

The Effect of Monoaural Beats Music Treatment as Alternative Therapy to Increase the Learning Concentration in Down-Syndrome Students

MOHAMAD AMIN^{1,*}, INTAN AYU IDHA WULANDARI¹, LAILA NUR ALFIAH¹, SURYADI², DINA MAULINA³, RENA LATIFA⁴, IHYA FAKHRURIZAL AMIN⁵, KODAMA YAYOI⁶, YAYUK PRIHATNAWATI⁷ AND INDRIYANI RACHMAN⁸

¹Department of Biology, Faculty of Mathematics and Sciences, Universitas Negeri Malang, Semarang St. No. 5 Malang, East Java, 65145, Indonesia

^{*}(e-mail : mohamad.amin.fmipa@um.ac.id; Mobile : +62 82142262999)

ABSTRACT

In Indonesia, 1% of the population is suffering from Down Syndrome (DS) due to trisomy of chromosome number 21. The music with slow rhythms has impact to increase the learning concentration by the brain waves α . Monoaural beats music produced the harmony of the music frequency in range 8-12 Hz which provides a relaxing effect in human. The purpose of this study was to understand the effect of monoaural beats music on increasing cognitive, affective and psychomotor of children with down-syndrome. The study was conducted with purposive sampling and used 10 people of DS disease from Special Junior High School (SMP-LB) in Malang city as a sample. The music therapy treated for 15 min to the down-syndrome student's and observed their activities in the classroom. Indicators of activity included the focus of view, effective, cognitive and psychomotor. The results of the study showed that the therapy monoaural beats music improved the learning concentrations of down-syndrome students in focus of view and effective aspects.

Key words : Concentration of learning, monoaural beats, music, down-syndrome

INTRODUCTION

Health is indicated by the existence of a stable condition in terms of physical, mental and social to carry out life activities. Mental abnormalities characterized as a decreasing the intelligence level or a decrease in the intellectual function during the development period for the age group. One of the many mental disorders that occur in Indonesia is the down-syndrome. Indonesia's population reaches 266,927,712 with 700 people suffering with down-syndrome. The previous study said that the down-syndrome reported an average of about 1 : 660 births in the world. Almost 95% of the down-syndrome is caused by

trisomy in chromosome number of 21, HSA21 (Doran *et al.*, 2017).

The brain consists of billions of neurons with the same genetic code. During the early stages of development, there are biological processes that distinguish the function of neurons that respond to sensory pathways. Specific genes are activated in various parts of the brain to form neurons to make the signal respond from receptor of the body through sensing pathways (Cole *et al.*, 2017). Learning is a mental or psychological activity that takes place in active interactions with the environment which results in changes in knowledge, understanding, skills, values and attitudes (Hanh *et al.*, 2018). Unconditionally, the

²Special Education Department, Faculty of Education, Universitas Negeri Malang, Surabaya St. No. 5 Malang, East Java, 65145, Indonesia.

³Biology Education, Faculty of Teacher Training and Education, Universitas Lampung, Prof. Dr. Soemantri Brojonegoro St. No. 1, Bandar Lampung, 35145, Lampung, Indonesia.

⁴Faculty of Psychology, Syarif Hidayatullah State Islamic University Jakarta, Indonesia. Jalan Kertamukti No. 5, Pisangan, Ciputat, Tangerang Selatan, Banten, Indonesia.

⁵Faculty of Medicine, University of Indonesia, Universitas Indonesia, Jl. Salemba Raya No. 4, Kenari, Senen, Central Jakarta City, Jakarta 10430, Indonesia.

⁶Faculty of Humanities, The University of Kitakyushu, Japan.

⁷Junior High School Laboratory Universitas, Negeri Malang, Jalan Simpang Bogor T7 Malang, Indonesia.

