

Music Perception as Cognitive Schemata: Introduction to Theory and Didactic Application

Nour Ben Hamadi

Abstract— This paper is a theoretical research based on a multi-disciplinary approach (musicology, psychology and didactics) that tends to contribute to the development of music education theory, strategy and practice in Tunisia. This study explores ongoing research in the area of music psychology. It presents a proposal to better define the development of music perception in childhood through schema theory perspective. According to an investigation that combines reviews of work relating to cognitive psychology and musicology, child music perception is an interactive process that involves two types of schemata: (1) Pre-existing schemas depending on children's prior knowledge and its connections and (2) New schemas depending on learning and teaching situation, both of which are mainly affected by child characteristics (age, socio-emotional skills and cultural background) and music features (musical pattern and rhythm). The developmental perspective should enable education leaders and practitioners to organize their knowledge to make it more readily amenable to efficient practical application, and this paper sets out the didactic challenges of a cognitive psychology of music.

Index Terms— Cognition, Didactics, Developmental Psychology, Music Perception, Music Psychology, Schema Theory.

1 INTRODUCTION

Theories of child developmental psychology have been applied fruitfully in education field over the last several decades. Since the use of behavioral model defined by Watson in 1913 and Skinner in 1945 until the constructivist concept as framed by Dewey in 1938, Vygotsky in 1934 and Piaget in 1970, the teaching-learning strategies evolved in manner that best meets learner needs. Likewise, schema theory as defined by Bartlett in 1932 [1], originally appeared in order to help cognitive psychologists better understand how the brain gains knowledge and responds to it through a dynamic system of units and an identification of key factors affecting the cognitive processes. Since then, the concept was introduced into education sphere with numerous works such as Minsky's in 1975 [2], Anderson's in 1977 [3] and Rumelhart's in 1980 [4]. Schema theory provides a theoretical and empirical basis of children knowledge perception and sets out instructional practices that teachers should carry out.

From the above overview it is apparent that the application of the schema theory in music perception studies is quite effective and it suggests two main types of purpose: heuristic and didactic. When listening to music, the brain creates and/or activates several linked mental structures (schemata) that interact among each other and determine the response of the listener to musical stimuli [5]. Thus, schema theory provides a comprehensive description about music perception and thereby enhances our understanding of cognitive heuristics. As for the didactic purpose, the practical application of the theoretical framework in order to foster music learning process amongst children vindicates the relevance of the role of schema theory in music educational setting [6].

Given the importance of schema theory within music perception process, which are the types of schemata involved in child music perception process? In which ways are musical knowledge units and their connections represented and structured? And how can theoretical findings improve teaching

and learning music amongst children?

2 THE SCHEMATIC BASIS OF MUSIC

In what follows, we first give precise definition of basic concepts underlying our topics in musicology, psychology and didactics and we focus much attention on the conceptual overlap within the epistemic triad. It is then essential to conduct a careful literature review in order to avoid confusions and misunderstandings and provide a solid methodological foundation for the whole research.

2.1 Basic Concepts

2.1.1 Music Perception and Cognition

Music psychology (or psychology of music) is the scientific branch of cognitive psychology that deals with the identification of mental mechanisms in musical sounds perception. Along this dimension, it is fundamental to study and analyze the basic building blocks of music, which are melody and rhythm. It also includes the theoretical and emotional concepts related to music. In terms of psychology, music perception is information processing that implies cognitive stages. Every stage of the cognitive process is characterized by a definite complex of mental abilities: memorization, recognition and (re)production, each of which, in turn, involves a series of sub-stages and other set of cognitive skills such as motor coordination and acoustic analysis [7]. The study of music perception proves itself useful especially in cognitive rehabilitation [8], treating learning disorders [9] and more specifically in structuring educational curricula to enhance learning and teaching music [10].

