**Presentation: Can music therapy support the vulnerable brain?: Explorations of possible music therapy approaches for supporting neurocognitive development and strengths In children undergoing cancer treatment**

Abstract:

Music engages nearly every brain area (Levitin, 2013), making it a unique and compelling resource in therapeutic treatment. Music therapy may be a powerful intervention for children receiving brain-injurious cancer treatment interventions. Music therapy interventions may remediate reported neurocognitive late effects, and thus, support cognitive resilience. It is the presenter's intention to provide a neuroscience-informed exploration of neurocognitive late effects in children undergoing cancer treatment, demonstrate music therapy's relevance for this population, and to suggest music therapy interventions that draw from existent MT approaches with TBI and ADD, as well as methods of non-MT cognitive remediation, in hopes of providing ways of care for the vulnerable developing brain in children undergoing cancer treatment.

Summary:

Childhood cancers occur in about 1 in 285 children before 20 years of age (Ward, 2014), and are the leading cause of death in children under 15 (National Cancer Institute, n.d.). However, medical advances have increased the 5-year survivorship to 80% over the last half century (National Cancer Institute, n.d.). Leukemia and central nervous system tumors are the most common types of childhood cancer (Ward, 2014), and typically require highly neurotoxic and injurious surgical resection, chemotherapy and cranial radiotherapy (CRT) (Butler & Mulhern, 2005). The developing child's brain is highly susceptible to neurotoxic agents, particularly in areas involved in higher-order cognitive processing (Moore, 2005). Glial cells myelinate axons, particularly in the prefrontal cortex, throughout childhood and into adolescence to ensure optimal neuronal signaling and healthy development (Purves, Augustine, Fitzpatrick, Hall, LaMantia, & White, 2012). Myelinated axons comprise white matter in the brain, and it is this type of brain tissue that is most vulnerable to chemotherapy and CRT (Moore, 2005), resulting in disruption to cognitive development (Askins & Moore, 2008).

Brain imaging studies have demonstrated white matter deficits in children treated with chemotherapy and CRT (Carey et al., 2008; Reddick, Glass, Johnson, Laningham & Pui, 2009; Schuitema et al., 2013). Associations have also been uncovered between white matter deficits and neurocognitive dysfunction in childhood cancer patients and survivors treated with chemotherapy and CRT (Mulhern et al., 2000; Reddick et al., 2009). Neurocognitive late effects in childhood cancer survivors include deficits in attention and learning (Reddick et al., 2009), motor and perceptual timing (Mahone, Prahme, Ruble, & Mostofsky, 2007), memory (Brown et al., 1992), working memory and information processing (Schatz, Kramer, Ablin, & Matthay, 2000), IQ (Askins & Moore, 2008) and academic performance (Harila-Saari et al., 2007). In fact, such late effects resemble deficits in patients with traumatic brain injury (TBI) (Butler & Mulhern, 2005) and attention-deficit disorder (Askins & Moore, 2008).

Luria (1963) was the first to suggest that the brain could recover from an insult. Gray matter (Dowling, 1998) and white matter changes, as a result of injury, are not

always permanent (Askins & Moore, 2008). Plasticity, or neural restructuring as a result of environmental input, occurs in our brains throughout life, but peak occurrence is during childhood development. Thus, the very quality that renders the developing brain vulnerable is the same characteristic that allows its resilience and strength (Dowling, 2009).

Thaut & McIntosh (2010) discuss how music experience can support brain rehabilitation and change behavioral outcomes. Music activity has been shown to support attentional skills, memory, executive functioning, motoric function, and verbal skills (L'etoile & Lagasse, 2013). Neuroimaging studies reveal the underpinnings of these changes, including increases in white matter, namely in the corpus callosum, which connects the right and left hemispheres, and gray matter, as well as stronger connections between areas involved in the above skills (Levitin, 2013). Since brain areas involved in musical tasks overlap with areas involved in the above cognitive and motor skills, music therapy (MT) may be a motivational way to engage childhood cancer patients and survivors in preventative and rehabilitative treatment for the effects of cancer treatment protocols. No literature exists regarding the application of music therapy in cognitive remediation for the effects of neurotoxic cancer treatment in children. It is the author's intention to explore and suggest music therapy interventions for this population, drawing from existent MT approaches with TBI and ADD, as well as methods of non-MT cognitive remediation, in hopes of providing ways of care for the vulnerable developing brain in children undergoing cancer treatment.

