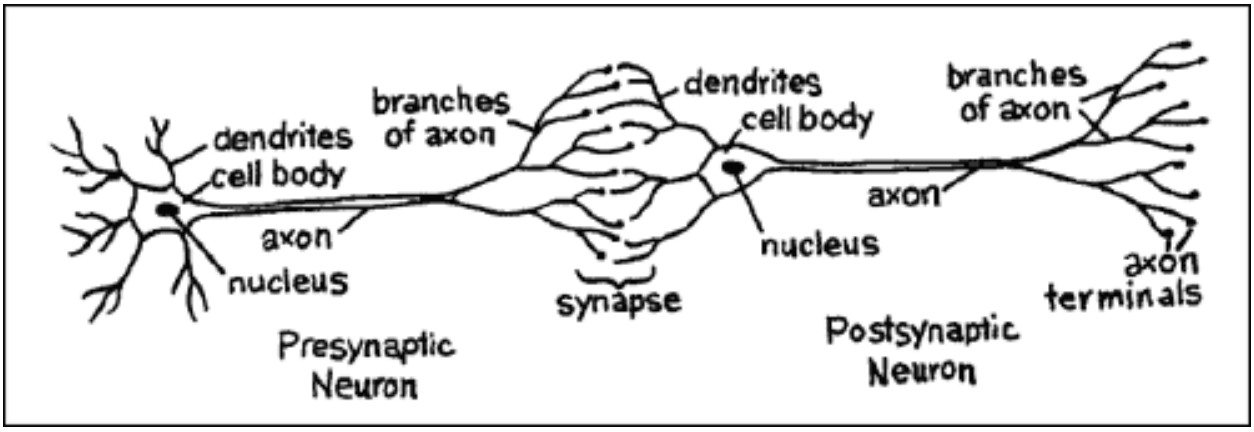


Illustration from the National Institute of Health & National Institute on Drug Abuse [NIH & NIDA], 2010

Myelination—The Case for Repetition

As this pathway in the brain is built through the systematic expansion of new concepts, it is strengthened by repetition. This repetition initiates a process called myelination that Curtis (2014) identifies as "critical to the learning process" (p. 53). He explains that "if information is

experienced repeatedly, the brain becomes more efficient in this communication by building a fatty coating [called myelin] on the brain cell's axons" (p. 53). Levitin (2009) states that "a number of studies show regional changes in brain volume and in gray-to-white matter density as a function of musical practice" (p. 225). The brain not only changes, it grows!

The What/Where Pathways: A Distinction Between the Visual and Spatial

The Ventral Path is the 'What'

Rhythm. Just as the beginning of human life is recognized by its heartbeat, so music is established at its core by a rhythmic pulse. Since the neural pathways that are required for music literacy are established incrementally, music must first be stripped down to this most basic unit. During childhood piano lessons, my mother often said, "Rhythm is more important than the notes." This foundational concept can be tested with a little experiment. Hum *Happy Birthday* on perfect pitch, but make sure that the rhythm is significantly different from the original. Then, repeat the song with perfect rhythm, but sing very painfully off key. Each time, ask your test subject to identify the song. There is almost always correct identification on only the second run-through. This is a candid indicator that the first step into music literacy is an understanding of rhythm. Hodges (1992) sets forth "rhythmic sight reading [as] a strong predictor variable" for good music reading (p. 6).

Hold a note in your hand—the Rhythm Bag. Since these musical "pathways [must be] established through interaction with the information" (Jacobi, 2012, p. 12), why not actually hold a note in your hand? Take a length of pipe cleaner, rolling up half of it into a flat circle, while leaving the other half straight. This note, with its rhythmic value, is the 'What' of music and is processed through what is known as the ventral pathway of the brain. Make many notes with

different values, write time signatures on cards, and toss it all into a bag with popsicle sticks for bar lines. Use this rhythm bag to create and experience rhythm. This strategy, taken from the highly interactive curriculum of *Music for Young Children* (https://www.myc.com), corresponds with what Hodges (1992) has noted, that "experiencing music reading activities prior to formal explanation produce[s] higher music reading scores" (p. 4).

The Dorsal Path is the 'Where'

Pitch. When five lines are drawn, with a clef imposed upon them, these rhythmic notes can be placed on the lines and in the spaces between to give them pitch. This is now the 'Where' of music and is built along the dorsal path in the brain. It is the combination of the 'What' and the 'Where' that gives each note its identity, creating a musical alphabet. Emond and Comeau (2013) present an interesting comparative study on the effectiveness of the Intervallic and Middle-C methods for cementing this alphabet into the long-term memory. Using the Intervallic method to teach music literacy is much like teaching a kindergartener to read by presenting sight words to memorize. However, this only teaches a relative, rather than a concrete, 'Where.' The strength of the Middle-C approach is that it brings into focus the actual identity of each note, similarly to a study of phonics. New notes are introduced in a systematic way, with similar actions expected from each hand. The intervallic and pattern recognition that contributes to an automation of music reading develops later. To build the best pathways in the brain, a thorough understanding of the 'What' and the 'Where' is necessary.