2.1.2 Schema Theory and Cognitive Schemata

Schema theory was first announced by Bartlett in 1932 and it is one of the most fundamental psychological theories [11]. The concept of schemata recalls the primitive cognitive model of Stimulus-Response (S-R) and states that knowledge perception (stimulus) sets out network of mental structures (schemata)

that generates comprehension and behavior patterns (response) [12]. According to Piaget's theory and its findings about the processes of assimilation and accommodation, schemas are flexible and variable. Whenever there is an interaction between pre-existing schemas and new ones, schemata adapt and evolve. It is necessary at this point to emphasize the relevant role of memory abilities in all stages of the mental process; children develop schemata about everything they experience and store them within a dynamic system so that they can use it later [13]. The field where schema theory has been most systematically developed is educational area [14], for example language comprehension [15], improving writing ability [16] and developing student's reading skills [17]. Analogical reasoning provides epistemic and scientific basis for the application of schema theory in a music educational setting. Accordingly, children build abstract mental representation of the relational structure of music concepts in the form of schema theory. Thus, music schemata are a complex system of networked concepts [18] and knowing which and how musical concepts are related should enable us to know how they can be used efficiently in learning-teaching strategies.

2.1.3 Music Education

Education is a dynamic system of acquiring and transferring knowledge through systematic instruction. Dewey [19] declared that the educational process has two sides, one psychological (cognitive) and one sociological which states that, education does not only involve imparting knowledge, but also includes transmitting values, skills and attitude. Moreover, education encompasses two notions: learning and teaching. Learning is a process and it can be defined as the aim of education. It refers to the role of the learner and its intellectual abilities of acquiring knowledge and skills through experience or teaching. On the other hand, teaching is mainly an action. It refers to the role of the teacher (educator /instructor /tutor) and his or her method of transmitting information. The efficiency of action depends on an active method that reflects a good knowledge of both subject matter and mental abilities of the learners. When discussing method of teaching in a schooling context, it is about didactics concept. Every school subject has its own didactics. For a better understanding of didactics within the specific area of music, it should be noted that music didactics deal with content, materials, aims and processes of evaluation in a music classroom [20].

2.2 Types of Schemata

Music perception schemata in a music educational setting can be classified into two types: Pre-existing schemas and new schemas. It is therefore obvious that the whole art of schema theory consists of nothing more than the learner's capability of combining his or her own background of knowledge and skills with new perceived informations [17].

2.2.1 Pre-existing Schemas

Pre-existing schemas refer to children's existing knowledge and abilities which are there before the learning-teaching event [21]. They cover musical-cultural and socio-emotional backgrounds.

Musical and cultural background. Long before attending

music classrooms, children develop musical cognitive schemata by experience, through culture-specific music [22]. Many studies have shown that children start acquiring musical abilities even before birth [23], [24] and continue to develop them as they are spontaneously exposed to music in their cultural living environment. Findings of previous study indicate that, by at least the age of three, cognitive frameworks about melodic and rhythmic structures appears to be in place [7]. The latter outcome suggests that children, by the age of three and after, are able to discriminate pitches, intervals and rhythmic features within a modal structure. Moreover, as children grow up and gain more experience, according to assimilation-accommodation principles, schemas about musical knowledge change consistently.

Socio-emotional background. At this point, we need to think of music perception as more than mere music knowledge and brain processes. It is about knowing how the socio-emotional component generates cognitive schemata that affect in their turn knowledge schemata and consequently music perception and learning process. It is well known that music brings about emotion [25]; it can stir up old memories, arouse positive or negative feelings and affect the mood, and what leads the emotional schema to a positive response rather than a negative one is the social being of the individual. It is also accepted that emotional schema drives memory and plays a crucial role in music cognition. First, it helps in storing musical information (memorization) and secondly it improves retrieving old information (recognition and (re)production) [26]. In short, the melding of emotional and music knowledge schemata promises to engage powerful educational applications.

2.2.2 New Schemas

In this section, we will focus more in depth on the practical learning-teaching situation to pinpoint the cognitive schemata across the didactic triangle while supporting the relevance of the connection between pre-existing and new schemata.