References:

Askins, M., & Moore, B. (2008). Preventing Neurocognitive Late Effects in Childhood Cancer Survivors. *Journal of Child Neurology, 23*(10), 1160-1171.

Brown, R., Madan-Swain, A., Pais, R., Lambert, R., Baldwin, K., Casey, R., . . . Kamphaus, R. (1992). Cognitive status of children treated with central nervous system prophylactic chemotherapy for acute lymphocytic leukemia. *Archives of Clinical Neuropsychology, 7,* 481-497.

Butler, R., & Mulhern, R. (2005). Neurocognitive Interventions for Children and Adolescents Surviving Cancer. *Journal of Pediatric Psychology, 30*(1), 65-78.

Dowling, J.E. (1999). *Creating mind: how the brain works*. New York: W.W. Norton.

Carey, M., Haut, M., Reminger, S., Hutter, J., Theilmann, R., & Kaemingk, K. (2008). Reduced Frontal White Matter Volume in Long-Term Childhood Leukemia Survivors: A Voxel-Based Morphometry Study. *American Journal of Neuroradiology*, 29, 792-797.

Harila-Saari, A., Lahteenmaki, P., Pukkala, E., Kyyronen, P., Lanning, M., & Sankila, R. (2007). Scholastic Achievements of Childhood Leukemia Patients: A Nationwide, Register-Based Study. *Journal of Clinical Oncology, 25*(23), 3518-3524.

L'etoile, S., & Lagasse, A. (2013). Music Therapy and Neuroscience From Parallel Histories to Converging Pathways. *Music Therapy Perspectives,31*, 6-14.

Levitin, D. (2006). *This is your brain on music: The science of a human obsession*. New York, N.Y.: Dutton.

Levitin, D. (2013). Neural correlates of musical behaviors: a brief overview. *Music Ther. Persp., 31,* 15-24.

Luria, A. (1963). *Restoration of function after brain injury*. New York: Pergamon.

Mahone, E., Prahme, M., Ruble, K., Mostofsky, S., & Schwartz, C. (2007). Motor and Perceptual Timing Deficits Among Survivors of Childhood Leukemia. *Journal of Pediatric Psychology, 32*(8), 918-925.

Moore, B. (2005). Neurocognitive Outcomes in Survivors of Childhood Cancer. *Journal of Pediatric Psychology, 31*(1), 51-63.

Mulhern, R., Palmer, S., Reddick, W., Glass, J., Kun, L., Taylor, J., . . . Gajjar, A. (2000). Quantitative white matter loss explains risks of young age for neurocognitive deficits in medulloblastoma survivors. *Archives of Clinical Neuropsychology, 15,* 791-792.

National Cancer Institute. (n.d.). Cancer in children and adolescents. from http://www.cancer.gov/types/childhood-cancers/child-adolescent-cancers-fact-sheet

Purves, D., Augustine, G., Fitzpatrick, D., Hall, W., LaMantia, A., & White, L. (Eds.). (2008). *Neuroscience* (5th ed.). Sunderland, Mass.: Sinauer.

Reddick, W., Glass, J., Johnson, D., Laningham, F., & Pui, C. (2009). Voxel-Based Analysis of T2 Hyperintensities in White Matter during Treatment of Childhood Leukemia. *American Journal of Neuroradiology, 30,* 1947-1954.

Schatz, J., Kramer, J., Ablin, A., & Matthay, K. (2000). Processing speed, working memory, and IQ: A developmental model of cognitive deficits following cranial radiation therapy. *Neuropsychology, 14,* 189-200.

Schuitema, I., Deprez, S., Hecke, W., Daams, M., Uyttebroeck, A., Sunaert, S., . . . Sonneville, L. (2013). Accelerated Aging, Decreased White Matter Integrity, and Associated Neuropsychological Dysfunction 25 Years After Pediatric Lymphoid Malignancies. *Journal of Clinical Oncology, 31*(27), 3378-3388.

Thaut, M. & McIntosh, G. (2010). How music helps to heal the injured brain: Therapeutic use crescendos thanks to advances in brain science. Retrieved from http://dana.org/Cerebrum/2010/How_Music_Helps_to_Heal_the_Injured_Brain__Therapeutic_Use_Crescendos_Thanks_to_Advances_in_Brain_Science/

Ward, E. W. (2014). *Childhood and Adolescent Cancer Statistics, 2014* [PowerPoint presentation]. Retrieved from
http://www.cancer.org/research/cancerfactsstatistics/cancerfactsfigures2014/