Spatial location—translating the 'what' to the 'where'. The 'What' and the 'Where' exist both on the page and on the keyboard, making necessary "a visuospatial sensorimotor translation between the notes on the stave and appropriate keypresses" (Stewart et al., 2003, p.

82). Stewart et al. (2003) "suggest[s] the existence of crosstalk between ventral and dorsal stream structures" (p. 81), so that with repetition and experience, as the "music reading skills [of the beginner move to an advanced level, there] exists a smooth coordination of visual encoding and motor skills . . . [T]his combination requires a transition from multitasking to cognitive processes concurrency" (Emond & Comeau, 2013, p. 33). For an expert pianist, "the notes played are not accompanied one at one by conscious expression . . . [but] tend to remain implicit" (D'Anselmo, Giuliani, Marzoli, Tommasi, & Brancucci, 2015, p. 120). This "cognitive concurrency" means that the decoding and execution of a musical score has become a natural, automated process, and this is the goal—this is what it means to be truly musically literate.

Your Brain Needs Time

Reading Musical Notation

Chunks. Achieving music literacy does take time. Your brain needs time. Pathways are not tromped down overnight. Significant to this process is how the eyes actually read musical notation:

> Evidence suggests that an individual's level of musical experience significantly influences eye movements. Experienced music readers read ahead of the point of performance in units or chunks. This "previewing" allows the eye to fixate on structurally important features, such as chords or melodic fragments, and to skip over less important details which may be filled in. (Hodges, 1992, p. 1)

Emond and Comeau (2013) concur with these findings: "As notes are being read on the staff, motor movements are planned and executed, while the reading process is progressing beyond what is currently played" (p. 33).

Focus. Additionally, "it has also been found that better keyboard readers economize on eye movements, keeping their eyes focused on the music, while poorer readers engage in many needless shifts from the music to the hands" (Hodges, 1992, p. 1). Some teachers will cover the hands of their students to prevent this, but it begs the question: *Are these "needless shifts" perhaps needful to the beginner as the brain sorts out the 'What'/'Where' transposition from the page to the keyboard?* Over time, these eye shifts disappear on their own.

Asymmetry. There are "hemispheric asymmetries in music sight reading . . . due to the fact that the two hands play substantially two different tasks (reading two different clefs)" (D'Anselmo et al., 2015, pp. 120 & 123). This means that each hand can have a different response time. Piano students have a tendency to play each hand separately, as the decoding process unfolds, but the brain must learn to "analyz[e] the visual stimulus (notes in the upper and lower staff) as a whole before the starting of the motor output" (D'Anselmo et al., 2015, p. 124).

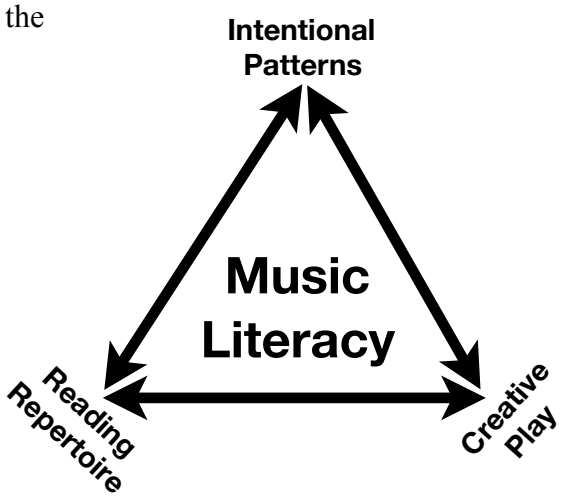
Utilizing Time

Frequency of time—consolidation processes. Following a training or practice session, the brain needs time for "stabilization and consolidation processes, [as it sorts through new information and skill development]. It has been shown . . . that significant training-dependent gain in performance following a training experience can appear 24 hours post-training" (Adi-Japha, Berke, Shaya, and Julius, 2019, p. 1). This "performance enhancement" (Adi-Japha et al., 2019, p. 8) means that the previous session accomplished its purpose and the learner is ready for the next session. The practical application of this, for the development of music literacy, is the establishment of a routine—a consistent corner of the day that is carved out and reserved for piano practice. Time is necessary for the implementation of routine and repetition.

