ADDING EMOTION TO THE GIFTED MUSICAL MIND:

TOWARDS A MODEL OF MUSICAL THINKING

The International Journal of Creativity & Problem Solving (2010), 20(2), 85-108.

Roland S Persson, PhD
Professor of educational psychology
School of education & communication
Jönköping University
PO Box 1026
SE-55111 Jönköping, Sweden

E-mail: pero@hlk.hj.se

Abstract

Much research has explored cognitive functions and the nature of information processing since the cognitive revolution began with the advent of computers. With the establishing of music psychology attention was directed also to the cognition and processing of music. However, the initial reluctance of Science to avoid the study of emotions became a problem especially in studying music as a cultural phenomenon, with the inherent ability to trigger strong affective responses. For future research into music behavior to arrive at a more complete understanding of musical giftedness and what separates general music information processing from gifted music information processing, a heuristic model of gifted musical thinking, including affective behavior, bringing domain constituents together, is much needed. This is therefore the objective of this article, namely to review relevant research and in so doing propose a differentiated model of gifted musical thinking by outlining cognitive function and bringing the most probable constituents of such musical thinking together, drawing from Persson's (2009) multidimensional model of musical giftedness, which adds the significance of affective responses and emotive skills to the construct of musical giftedness.

Introduction

With an increasing number of studies research has shown that with intellectual giftedness comes also a brain that functions differently from the brain of a non-gifted individual in terms of neurophysiological correlates, and consequently also in terms of information processing characteristics (Alexander, O'Boyle & Benbow, 1996; Eysenck & Barrett, 1993; Geake, 2009; Jausovec, 2000; Ostatnikova *et al*., 2000; Shore & Dover, 1987; Singh & O'Boyle, 2004; Thompson *et al*., 2001). In regard to musical cognition and its neurophysiology, which has attracted a considerable interest in recent years, it is also clear that music cognition differs neurologically from other cognition (Koelsch, 2005; Patel, 2007; Peretz & Zatorre, 2009). However, the main focus of research has been to study music cognition in general terms viewing music as a universally human and evolutionary phenomenon. Much less attention has been paid to *gifted* musical cognition and its concomitant neurophysiology. But by the use of EEG and increasingly also neuroimaging techniques researchers have established that there are indeed structural differences as well as differences in brain activation patterns also when comparing musicians with non-musicians. Additionally, there are within-group differences between imagining music and composing music (Gaser & Schlaug, 2003; Münte, Altenmüller, & Jäncke, 2002; Parsons *et al*., 2005; Petsche *et al.,* 1993; Petsche, Von Stein & Filz, 1996; Schlaug *et al.,* 1995a; 1995b; Schneider *et al.,* 2002). There is in the literature supportive but more circumstantial evidence, empirical and anecdotal, reinforcing the notion that qualitative differences in information processing exists when comparing general music cognition with gifted music cognition also. For example, studies have demonstrated that artists and scientists differ on the biologically based personality construct of Neuroticism – Stability, where artists lean towards the neurotic and scientists towards the stable (Eysenck, 1990). Research has also shown that psychological androgyny is related to musically talented individuals in comparison to non-musically talented individuals; that physiological androgyny is an attribute specific to composers indicating that testosterone and its relation to visuospatial abilities is significant to certain types of musical abilities (Hassler, 1990; 1992). Furthermore, musical aptitude does not relate strongly to IQ, at least not in a straightforward and simple manner (Bruer, 2002; Shuter-Dyson & Gabriel, 1981; Winner, 1996;). The affective impact of music also needs to be considered in differentiating between gifted and non-gifted musical thinking on the assumption that gifted musicians are more attuned to emotion-eliciting stimuli than the general population is (cf. Bastian, 1989; Bastian & Koch, 2010; Persson, 2001; Winner & Martino, 2002). Compare with the following self-reports of gifted musical information processing:

"I carry my thoughts about with me for a long time, often for a very long time, before writing them down", Ludvig van Beethoven reminisced in a conversation with his student Louis Schlösser (in Morgenstern, 1956). "I can rely on my memory for this and can be sure that, once I have grasped a theme, I shall not forget it even years later. I change many things, discard others, and try again and again until I am satisfied; then, in my head, I begin to elaborate the work in its breadth, its narrowness, its height, its depth and, since I am aware of what I want to do, the underlying idea never deserts me. It rises, it grows, I hear and see the image in front of me from every angle, as if it had been cast [like sculpture], and only the labor of writing it down remains; a labor which need not take long … You may ask me where I obtain my ideas. I cannot answer this; they come unbidden, spontaneously or unspontaneously. I may grasp them with my hands in the open air, while walking in the woods, in the stillness of night, at early morning. Stimulated by those moods which poets turn into words, I turn into tones which resound, roar and rage until at last they stand before me in the form of notes" (p. 87).

Danish composer Vagn Holmboe (1991) outlines the genesis of his Symphony no. 6, very similarly: "… without my knowing one note of the music. It stood quite clear to me as a larger totality in my consciousness; I knew how it had to be … sounds streamed forth now as if on their own; they sang in me, and I had to use all the ability and technique I had [to manage to write it all down]" (p. 39).

Contemporary jazz flutist Paul Horn (in Boyd & George-Warren, 1992) recollects similarly, that "when I was younger I didn't know such terms as 'peak experiences,' but I used to feel really high [at least at certain times while playing music]. When I started to improvise, I found I could get up and play music, with thoughts coming, and these thoughts could be translated into music. I got an idea of what I could hear in my mind, and my inner ear would somehow find a connection [through] my arms and fingers to my instrument. That excitement is always with me. I think any time I improvise it's exciting because you don't *know*; it's always new. Intellectually by the time you've even thought about it, you're eight beats later" (p. 160).

Guitarist Bernie Larson (also in Boyd & George-Warren, 1992) have emotional experiences of an extraordinary kind whilst writing songs: "There will be times you wander from consciousness and then you'll be aware of where you're at, and at other times it's downright startling to open my eyes. I will be flying; it's just like soaring … You can be sitting there with nothing much happening and you can hear just a drumbeat, the rhythm thing will start happening and twenty minutes later you have a song sitting in front of you. And you didn't have much to do with it" (p. 168).

Swedish cellist Frans Helmerson (in Ödman, 1990) outlines the experience of a performance as a type of transcendence: "I become one with the music in that exact moment. There is a flow. The boundary between consciousness and intuition becomes fluid" (p. 251, as translated from Swedish by the current author). Famed singer Janet Baker argues in a similar fashion, that "musicians' business is emotion and sensitivity--to be the sensors of the human race" (in Crofton & Fraser, 1985; p. 112). Composer Fredrick Delius, in turn, exclaims "how can music ever be a mere intellectual speculation or a series of curious combinations of sound that can be classified like articles in a grocer's shop" (in Crofton & Fraser, 1985; p. 49).

Hence, it would appear that the musically gifted brain is indeed different from the non-musically gifted brain. These brief narratives demonstrate that irrespective of which the underlying neurological functions and cognitive processes are, performing and/or composing music is usually tied to a particular state of mind; an emotional state regarded as something positive, on occasion even as something intrusive. Even though the affective musical experience has universal appeal to a general population (Gabrielsson, 2001), generating music seems to also be a state of mind unique to a musically gifted population in terms of intensity and character.

The reason for a relative lack of attention to what could be considered *gifted* musical cognition and a musically gifted brain is likely to be dependent on the void of a satisfactory definition of what it means to be gifted. Unlike intellectual (or academic) giftedness which for a considerable time has had a generally accepted theoretical basis largely defined and measured by the IQ (Kreger-Silverman; 2009; Lohman, 2009), there is as yet no consensus amongst researchers of what it is to be musically gifted (Shuter-Dyson & Gabriel, 1981; Persson, 2009).