⁸Department of Life and Environment Engineering, Faculty of Environmental Engineering, The University of Kitakyushu, Japan.

abnormalities in genes controlling biological processes occur in down-syndrome children. The ability of thinking from down-syndrome children falls into the category of mild to moderate mental retardation. They learn less in certain abilities as compared with the normal children. Therefore, music is used as a therapy to increase the concentration of learning for people with down-syndrome (Myles, 2017). According to the previous study, the stimulus (experience) of sensing pathways where sensing neurons were exposed during the critical and sensitive period of early development (including in the uterus) regulates most of the brain's ability to interpret signals and pathways in the brain which regulates or controls language, intellectual, emotional, psychological and physical responses.

The learning concentration is the activities of language, intellectual, emotional, psychological in the process of change of behaviour expressed in the form of mastery, use, assessment of attitudes, knowledge and basic skills found in various fields of study (Albaugh *et al.*, 2017; Cole *et al.*, 2017). The best concentration of learning can be done well when someone optimally performs his role as a student (Detorakis *et al.*, 2018). Contradictions, the bad concentration is caused when the student did not store or masters the subject matter. Therefore, it was necessary to increase the learning concentration to store or master the subject matter more effectively.

Music is part of life and the development of the human soul to basic force effective to calm and bring inspiration (Donoghue, 2017). Rhythm, beat and harmony of music can affect human physiology, especially brain waves, heart rate, and blood pressure (Emeka, 2015). Finally, they got the arouse feelings and memories. Music can cause an increase in one's cognitive performance (Moussard *et al.*, 2016). The type of music used in this study was monoaural beats, because it made effect on the strong brain waves (brainwave) and nerve respect electrical activity (Detorakis *et al.*, 2018). Monoaural beats include a single wave, which does not need headphones to listen (Emeka, 2015). In this situation, the brain enters alpha waves (8-12 Hz) commonly called a wave of relaxation. Therefore, monoaural beats music therapy is expected to have a positive influence on learning outcomes and students can achieve complete learning.

Music therapy is an alternative chosen to down-syndrome treatment, because music is easy to use and very cheap device, easy to learn with the melody method, rhythm and sound harmonization appropriately. The type of music suitable for therapy was the classical instrumental music with a slow tempo harmony formed. The rhythm, beat and luster of music affect human physiology, especially brain waves and heartbeat, in addition to arousing feelings and memories (Ross *et al.*, 2016). Music has a strong influence on the learning environment. Research shows that learning is easier if students are relaxed and receptive. This research related to people's heart rates in this situation is 60 to 80 per minute (Nord *et al.*, 2019). By the music, the positive treatment to increase the concentration of learning process in down-syndrome students was given. The purpose of this study was to explain the effect of music on improving cognitive, effective and psychomotor abilities of children with down-syndrome and to identify the influence of the music between down-syndrome and normal students in the same age.

MATERIALS AND METHODS

This research was a descriptive qualitative research to describe a social phenomenon at the time the research was conducted at Malang State Public SMPLB located at Jalan H. Ali Nasrudin No 2 Kedungkandang Malang, Indonesia. This research implemented on 15 October-10 November 2018. Ten students with down-syndrome and control were selected from Elementary Laboratory School, Universitas Negeri Malang at random.

The instruments used in this study were :

1. The learning concentration scale was a tool for assessing students' concentration of learning which lists statements or questions that were prepared based on indicators of concentration learning research (Brook and Hunter, 2016). The scale made using the Likert scale (Table 1) was very good, good, not good and very not good (Suárez *et al.*, 2018).
2. The observation sheet was used to determine the activities and processes for implementing learning in class before and after being given classical music therapy.

Table 1. Observation sheet

S. No.	Rated aspects	Scores			
		1	2	3	4
1.	Focus of view				
2.	Listen to the teacher's explanation (effective)				
3.	Answering questions correctly (cognitive)				
4.	Active in activities (psychomotor)				
5.	Do activities according to the teacher's instructions (psychomotor)				
6.	Paying attention to demonstration activities (effective)				

According to Manly *et al.* (2001) with modifications the related aspects in observation sheet were : Score 4, if students obtained full focus of view from the beginning of learning until the end of learning. Score 3, if students were provided a focus of view from the beginning of learning and partly till the end of learning. Score 2, if students were not provided focus of view in certain parts during the learning process in class and score 1 if students were not provided focus of view from the beginning until the end of the learning was complete.