New schemas relating to the learner and the lesson content. By the end of every music lesson, learners must have gained new knowledge in a way that bridges to prior one [27]. Moreover, in an instructional context, learners become more able to comprehend and gain new skills by calling upon their old mental pathways. Thus, new exposure to musical knowledge leads to new mental representation about music elements and their emotional bond.

New schemas relating to the relationship between learner and teacher. A number of studies have claimed that teacher-learner relationship impacts the knowledge perception process [28],[29]. Hence, while a positive teacher-learner relationship is favorable to knowledge gain, an unfavourable relationship may negatively influence the learning process. The nature of relationship between teacher and learner depends greatly on children's social skills and emotional state [30]. Therefore, new schemas are a combination between children's socio-emotional schemata and schemas relative to a particular learning situation.

3 DIDACTIC CHALLENGES OF COGNITIVE SCHEMA IN MUSIC

In 1996, the department of training and retraining under the auspices of Tunisian Ministry of Cultural Affairs, has developed and published curriculum for music education. In accordance with educational guidelines, teaching helps develop in children the skills that enable them learn and use appropriately Arabic musical modes and rhythms' fundamentals. The structure of general music program shows seven grade levels according to a modes-based classification. The music program is designed to offer a set of musical subjects and a great degree of freedom to approach the subject matter. Thus, teachers are encouraged to meticulously choose their own teaching methods and enhance their techniques in order to better meet learners' needs.

The subject matter of music, both melodic and rhythmic, is learned mainly and effectively through dictation, solfege (reading) and instrument playing lessons. Therefore, these subjects are the backbone of music teaching. This clearly explains the obsession of teachers as well as learners, at all levels, with results in this specific trio (dictation, solfege and playing an instrument). By all means the assessment in music instructional system is of first importance. However getting good marks should not to be a didactic goal in itself. Marking is the kind of measure of assessment used in Tunisian music education system. It provides accurate and comprehensive evaluation of each learner as it reflects the level of learning the student has acquired cognitively and technically in a musical performance.

It is well known that art evaluation tends to be highly subjective [31] whereas in an instructional setting, assessment needs to be as objective as possible in order to bring precise outcomes about how far children have progressed in each of skill and how their progress compares to peers [32]. In this context, whether it is about singing, reading solfege, composing, improvising or playing an instrument, teachers' assessment has to comply fully with objective explicit criteria [33].

3.1 Application of Schema Theory to Musical Performance

Integrating schema theory across musical performance draws the effective ways in which theory can be translated into practice. In instructional setting, musical performance can be defined according to four abilities: singing, playing a music instrument, composition and improvisation.

3.1.1 Singing

Singing in music classroom is a music perception process through which voice instruction is conducted [34]. The vocal activity is intended here to provide a comprehensive and developmental experience for vocal and aural skills for children. However, singing is not only allowed for those who have euphonious voice and (or not) might aspire to a singing career, but it is a general activity that plays a key role in music didactics. By learning songs, musical knowledge can be readily transmitted and therefore it reveals pattern of child musical

development [7].

By practicing, brain starts building cognitive schemas about melodic and rhythmic structures of music in order to realize how proper vocal technique is accomplished. Melodically, children develop a greater awareness of musical sounds that includes the accuracy of vocal reproduction of pitches, intervals and ornaments in relation to maintenance of a modal center in taught songs [35]. Rhythmically, children refine their sensor motor skills related to cognitive schemata of rhythmic pattern. The latter reflects the ability of reproducing different notes duration (sounds and silence), tempo and accents within the interaction between lyrics rhythm and melodic one [35].

Schema acquisition processes in singing require a set of cognitive skills: aural memory, recognition and vocal (re)production processes [7]. In a classroom context where teacher is the main source of information and children are the receivers, learners think of teachers as role models that need to be imitated in vocal techniques and modes of interpretation [36]. By so doing, every student should be able to shape a personal and unique interpretation.