Quality of time—moving from a plateau. However, "time alone is not enough" (Collins, 2014, p. 12). There comes a point at which it seems that no matter how much the student continues to practice, no improvement is made. This is a plateau. According to Lindstedt and Gray (2017), "a plateau exists when there is a better method for implementing the current goal" (p. 1844). When the current method has lost its edge and no longer challenges and inspires, absent-minded practice is sure to follow. "In 1993 . . . Ericsson and his colleagues [coined the term] deliberate practice" (as cited in Collins, 2014, p. 12). Quality practice time that produces improvement must be intentional, with methods and techniques that incrementally build upon each other, stimulating learning.

Creating Memory Pathways with the Music Literacy Triangle

For the budding pianist to become musically literate, time spent at the piano must be based on a plan, and needs to have "deliberate" direction. "Even [though] more recent brain research reveals that learning is more effective when teachers use many different types of approaches and techniques because more memory pathways are built" (Jacobi, 2012, p. 16), it needs to be wrapped into one package. Hodges (1992) states that "an important step… would be a comprehensive theory of music reading" (p. 6). Based on cognitive processes, I propose utilizing a 'triangle' approach to build and reinforce the memory pathways necessary for music literacy. This Music Literacy Triangle has three vital components, of which each gives and takes from the other two: intentional patterns, creative play, and reading repertoire.



Intentional Patterns

From patterns to repertoire. Patterns are paramount! It is the systematic arrangement of patterns that makes the piece. Therefore, it makes sense when Emond and Comeau (2013) present "the importance of pattern recognition in various tasks related to music reading" (p. 27). Since the different elements of music are learned and processed with separate neural networks, the fingers can learn a pattern first, without note-reading, for the sake of the pattern itself (e.g. 5-note vocalize patterns, Hanon, and technique—such as scales, chords, and arpeggios). Then, when the student encounters these patterns within the repertoire, the fluidity of movement that has been practiced, along with the strength that has developed, will become integrated with the progress of the note reading study.

From patterns to play. Intentional patterns form the structural foundation for creativity. Take technique to the next level and turn the patterns into play. Experiment with creative combinations. By stringing the patterns together and trying endless variations of them, the student can depict the different colours of mood and movement in nature. Be sure to establish a pulse! Since it is common for students to get stuck with a certain pattern or style, encourage exploration of texture, rhythm, and register by using only the black keys. Experimentation and creativity can flow more easily, for everything played will sound wonderful without needing to focus on the choice of notes.

Creative Play

From play to patterns. Hodges (1992) found that "creative activities, such as composing, . . . led to improvements in music reading scores" (p. 4). Creative play gives purpose to the patterns. Using the patterns as building blocks, a musical masterpiece can be