Score 4, if students listened to the teacher's explanation from the beginning of learning until the end of learning. Score 3, if students listened to the teacher's explanation from the beginning and partially till the end of the lesson. Score 2, if students listened to the teacher's explanation. Score 1, if students did not listen to the teacher's explanation from the beginning of learning until the end of learning.

Score 4, if students answered all four questions raised by the teacher. Score 3, if students answered 3 questions. Score 2, if students answered 1-2 questions and score 1, if students did not answer any questions raised by the teacher.

Score 1, if students were writing and reading activities well. Score 2, if students were writing and reading activities not fluently. Score 3, when students were less able to do writing and reading well and Score 4, if students were not able to do writing and reading well.

Score 4 : students were able to carry out activities according to the teacher's instructions. Score 3, if students were able to do some activities according to the teacher's instructions. Score 2, when students were less able to carry out activities and Score 1, if students failed to carry out activities according to the teacher's instructions.

Score 4, when students were able to carry out bold demonstrations of the results of their work

in front of the class with full confidence. Score 3, if students were able to demonstrate the results of their work in front of the class with less or no confidence. Score 2, when students were less able to carry out bold demonstrations and Score 1, if students were not able to carry out demonstrations of the results of their work in front of the class.

The stages of the research procedure in the study were :

This stage was preparation stage for carrying out treatment. At this stage, the steps taken were : (a) complete research permit documents, (b) consult with the school regarding technical research plans, (c) observation of the school about research and (d) conducting research.

The steps taken at the implementation stage were as follows : (a) preparing musical instruments; (b) conditioned class, (c) asking children not to feel tense, worried and afraid, (d) ask them to close their eyes and (e) ring music therapy for 15 min. This 15 min time was determined based on the longest ability of down-syndrome students to focus on their activities (these results were based on the results of previous preliminary observations). Descriptive statistics or deductive statistics were part of the statistics of learning how to collect data and present data so that it was easy to understand. Descriptive statistics were only related to describing or giving information about a data or situation or phenomenon. With descriptive statistical words it functioned to explain conditions, symptoms or problems.

RESULTS AND DISCUSSION

This study used a control group and treatment group aimed at getting a comparison of the concentration of learning between samples given music therapy and samples not given music therapy.

Fig. 1 shows that the provision of music therapy had an effect on the concentration of learning

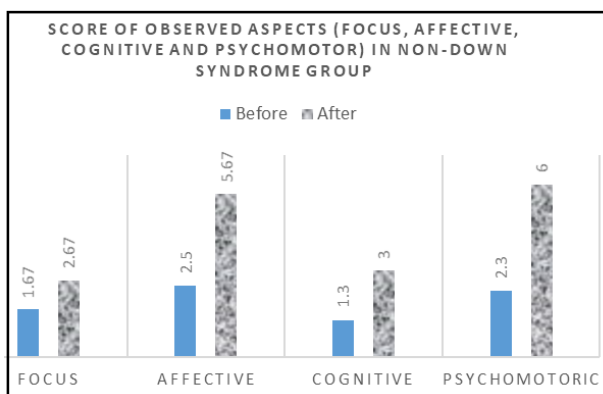


Fig. 1. The score results before and after treatment on four aspects (focus, effective, cognitive and psychomotor) were observed in the non-down-syndrome group.

in non-syndrome children (control group). In normal children, the provision of music therapy improved all aspects; the most significant increase was in the effective and psychomotor aspects (Fig. 2).