For cognitive and neurophysiological research to arrive at an understanding of musical giftedness and what separates general music information processing from gifted music information processing, a model of gifted musical thinking for heuristic purposes, bringing domain constituents together, is needed. This then, is the objective of this article: To propose a differentiated model of gifted musical thinking by bringing the most probable constituents of musical thinking together, drawing from Persson's (2009) multidimensional model of musical giftedness as well as from relevant empirical research.

The many aspects of human thought

The precise definition of human thinking has proven surprisingly elusive to Science. In fact, the scientific community has even been somewhat reluctant to view thinking as a single unifying concept. Thinking as a general phenomenon has mainly been the domain of philosophy and its many schools of thought and could be summarized as "the mental activity of (a) theoretical contemplation directed towards some object with a view to reaching a propositional conclusion; or (b) practical deliberation directed towards some object with a view to reaching a decision to act" (Flew, 1979; p. 353).

With the advent of computers and computer simulations providing the foundation of the cognitive revolution of the 1950s, an empirical interest in understanding the complex nature of mental activity was made possible (Hearnshaw, 1987). But, while our knowledge of cognitive processes and functions has increased tremendously because of technical innovations, the definition of thinking in terms of a general and all-inclusive architecture continues to remain elusive. Humphrey (1951), for example, explained that thinking is "what happens in experience when an organism, a human or animal, meets, recognizes and solves a problem" (p. 311). To Russian researcher Tikhomirov (1988) thinking "is a process; a cognitive activity, the products of which are characterized by a generalized and mediated reflection of reality" (p. 14), and to Monin (1992), drawing on Artificial Intelligence, thinking is outlined and made possible by a complex system consisting of a set of inter-connected elements capable of retrieving information from the environment, memorizing and retrieving it, and making goal-oriented decisions.

While these attempts at definitions are appropriate, they are also somewhat simplistic. Thinking currently tends to be conceptualized more as information processing and outlined as various cognitive functions. These have been intensely and separately studied since the beginning of the cognitive revolution focusing on memory, sensation, perception, consciousness, reasoning, problem solving, decision-making, and judgment. But, without much effort to outlining an all-inclusive model of thinking relating the various functions to one another. Research relevant to thinking thus far could therefore be said to have focused on different *aspects* of cognition rather than of thinking as a whole. Some of these aspects are, for example, creative thinking (Finke, Ward & Smith,1992), convergent and divergent thinking (Guildford, 1967), intuitive and analytical thinking (Hogarth, 2004; Peters, Hammond & Summers, 1974), critical thinking (Halpern, 1998; Kuhn, 1999; Reece, 2007), positive and negative thinking (Goodheart, 1985; MacCleod & Moore, 2000), visual thinking (Arnheim, 1969; Zhukovskiy & Pivovarov, 2008), auditory thinking as well as inner hearing (McAdams & Bigand, 1993; Brodsky, Henik, Rubinstein & Zorman, 2003), lower and higher-order thinking (Kratwohl, 2002; Lewis & Smith, 1993), thought process monitoring (metacognition) (Flavell, 1979), cognitive styles (Jonassen & Grabowski, 1993), and thinking as a normal state as opposed to an altered state of consciousness (Kirsch & Lynn, 1995; Tart, 1990). To complicate matters further it has also been suggested that there are preferential styles of thinking (Sternberg, 1997).

Needless to say, there is a great deal of overlap and confusion in theory and function, which makes comparisons between these aspects difficult at best (Ziegler & Raul, 2000). Cuban (1984) even refers to the definition of thinking skills, reasoning, critical thought, and problem solving as a “conceptual swamp”.