3.1.2 Playing a Musical Instrument

Playing a musical instrument is the ability to yield musical sounds with any types of musical instruments. Musical instruments can be classified into three main categories according to how sounds are produced: percussion, wind, and stringed. Therefore, during the learning process an emphasis is on the multitasking skill which represents the ability of managing simultaneously (quite) advanced motor action and cognitive tasks in a manner that preserves the accuracy of the reproduced musical sounds [36].

As for singing, learning to play an instrument follows the same cognitive process of memorization, recognition and (re)production. However, it seems to be more complex since it involves more mental skills than singing cognitive process [36]. First, instead of reproducing vocally musical sounds, learners make sounds with a musical instrument through a motor task. Second, imitating the teacher during memorization task involves visual and motor memories, in addition to aural and emotional memories (involved in singing) [37].

3.1.3 Composing and Improvising

Although our child music education system draws narrow didactic aims that confined to imparting music knowledge, usually to be memorized and reproduced in the same form it was received, supporting children's creative abilities like composing and improvising should be a priority in a music curriculum [38]. Indeed, celebrities of the past confirm the idea that creativity in music art has no age limit- Mozart was only six years old and Beethoven nine when they wrote their first musical compositions.

Music composition is the ability of organizing music sounds into melodic and rhythmic structures in accordance with normative musical shape. Thus, the process of composing is submitted to cultural conventions that impose explicitly and (or) implicitly a set of technical and stylistic characteristics for the composed music [39]. Improvisation shares nearly the same cognitive process of composition with the only difference that composing implies materialization of musical crea-

tion so that it lasts in time, as opposed to improvising [40].

Thinking composition-improvisation in a classroom context entails impregnation with specific cultural and music norms, so that little composers can build, modulate and store continuously new schemas about musical knowledge [39]. For that reason, effective composing-improvising process tends to be a long-term process. This is all the more reason we should promote early music education and creative skills at an early age.

3.2 Didactic Activities to Develop Music Perception in Instructional Setting

Any attempt to enhance children's music perceptual abilities in a learning-teaching context is contingent by general instructional setting and music-specific context. Teachers also play a key role in that when deciding on which teaching method to use in their lessons.

First and foremost, it is worth reminding the importance of attending music classes at an early age. It is well known that child's early years are the best years for building strong foundations for cognitive skills [41]. By learning music at an early age, children accumulate various cognitive experiences -social, emotional and sensor motor experiences, and develop, consequently, more opportunities that deepen and strengthen their comprehension of music [35]. In short, the earlier we learn the easier it is to learn more later on. Furthermore, music classroom, like any other children's classes, has to be a supportive learning environment based on a positive teacher-learner relationship that fosters children social and emotional development and impacts, thus, their potential of perceiving music [42]. Another key aspect of effective instructional strategy in music education is the choice of an active teaching method that place the learner in the core of learning process by involving children's prior knowledge schemas and experiences [37].

Given the specificity of each musical perceptual skill, children's music curriculum presents targeted musical didactic activities. Three key activities are highly recommended: listening, singing and reciting. The main purpose of these activities is to enhance music perception and related sensor motor skills by learning how and when to apply specific memorized information. Listening in class as well as singing and reciting are activities that children can only benefit from. Children who listen and memorize music from different cultural backgrounds gain an expanded bank of sounds and musical expressions [43]. Besides, listening to music and singing in class avoid routine and boredom which raise children's interest and curiosity for learning [44]. Finally, teachers can strengthen the connections between subject matter and purpose of learning by engaging learners in multi-memory activities (aural, visual and motor), such as imparting music information through physical movements [45].