Fig. 3 shows that the down-syndrome group with music therapy had an influence on the concentration of learning. The most significant improvement was in effective aspects (Fig. 4). The treatment group with the provision of

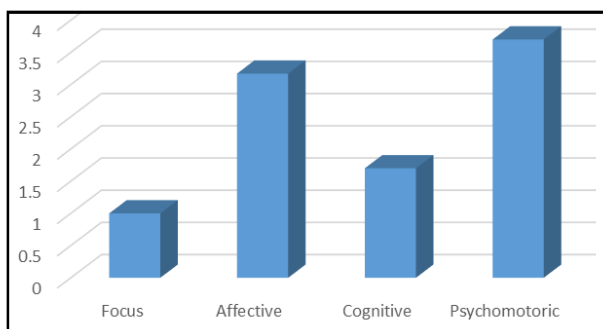


Fig. 2. Improving of score in observed aspects (focus, effective, cognitive and psychomotor) in normal students group.

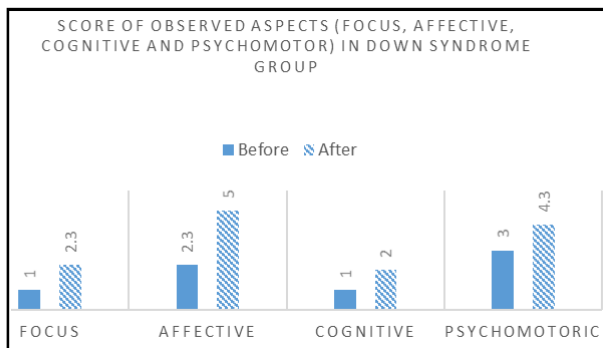


Fig. 3. The score results before and after treatment on four aspects (focus, effective, cognitive and psychomotor) observed in the down-syndrome group.

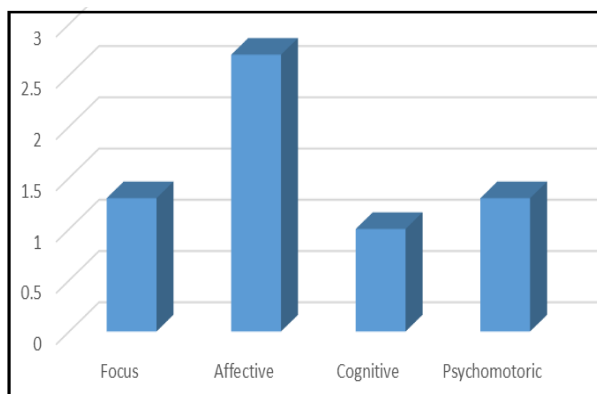


Fig. 4. Improving of score in observed aspects (focus, effective, cognitive and psychomotor) in down-syndrome group.

music therapy showed that music affected the development of effective and psychomotor aspects. This study was conducted with three replications which showed that down-syndrome students were obedient to the teacher. It was caused by the music therapy impact on mood and relaxation of the body (Junior *et al.*, 2019). In this study, it was also known that the level of cognitive aspects (memory, thoughts, symbols, reasoning and problem solving) for patients with down-syndrome was relatively constant. It was due to limited cognitive ability, it affected their academic ability due to attention, metacognition, memory and slow generalization compared to normal children (Kazemi *et al.*, 2016). In this study, the score for the focus aspect of the view for Down syndrome students was good. Kinnear *et al.* (2018) said that children with down-syndrome had good visual processing skills even though they had eyes that look squinted.

The results of research in psychomotor aspects (skills) showed poor results. This was due to obstacle in motor skills of patients with down-syndrome. Motor skills were abilities in movements carried out by members of the body to carry out an activity. The motor development of a child with a down syndrome was not as fast as a normal child. This condition was caused by internal and external factors. Internal factors originated from within the child itself such as fear, anxiety, worry and others. External factors originated from the environment, namely, the class atmosphere that was not conducive, if someone feels difficult to concentrate one of the main causes was that the person was not able to enjoy the activities (Roddy *et al.*, 2018). Effective and psychomotor aspects showed that