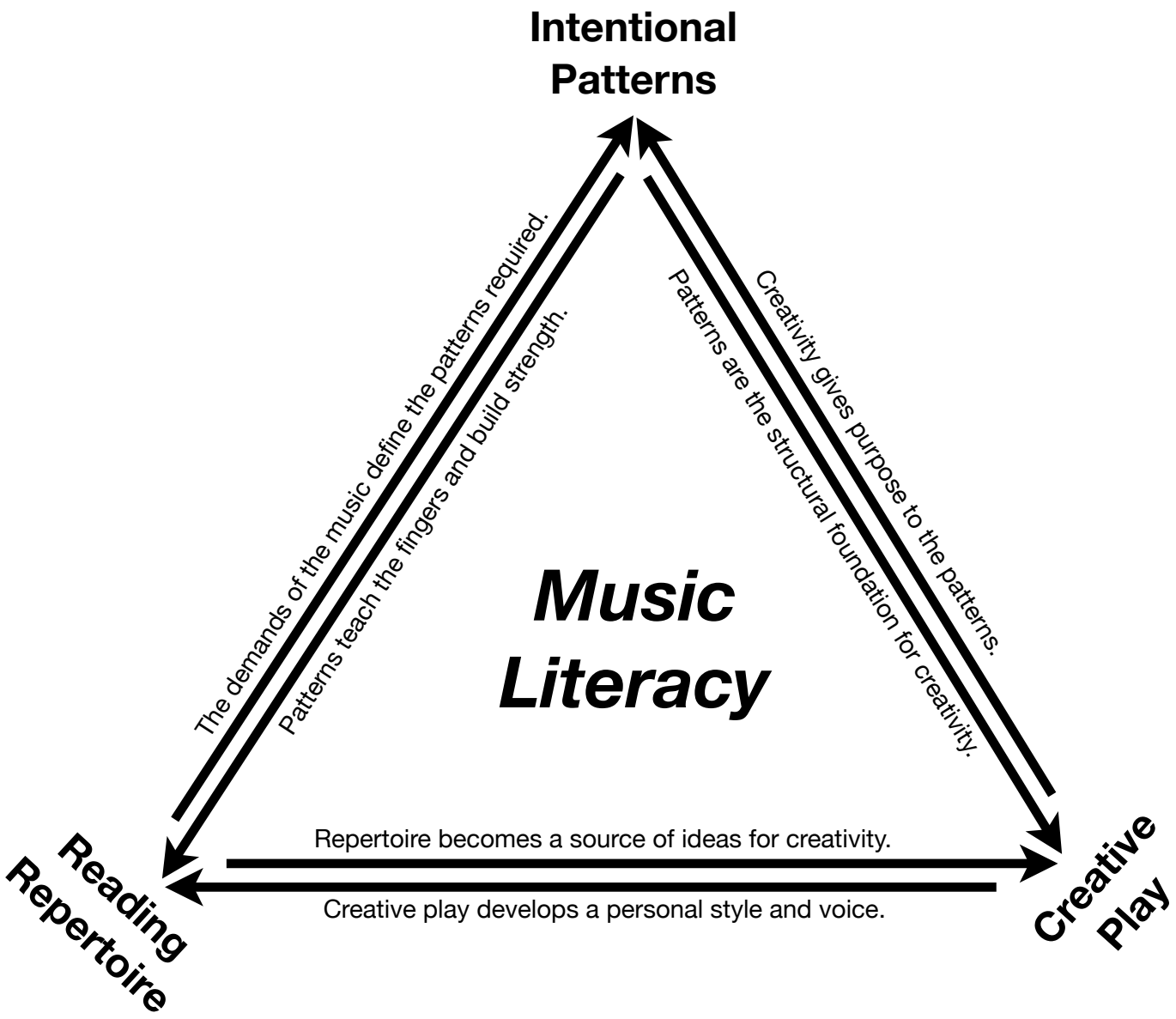
made. A compelling curriculum that develops creative composition with the use of patterns is the "Music By Me," series by Kevin Olson and Wynne-Anne Rossi. The student needs to wield a pencil! Writing music on the staff, even the simple music of a beginner, creates a strong foundation for music literacy.

From play to repertoire. Creative play can infuse music reading with a personal style. It aids in the development of a personal voice in both high art piano performance and in contemporary ad lib that is read from a simple note framework. When the student reads the notes on the page and learns to play them, there ought to be a synthesis of the authentic intentions of the composer with the personal interpretation of the performer. This is the emergence of musicianship.

Reading Repertoire

From repertoire to patterns. It is the repertoire that defines and demands which patterns should be focused on. Take cues from the repertoire itself for what elements and keys to incorporate into practice time. Cement the pattern pathways by always using consistent fingering—then use this fingering when the repertoire contains the pattern. The fingering becomes the automated link between the piece and the pattern.

From repertoire to play. Creative ideas emerge both from one's self, and from the study of others. For a seemingly endless supply of creative ideas, open that anthology of Beethoven sonatas and study the different contours of his many varied moods. Even a late beginner can open this book to find little seed ideas for creativity. Improvise using the musical shapes you can see within your own ability. Take delight in using the motivic ideas from your own repertoire to create a totally different piece.



Reading repertoire may seem like the only goal, but it cannot stand alone. The research of Emond and Comeau (2013), along with Hodges (1992), as stated earlier, shows that "pattern recognition" and "creative activities" form an integral part in developing the skills necessary to really read music. It is the three components of the Music Literacy Triangle—intentional patterns, creative play, and reading repertoire—that together provide the framework for creating and strengthening effective memory pathways for music literacy.

Conclusion

Just as the English student progresses from phonics to literature, the pianist makes gains in musical fluency from the Middle-C method to Beethoven. Step by step, with dendrite added to dendrite, musical pathways in the brain are formed and reinforced. The eyes learn to recognize and translate the musical score, while the motor execution becomes an automated response. Incorporating each vertex of the Music Literacy Triangle into a predictable piano practice schedule, will be significant in promoting systematic and deliberate advancement along the journey toward music literacy.

Recognizing this fact, that pathways are actually built in the brain during the learning process, can be incentive to the piano student to practice carefully and deliberately, for every action will have a direct positive or negative effect on the success of the next step. Knowing that these pathways go through stabilization and consolidation processes, gives confirmation that consistency and repetition are essential. Understanding that distinct neural processes are necessary for music literacy, aids in forming a comprehensive strategy. Realizing that being on a plateau is not the end of the road, but just an indication you are ready for the next challenge, can alleviate discouragement.

Music literacy is a journey from symbol to sound. The brain is absolutely incredible as it processes this visuospatial experience into an automated skill. Your brain is capable of infinite possibilities!

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