It is significant to observe that one aspect of cognitive processing—the emotions— has been conspicuously missing in research until quite recently, in spite of an intense pursuit of charting and understanding cognitive functions (Strongman, 1987). While the tide has turned somewhat since the beginning of the cognitive revolution, emotional cognition now is recognized as viable empirical research and is being studied more systematically both cognitively and neurophysiologically (eg. Frijda, 1986; 2007; Gainotti & Caltagirone, 1989; Ortony, Clore & Collins, 1990). But as far as musical giftedness is concerned affective behaviors as part of determining and identifying giftedness continues to remain absent.

The psychology of music, a well-established field of psychological research since the mid-1980s (Sloboda, 1986), like mainstream psychology, initially had considerable difficulties in dealing with the emotional aspects of music. Given that the ability of music to evoke emotion could cogently be understood as that which has given music a culturally universal appeal (Gabrielsson, 2001; Molnar-Szakacs & Overy, 2006), it is somewhat paradoxical that the scientific community for many years has studied music cognition completely separate from subjectivity. Much of the earlier writings on the psychology of music ignores emotion or alternatively make mention of emotion only in passing as more or less inconsequential in understanding music cognition or musical giftedness (eg. Bamberger, 1991; Deutsch, 1982; Dowling & Harwood; 1985; Seashore, 1967; Sloboda, 1985). On occasion efforts to define musical talent does take motivation and task commitment into account (eg. Haroutounian, 2002; Kay & Subotnik, 2004), which invariably falls within the notion of affective behavior. But the positive emotional experience; the hedonism of generating music, so crucial to musicians, directly dependent on the impact of the musical structure itself (Krumhansl, 2002; Peretz, 2001; Persson, Pratt, & Robson, 1996; Sloboda & Juslin, 2001), still remains unaccounted for in all definitions of musical giftedness thus far, with the exception of the Multidimensional Model of Musical Giftedness (Persson, 2009).

The Multi-Dimensional Model of Musical Giftedness

What it means to be gifted in the field of music has been studied for well over a century. Many researchers have in various ways approached a definition on the basis of memory, perceptual skills, and generative abilities (eg. Shuter-Dyson & Gabriel, 1981; Seashore, 1965). Their reasoning has been, implicitly or explicitly, that there exists one *single* cognitive capacity, sometimes argued to be subdivided into several abilities together accounting for more or less all human musical behaviors. This line of thought eventually lead Gardner (1983) to propose that musical behavior is, in fact, an intelligence in its own right; one of at least seven distinct intelligences with developmental, psychometric, and evolutionary validity. Gardner may well be correct in that musical behavior is a separate faculty and intrinsic, but not exclusively unique, to the human species. In all likelihood, while every individual can relate to music and perform music by the same token as they can speak, understand, and relate to language, it is very obvious that not everyone is gifted or becomes a gifted musician, own the behavioral attributes of such an individual, or has the necessary genetic and environmental prerequisites for developing the needed skills (Gagné, 1999; 2009). Efforts to define musical giftedness therefore, has been troubled by two main issues to date, of which one has been to confuse general musical behavior (or musical intelligence) with *gifted* musical behavior. The two are related by necessity but are clearly also not the same. The second issue has been epistemological, namely the relative reluctance of scientists to consider subjectivity as a part of understanding musical behavior in general and gifted musical behavior in particular. Eysenck (1990) and Kemp (1996), in discussing personality traits of musicians and artists, came close when demonstrating that musicians are typically characterized as being introverted and emotional. But neither researcher specifically made the connection to musical giftedness. Affective behavior, or subjectivity, in terms of motivation, conceptualization. composition, performance, and the communication of music, is an inalienable part of musicianship as demonstrated by an increasing number of empirical studies (Gabrielsson & Lindström, 2001; Juslin, 2001; Miell, Macdonald & Hargreaves, 2005; Persson, 2001; Simonton, 2001). It follows that affective behavior cannot reasonably be overlooked when conceptualizing a model of musical giftedness as a *multidimensional* phenomenon. Persson (2009) argues that such a model needs to take the following into account:

- Musical giftedness needs to be understood in terms of *core skills* common to all domains in which giftedness is to be studied or identified.
- Musical giftedness needs to be understood in terms of *key skills* specific to particular musical domains.
- Musical giftedness is dependent on heredity, but the biologically determined potential must be stimulated and allowed to develop in a suitable environment to manifest.
- The nature of stimulation and development differs between musical domains.
- Everyone has musical capacity unless there is a neurological dysfunction. But everyone is not, nor can they become, musically gifted.
- Lack of individual and developed musical skill is not to be equaled to being void of musical capacity.
- Extensive practice of skills is the only means to develop a gifted individual to mastery of those skills thereby reaching full potential.
- Identification of musical giftedness is three-dimensional: 1) objective and generalizable; 2) subjective and individual, and 3) social as based on estimated value or appreciation in a context of supply and demand.

The core skills are the core operations of musical intelligence, namely those often included in psychometrically constructed musical aptitude tests: pitch, rhythm, tempo, timbre, loudness and spatial location. However, included in this set of cognitive auditory functions should most likely also be added affective behaviors in relation to music. It is difficult to imagine any kind of musical activity without emotionality being an integral part, especially since recent neurophysiological research points towards the differentiation between emotional processing and the emotional processing of music in the brain (Peretz, 2001). However, such emotionality is clearly more important to some than it is to others, which has been demonstrated by the study of reasons for musical taste and preference (Hargreaves, 1982; Machotka, 1982; Persson, 1993).

Table 1, about here

The key skills of musical giftedness are more difficult to outline because there is as yet no agreed definition of musical domain specificity, which they are, and what constitutes them. However, while all musically gifted probably share the musical core skills, which additional skills they then need to excel in their chosen field of pursuit must by necessity differ to some degree. Drawing from a large number of studies as well as some anecdotal evidence, Persson (2009) suggests that there are tentatively three such domains: voice performance, instrument performance, and composing (including conducting and arranging). These domains are characterized by both unique and shared key skills (see Table 1). Note that voice and instrument performance are not construed as “creative” in this model. If pertaining to Western Classical music, which a majority of studies into music behavior does, replication, usually construed as performance authenticity, is often the norm for performers to follow rather than being in any way creative in terms of being generative (Persson, 2004).

A multidimensional model of gifted musical thinking

A database search using appropriate search terminology was performed employing databases PsychInfo, MedLine, and Google Scholar, yielded a surprisingly meager result in terms of empirical studies into the nature and constituents of musical thinking (Table 2). MedLine returned no hits, while PsychInfo returned 67 hits of which nine did address the issue, but these were studies published in languages other than English or dealt with musical thinking exclusively as a creative process. Google Scholar, on the other hand, returned 1.370.000 hits but of these only 10 studies were relevant. These also focused exclusively on creative processes, but three of these did indeed make use of the term musical thinking, namely Root-Bernstein (2001), Warshaw (2007) and Wille and Wille-Henning (2008).

Table 2, about here

There is no differentiation made between different types of musical giftedness in these studies. Both Wille-Henning and Root-Bernstein make comparisons between composing music and scientific reasoning arguing that these two share more in terms of their thinking processes than they are different from one another (see also Root-Bernstein & Root-Bernstein, 2004). They may well be correct, but in all likelihood mainly with respect to musically gifted composers and arrangers. Not necessarily in regard to other types of domains of musical giftedness, as research into the personality of performing musicians suggests (Eysenck, 1990; Hassler; 1990; 1992; Kemp, 1996).

As shown by the Google Scholar database search it is common in the general music literature to refer to musical thinking. It is a notion, however, that tends to be used very loosely and only rarely in a scientific context. There are a few exceptions to this, however, one being Boardman's (1989) anthology *Dimensions of Musical Thinking.* The Editor explains, that the anthology is a response to a need for schools to teach general thinking skills as applied to music and music education. The basic premise of the anthology is surprisingly that there is, in fact, nothing particularly musical about musical thinking, which is somewhat contradictory to the neurophysiological research done to date (eg. Gaser & Schlaug, 2003; Peretz, 2001). Also, no distinction is made between general thinking and gifted thinking, and the issue of emotion and music is altogether absent.