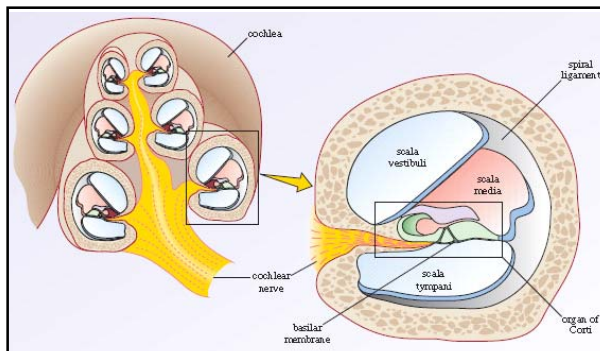


Fig. 5. The mechanism of the entry of stimulus towards the hearing organs.

a good result for non-syndrome students indicated by the behaviour of taking notes/writing information and making work answers (Zampini *et al.*, 2015).

Music can make people with down-syndrome able to follow the learning process well. Music waves affected the human brain precisely in the limbic system. The limbic system is a 'life' that determines how individuals live and behave in their environment (Rools, 2015), therefore, when music affected the work of the limbic system the emotions of people with down-syndrome were well conditioned and influenced the concentration of learning that was initially not good.

The mechanism of the entry of monaural beats impulse accommodated by auricula and directed to the meatus acusticus externus gave rise to vibrations of the tympanic membrane resulting in vibrations (Fig. 5). These vibrations were continued towards the additive vibration of the bone vibrating perilymph in scala vestibuli and through helicotrema to vibrate perilymph in scala tympani and the perilymph vibrations moved the vestibule and basilar membranes with the result of endolymph which gave rise to the possibility of receptor in the cortical organ. Then the music that had been passed on to the inner ear section led to the nerve cochlearis of the peripheral part leading to the ganglion spirale in the central part of the cochlear nerve and the cochlearis nucleus, a small portion did not cross and most cross the midline as the corpus raphezoidum and some stop in the nucleus. Trapezoidi and some did not. Next to the lateral lemniscus and inferior colliculus, there were those who stopped and some who did not. Inferior auditiva brachium colliculi were in areas 41 and 42, hearing stimuli (Avario *et al.*, 2019).

Initially Thomas Willis explained that the limbic system was used to signify a cortical border encircling the brain stem. Limbic structure included other aspects of behaviour such as controlling social interactions (Albaugh *et al.*, 2017), as a place to store memories and regulate emotions (Roddy *et al.*, 2018).

Music mechanism affected the limbic work system which when entered the ear it vibrated the ears and ear bones (malleus, incus, stapes). When the hearing bone vibrated, it sent a signal through nerve VIII (vestibulocochlearis). After stimulating the VIII nerve, the signal went to the cerebrum cortex and then to the wernicke and brocca area, then the signal was processed in the neuron cell body. After the signal was processed, active chemicals were released which responded to by the nucleus amygdala so that the limbic system was automatically activated. Anatomical and physiological progress led by James Papez to describe neural circuits to connect actions and perceptions to circuit emotions. Papez consisted of the hippocampus that connected the fornix through the mamillo-thalamic tract to the anterior nucleus of the thalamus and then returned to the cingulate cortex. According to Papez emotion arose both from cognition that entered the circuit from the cortex through the hippocampus or from visceral and somatic perceptions. Papez argued that the cingular gyrus cortex was seen as a receptive area for experiencing emotions as a result of impulses that came from the hypothalamic region or the formation of the hippocampus (Nord *et al.*, 2019).