The purpose of this section has been to discuss the considerations that a music teacher can take to plan and implement successful schema theory-based didactic activities that promote children's development of music perception skills as they engage in learning discipline-specific content. We have provided key practical recommendations to help educators in choosing and shaping their didactic methods. However, our suggestions are far from exhaustive. It is essential to keep discussions flowing so that practitioners can benefit from further

outcomes of this topic featuring other challenging aspects of the crossed insight from schema theory and music didactics, such as integrating schema theory in sight-reading music, music interpretation and orchestration.

4 CONCLUSION

Research in promoting educational practice in music classroom is a pertinent theoretical issue in music education. This calls for a deeply cross-disciplinary approach -from neurosciences to psychology, sociology, learning sciences and connecting them to music theories. This paper although it does not rely on empirical research, it lays the theoretical foundation of the application of schema theory in music perception to understand its didactic scope and implications. However, empirical research should be carried out in parallel with it and give a broader view to our conclusions.

REFERENCES

- [1] F. C. Bartlett, *Remembering*. Cambridge: Cambridge University Press, 1932.
- [2] M. Minsky, *A framework for representing knowledge*. Massachusetts: Massachusetts Institute of Technology Artificial Intelligence Laboratory, 1974.
- [3] R. C. Anderson, The notion of schemata and the educational enterprise: General discussion of the conference. *Schooling and the Acquisition of Knowledge*, pp.415-431, 1977.
- [4] D. E. Rumelhart, Schemata: The building blocks of cognition. *Theoretical Issues in Reading Comprehension*, pp.33-58, 1980.
- [5] M. Leman, *Music and schema theory: Cognitive Foundations of Systematic Musicology*. Berlin: Springer-Verlag, 1995.
- [6] G. F. Welch, A Schema Theory of How Children Learn to Sing in Tune. *Psychology of Music*, pp. 3-18, 1985.
- [7] N. Ben Hamadi, The developing musical mind: a cognitive study of modal sense awareness in childhood. *4th International Students Social Sciences Congress Proceedings*, 1, pp.133-152, 2019.
- [8] T. Sarkamo, M. Tervaniemi, & M. Huotilainen, Music perception and cognition: development, neural basis and rehabilitative use of music. *Wiley Interdisciplinary Reviews: Cognitive Science*, vol. 4, no.4, pp. 441-451, 2013.
- [9] S. Z. Saber & B. Hosseinzadeh, The effect of music on the attention and memory of the second-grade primary school students with learning disorder in Ghaemshahr city. *European Journal of Behavioral Sciences*, vol.1, no.2, pp. 36-43, 2018.
- [10] D. J.Hargreaves, N. A. Marshall, & A. C. North, Music education in the twenty-first century: A psychological perspective. *British Journal of Music Education*, vol.20, no.2, pp.147-163, 2003.
- [11] N. M. Steel, Schema (s). *Encyclopedia of the Sciences of Learning*. pp. 2933-2936, 2012.
- [12] J. P. Deconchy, Parcours métathéorique. Cadrages, concepts et itinéraires [Metatheoretical journey. Framing, Concepts and Itineraries]. *Perspectives cognitive et conduites sociales*, pp. 19-69, 1994.
- [13] J. W. Alba & L. Hasher, Is memory schematic?. *Psychological Bulletin*, vol.93, no.2, pp. 203-231, 1983.
- [14] B. Labasse, B, The status of cognitive schemas in discursive production and reception (Le statut des schémas cognitifs dans la production et la réception discursives) *Pratiques*. pp. 171-172, 2016.
- [15] D. E. Rumelhart, Schemata: The building blocks of cognition. *Theoret-*