In stark contrast to Boardman's publication stands Harold E. Fiske's (2005) *Connectionist Models of Musical Thinking,* which indeed outlines a pioneering and stringent theory unique to music cognition taking as a point of departure the question of what is left in music cognition once all cultural and historical stylistic features have been removed. Fiske's theory uniquely embraces also musical expression and interpretation. Music, Fiske (1990) argues, is a metalanguage and the outcome of the human ability to generate an indefinitely large number of tonal-rhythmic patterns. Unlike the human ability for language, however, musical patterns hold no propositional content. Musical content therefore, Fiske suggests, is limited to the found significance of inter-pattern relationships. Musical understanding is divided into cognitive process and sociological phenomenon. Musical understanding is at its most basic level "the construction and intercomparison of pitch-durational patterns. From this comparison activity, on-going decision-making about successive and nonsuccessive interrelationships is carried out" (Fiske & Royal, 2002; p. 79). No attempt is made by Fiske either to consider gifted cognition as opposed to non-gifted cognition, and the matter of subjectivity--so important to the gifted musicians themselves--is again avoided.

A third model of specific musical thinking is historical and from the latter years of the 19th century, namely the model of German physician and anatomist August Knoblauch (Johnson & Graziano, 2003). He outlined a detailed model of music processing, hypothesized the existence of nine disorders of music production and perception, and coined the term "amusia". Knoblauch relied to a great extent on contemporary knowledge of language processing, did also not address emotions, but viewed music processing as consisting of several abilities.

So, what could be considered "gifted musical thinking"? Hellmuth Petsche (in Revers, Fink & Kerenyi, 1979), as one of the pioneering neurophysiologists to turn to study the musically gifted brain systematically, reflects that "if I were to be asked how to explain music by means of neurophysiology, I would have to disappoint. No one can answer this question for the simple reason that the question itself is flawed … The only way [in which to understand] the various phenomena involved in experiencing music, is to [view the results of neurophysiological study] as mimicking these as coordinate systems resulting from experiments. When I say that I experience joy because of a piece of music, there certainly are changes in potentials deep inside the brain, but we cannot from this deduce that we have found the essence of the musical experience. Such a finding is only one piece of a complex mosaic, and knowing the neurophysiological correlate to my musical experience is merely a piece of this mosaic" (p. 84, translated from German by the present author). Following this line of thought, it appears ill advised to view musical thinking at any level in terms of a reductionist neurological model only. Musical thinking cannot be viewed as merely a neuronal activity. It also has a function, presumably evolutionary in nature (Cross, 2001). It most certainly has a culture-bound phenomenology (Blacking, 1990; Merriam, 1964), and there is in all likelihood differentiation between musical thinking in a general sense applying to all of humanity and musical thinking particular to individuals gifted in music.

A useful line of theory and research in outlining musical thinking is to frame cognitive functions involved in the processing of musical stimuli as lower order thinking and higher order thinking in accordance with *Bloom's Taxonomy of Educational Objectives* (Bloom *et al*., 1956) and its recent revision as well as elaboration by Andersen and associates (2001) and Hanna (2007). Higher order thinking occurs when a person takes new information and information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations (Lewis & Smith, 1993). Lower order thinking, by implication, is the very opposite, namely when interrelating, rearranging, and extending information does *not* occur. Hence, there is little or no problem solving in operation. This definition, however, is still inadequate in completely framing a musical thought process, and quite possibly in considering *any* higher order thinking process (cf. Krathwohl, Bloom, & Masia, 1964), the reason being that higher order thinking is invariably tied to expertise and operating skills at an expert level, which is in turn tied to a flow state: a merging of action and awareness occurring during perceived mastery (Alexander, 2003; Nakamura, 1988; Nakamura & Csikszentmihalyi, 2005). Flow is also a useful term in this context, although not unique in content. Other research traditions speak of Altered State of Awareness or Peak Experiences. In either case, they all refer to related affective states experienced as exceedingly positive, and they are often tied to various aspects of a generative process (eg. Estrada, Isen & Young, 1994; Kirsch & Lynn; 1995; Krippner, 1990; Russ, 1993)