Fornix was a main projection of a channel that connected the hippocampus with the mammillary body, anterior thalamic nuclei, and this part of the hypothalamus also had a small commissural component known as the hippocampal commissure (Kinnear *et al.*, 2018). The mamillo-thalamic canal fibers originated from the mammillary body and end in the anterior and dorsal nuclei of the thalamus. Stimulation of ventrally was directed towards the branch of the mammillary body to the tegmental core (mamillo-tegmental duct). The mamillo-tegmental channel together with the bundle fiber in the medial forebrain formed an important circuit between the medial limbic structure of the midbrain and the hypothalamus to connect emotional and behavioural perceptions. The anterior

thalamic nucleus received projections from the fornix and the mammillo-thalamic tract and connected through the anterior projection of thalamic to frontal and anterior cingulate cortex. The anterior thalamic projection carried a stimulus in the internal anterior capsule. The cingulum contained the longest different fibers, the parahippocampal gyrus, the amygdala, and the uncus that went to the sub-genua area of the frontal lobe. From the medial temporal lobe, this fiber reached the occipital lobe and the arch was almost 180 degrees in the splenium and continued anteriorly in the case of white cingulate gyrus. The dorsal and anterior fibers of the cingulum followed the superior aspect of the corpus callosum. Moussard *et al.* (2016) stated that after arching around the genu of the corpus callosum, fibers end up in the subcallosal gyrus and paraolfactory regions. Uncinate arkuata connected the anterior part of the temporal lobe with the poles and frontal orbital cortex (Fig. 5). The uncinate fascicular fibers were derived from fossil poles, uncus, parahippocampal gyrus and amygdala, then after the U-turn, entered the extreme capsule floor. Between the insula and putamen, the uncinate arcuate run lower than the fronto-occipital arcuate before entering the frontal lobe orbital region. Here, uncinate was divided into ventro-lateral branches, which ended in the anterior insula and lateral orbitofrontal cortex, and antero-medial branches that continued towards the cingulate gyrus and frontal pole.

Music is part of life and the development of the human soul which is a very effective basic force to calm and bring inspiration. So music is used as an alternative therapy because it can improve one's mind ability by influencing heart rate and blood pressure according to frequency, tempo and volume (Myles, 2017).

CONCLUSION

Based on the results of the study, it can be concluded that music therapy with the type of monoaural beats affected the improvement of the focus, vision and effective and psychomotor aspects in patients with down-syndrome. Music is very influential in increasing the concentration of learning for patients with down and non-down-syndrome, because music can affect brain waves which affect the work of the limbic system.

ACKNOWLEDGEMENT

The authors would like to thank gratefully the Universitas Negeri Malang for supporting the research through PNPB (Non-Tax State Revenue) Grant Funding. The authors also thank the Principal of Special Junior High School (SMP-LB) in Malang for supporting the research facilities. Also thank the teacher for the cooperation and support of this research activity and all of the members of molecular biology working group for the technical support.

REFERENCES

- Albaugh, M. D., Tuong, V. N., Simon, D., Louis, C., Kelly, N., Botteron, Nicholas, D. A., Alan C. E., Sherif, K. and James, J. H. (2017). Age-related volumetric change of limbic structures and sub-clinical anxious/depressed symptomatology in typically developing children and adolescents. *Biol. Psychology* **124** : 133-140.
- Avorio, F., Morano, A., Fanella, M., Fattouch, J., Albini, M., Basili, L. M. and De'Bonaventura, C. (2019). Olfactory stimulus-induced temporal lobe seizures in limbic encephalitis. *Seizure* **69** : 204-206.
- Brook, P. and Hunter, C. (2016). *Effective Study Techniques*. Otago : University of Otago.
- Cole, J. H., Tiina, A., Liam, R. Wilson, R. R, Young, T., Hong, T. D., Fryer, Julio, A. C., Arturo C. B., Obert, S., David, K. M., Shahid, H. Z., Peter, J. N. and Anthony J. H. (2017). Brain-predicted age in down-syndrome is associated with beta amyloid deposition and cognitive decline. *Neurobiology of Aging* **56** : 41-49.
- Detorakis, G., Sadique, S., Charles, A., Somnath, P., Bruno, U. Pedroni, Nikil, D., Jeffrey, K., Gert, C. and Emre, N. (2018). Neural and synaptic array transceiver : A brain-inspired computing framework for embedded learning. *Frontiers in Neuroscience* **12** : 1-19.
- Donoghue, J. O. (2017). The observed experiences of music therapy on parent-child interaction for families with children with down syndrome. *Res. Gate* **17**. doi : 10.15845/voices.v1 7i2.892.
- Doran, E., Keator, D., Head, E., Phelan, M. J., Kim, R., Totoiu, M. and Lott, I. T. (2017). Down-syndrome, partial trisomy 21 and absence of Alzheimer's disease : The role of APP. *J. Alzheimer's Dis.* **56** : 459-470.
- Emeka, G. (2015). Impact on stress associated with