- ical Issues in Reading Comprehension, pp. 33-58, 1980.
- [16] F. Sun, The application of schema theory in teaching college English writing. *Theory and Practice in Language Studies*, vol.4, no.7, pp. 1476-1482, 2014.
- [17] X. Zhao & L. Zhu, Schema theory and college English reading teaching. *English Language Teaching*, vol.5, no.11, pp. 111-117, 2012.
- [18] , T. S. Kuhn, The road since structure. *Science and the Quest of Reality*, pp. 231-245, 2000.
- [19] J. Dewey, *Democracy and education*, Hauts-de-Seine: Armand Colin, 2018.
- [20] C. Richter, The didactic interpretation of music. *Philosophy of Music Education Review*, vol.4, no.1, pp. 33-49, 1996.
- [21] A. Pritchard, *Ways of learning: learning theories and learning styles in classroom*. London: Routledge, 2008.
- [22] E. E. Hannon & L. J. Trainor, Music acquisition: effects of enculturation and formal training on development. *Trends in Cognitive Sciences*, vol.11, no.11, pp. 466-472, 2007.
- [23] P. Murphy, *Learners, learning & assessment*. London: Sage, 1999.
- [24] R. Colwell, *MENC handbook of musical cognition and development*. Oxford: Oxford University Press, 2006.
- [25] P. N Juslin & J. A. Sloboda *Music and emotion: theory and research*. Oxford: Oxford University Press, 2001.
- [26] M. D. Leichtman, S. J. Ceci, & P.A. Ornstein, The influence of affect on memory: mechanism and development. *The Handbook of Emotion and Memory: Research and Theory*, pp. 181-200, 2014.
- [27] V. Clarke, *Effective strategies in the teaching of mathematics*. Maryland: University Press of America, 2013.
- [28] M. van Manen, *The tact of teaching: the meaning of pedagogical thoughtfulness*. New York: Routledge, 1991.
- [29] H. O'Hara, The transcendent teacher-learner relationship: a class investigation. *Journal of Early Childhood Teacher Education*, vol.25, pp. 331-337, 2005.
- [30] S. A. Lynch & C. G. Simpson, Social skills: laying the foundation for success. *Dimensions of Early Childhood*, vol.32, no.2, pp. 3-12, 2010.
- [31] A. Pike, *Improving memory through creativity*. London: Jessica Kingsley Publishers, 2014.
- [32] G. K. Cunningham, *Assessment in the classroom*. London: The Falmer Press, 2005.
- [33] T. Rayment, *The problem of assessment in art and design*. Bristol: Intellect Books, 2007.
- [34] D. R. Mathis, *Melodic sculpturing: the art and science of singing*. Bloomington: AuthorHouse, 2009.
- [35] H. Goelman, H., C. J. Andersen, J. Anderson, P. Gouzouasis, M. Kendrick, A. M. Kindler, M. Porath and K. Jinyoung, Early childhood education. *Handbook of Psychology*, vol.7, pp. 285-297, 2003.
- [36] V. John-Steiner & H. Mahn, Sociocultural contexts for teaching and learning. *Handbook of Psychology*, vol.7, pp. 125-152, 2003.
- [37] R. E. Mayer, Memory and information process. *Handbook of Psychology*, vol.7, pp. 47-58, 2003.
- [38] B. Trilling & C. Fadel, *21st century skills: learning for life in our time*. San Francisco: Jossey-Bass, 2009.
- [39] A. F. Moore, Categorical conventions in music discourse: style and genre. *Music & Letters*, vol.82, no.3, pp. 432-442, 2001.
- [40] S. Larson, Composition versus improvisation. *Journal of Music Theory*, vol.49, no.2, pp. 241-275, 2005.
- [41] S. A. Raver, *Early childhood special education, 0 to 8 years: strategies for positive outcomes*. London: Merrill-Pearson, 2009.
- [42] R. C. Pianta, B. Hamre & M. Stuhlman, Relationship between teachers and children. *Handbook of Psychology*, vol.7, pp. 199-234, 2003.
- [43] A. Almeida, *Music proficiency*. New York: Heritage Music Press, 2006.
- [44] P. R. Pintrich, Motivation and classroom learning. *Handbook of Psychology*, vol.7, pp. 103-124, 2003.
- [45] C. A. Lindeman, *Musical classroom: backgrounds, models and skills for elementary teaching*. New York: Routledge, 2016.