First, what differentiates everyday musical thinking from gifted musical thinking? Music is everywhere in modern society and has multiple purposes. Most people tend to be consumers of music. Music in contemporary society is either used intentionally and in public as a background to manipulate consumer behavior (eg. Dubé, Chabat, & Morin, 2006) or personally for the purpose of building an identity in a group, keeping group cohesiveness, or is listened to passively for aesthetic pleasure or mood management (Hargreaves & North, 1999). A great many also sing and play instruments or are in the process of learning (Lamont, Hargreaves, Marshall, & Tarrant (2003). However, in this context there is a need to differentiate between playing or singing at a relatively basic level as characterized by lower order thinking (in taxonomical terms being able to remember, understand, and apply the basics of a skill) and at an advanced level as characterized by higher order thinking (being able use one's skill to analyze, evaluate, and create music at a more advanced level). Musical thinking for most individuals tends to be one which could be understood as of the lower order, and could be therefore also be outlined as a fundamental aesthetic response (Figure 1), which is indeed characterized mainly by passive input. It does not necessarily lead to a musical output in terms of any of the attributes more associated with higher order musical thinking. While there are several taxonomies of aesthetic responses differing in nomenclature (see Persson, 1993 for an overview), they all have in common that reactions to musical stimuli fall on a dichotomous dimension where affective response is pitted against intellectual (or analytical) response (cf. Armstrong & Detweiler-Bedell, 2008). Hargreaves (1982), for example, differentiates between five responses. Of these two are objective in nature: a) The objective-analytic in which the listener refers to the more technical aspects of what they hear (eg. I hear a piano playing), and b) The objective-global response, which is still technical but is characterized by a more holistic reaction (eg. This is modern music). There is also the purely c) affective and evaluative response as the listener reports the experience of certain emotional states as a direct result of the music (eg. feeling sad, happy,

Figure 1, about here

weird music, horrible music). The listener may also react d) by associations evoked by the music listened to (eg. I can hear birds; it reminds me of Paris). An aesthetic response may also be e) categorical. That is, the listener intellectually labels the music as typical of a certain style or genre (eg. This is Classical music, this is Country & Western).

For someone musically gifted the processing of musical information is by necessity more complex and also has a different function, namely to create, recreate, generate, and/or intentionally communicate a musical product. Needless to say, lower order musical thinking may develop into higher order musical thinking given that the necessary prerequisites are present such as genetic potential (Hunt, 1997), including a considerable capacity for processing and learning all things musical with ease and efficiency, socio-emotional support during development from master musicians (Manturzewska, 1990), and a very large investment in time practicing motor skills as well as cognitive skills (Ericsson, Krampe, & Tesch-Römer,1993; Hallam, 2001; Haroutounian, 2002; Harnischmacher, 1997; Nielsen, 2001). It is also likely that personality--especially in terms of how an individual relates to neuroticism and introversion plays a significant role (Eysenck, 1990; Kemp, 1996). It is of course possible for most to develop at least a degree of higher order musical thinking. To this all responsible education aspires (Boardman, 1989; Halpern, 1998), but the difference between the gifted and the non-gifted is nevertheless one of domain specific processing speed, metacognition, problem solving (Hettinger-Steiner & Carr, 2003; Swanson, 1992), and I shall argue also one of flow, affective intensity, sensitivity, and emotive skills (cf. Bastian, 1989; Bastian & Koch, 2010; Scherer, 2004; Scherer & Zentner, 2001).