- the dissection experience. *Adv. Physiol. Educ.* **39** : 96-101.
- Hanh, J. L., Loveall, S. J., Savoy, M. T., Neumann, A. M. and Ikuta, T. (2018). Joint attention in down syndrome : A meta-analysis. *Research in Developmental Disabilities* **89** : 83-93.
- Junior, M. S., Freitas, R. C., Santos, W. P., Silva, W. W., Rodrigues, M. C. and Cone, E. F. (2019). Exploratory study of the effect of binaural beat stimulation on the EEG activity pattern in resting state using artificial neural networks. *Science Direct*. doi : 10.1016/j.cogsys. 2018.11.002.
- Kazemi, M., Salehi, M. and Kheirollahi, M. (2016). Down-syndrome : Current status, challenges and future perspectives. *IJMCM* **5** : 125-133.
- Kinnear, D., Morrison, J., Allan, L., Henderson, A., Smiley, E. and Cooper, S. A. (2018). Prevalence of physical conditions and multimorbidity in a cohort of adults with intellectual disabilities with and without down syndrome : Cross-sectional study. *BMJ Open* **8** : 1-10.
- Manly, T., Anderson, V., Nimmo-Smith, I., Turner, A., Watson, P. and Robertson, I. H. (2001). The differential assessment of children's attention : The test of everyday attention for children (TEA-Ch), normative sample and ADHD performance. *The Journal of Child Psychology and Psychiatry and Allied Disciplines* **42** : 1065-1081.
- Moussard, Aline, Patrick Bermudez, Claude Alain, William Tays and Sylvain Moreno (2016). Life-long music practice and executive control in older adults : An event-related potential study. *Brain Res.* **1642** : 146-153.
- Myles, G. (2017). *Effects of Background Music on Cognitive Tasks*. Canada : Department of Psychology University of Western.
- Nord, C. L., Halahakoon, C. D., Limbachya, T., Charpentier, C., Lally, N., Walsh, V., Leibowitz, J., Piling, S. and Roiser, J. (2019). Neural predictors of treatment response to brain stimulation and psychological therapy in depression : A double-blind randomized controlled trial. *Neuropsychopharmacology* **44** : 1613-1622
- Roddy, D. W., Roman, E., Rooney, S., Andrews, S., Farrell, C., Doolin, K. and O'Hanlon, E. (2018). Awakening neuropsychiatric research into the stria medullaris : Development of a diffusion-weighted imaging tractography protocol of this key limbic structure. *Frontiers in Neuroanatomy* **12** : 1-16.
- Rools, E. T. (2015). Limbic systems for emotion and for memory, but no single limbic system. *Science Direct* **62** : 119-157.
- Ross, Erika K., Joo Pyung Kim, Megan L. Settell, Seong Rok Han, Charles D. Blaha, Hoon Ki Min and Kendall H. Lee (2016). Fornix deep brain stimulation circuit effect is dependent on major excitatory transmission via the nucleus accumbens. *NeuroImage* **128** : 138-148.
- Suárez-Alvarez, Javier, Ignacio Pedrosa, Luis M. Lozano, Eduardo García-Cueto, Marcelino Cuesta and José Muñiz (2018). Using reversed items in likert scales : A questionable practice. *Psicothema* **30** : 149-158.
- Zampini, L., Salvi, A. and D'Odorico, L. (2015). Joint attention behaviours and vocabulary development in children with down-syndrome. *J. Intellectual Disability Res.* **59** : 891-901.