Gifted musical thinking also needs to be considered in the light of musical giftedness as a differentiated construct. It is not feasible to view giftedness in music as one single domain of gifted behavior as discussed earlier. The Multidimensional Model of Musical Giftedness (Persson, 2009), suggests at least three such qualitatively different domains: Instrumental, Voice, and Composing (including arranging and tentatively conducting). It follows that if there is a difference in type of skills harnessed in developing as well as operationalizing each domain, then the nature and content of musical thinking will to some extent also differ between these domains (Figure 2).

The construction of a musical reality is invariably the foundation of gifted musical thinking for all the three domains. Musical reality is defined as "the subjective, dynamic, emotional basis from which musicians draw motivation, construe artistic understanding, and generate [musical products]" (Persson, 2001; p. 284). However, the construction of musical understanding may differ according to personal preference (Persson, 1993; 2001). Some like to apply visual imagery and tie it to the dynamics of the musical structure (semblance), while others do not indulge in visual imagery at all but rather focus on the flow of affective responses (mood). Others allow music to suggest imagery to them (mood + semblence). There are also those who ignore the possibilities of the musical structure to trigger affective responses and choose to focus on a norm. That is, they aim at authenticity being true to the style a certain composer or historical period (idiom). Finally, there are also musicians who completely ignore mood, semblence, or idiom, and focus exclusively on musical structure. Irrespective of which kind, it is important to observe that an understanding of the music to be learnt or created is always construed in accordance with some kind of personal *subjective* significance; one which gifted musicians often appear unwilling to abandon or reconstrue once learned and settled (Mayer, Allen & Beauregard, 1995; Persson, 1993).

The three domains of musical giftedness share metacognitive functions; or metaperception in Haroutounian's (2002) terminology, which is "the artistic counterpart to metacognition … describing the cognitive/perceptual functioning of a musician or any artist while making interpretive decisions" (p. xvi), as well as the state of flow relating to executing a skill at an expertise level. The experience involves a sense of control; or more precisely lacking the sense of worry about losing control yielding a strong and positive emotional experience (Csikszentmihalyi, 1992).

Figure 2, about here

Tied to the state of flow is the cognition of motor skills for the instrument and voice performer. Motor skills are of less significance to a composer, arranger, or a conductor, although it is not uncommon for gifted performers to be gifted composers or conductors also. Unique to the latter domain, however, is usually inner hearing, which Campbell (1989) explains is that, which, when using music notation, an individual "hears what he sees, and sees what he hears," once the skill has been developed. Gordon (1995) terms this phenomenon audiation defining it as hearing and comprehending music for which the sound is no longer or never has present. Audiation is to music what thinking is to language. Brodsky and associate researchers (2003) suggest that this ability is the most outstanding mark of a gifted musical mind. Interestingly, it appears that this ability is tied to cognitive motor processing because of rhythm. This is unique to musical thinking as opposed to other thinking (Brodsky *et al*., 2008; Chen, Zatorre & Penhune, 2006). While all gifted musicians are likely to have the ability developed in a way that differentiates them from non-musicians, the ability of inner hearing is useful but probably not necessary to a performer. For conductors, composers, and arrangers, on the other hand, it is the most striking feature about their domain of giftedness, as previously shown. As legendary conductor Hans von Bülow allegedly argued in his time: "A good conductor has the score in his head, not his head in the score" (in Bamberger, 1989). However, EEG patterns are different when composing music as opposed to imagining music by inner hearing (Petsche *et al.,* 1993; Petsche, Von Stein & Filz, 1996), suggesting that conductors may rely on different cognitive skills than do composers and arrangers. It is perhaps significant, too, to note that the origin of conducting was once more a matter of organizing than it was of artistic instruction and musical interpretation (Bamberger, 1989), so leadership skills are potentially also part of conducting. It would seem that conducting is a musical giftedness domain in its own right. However, I have chosen to group conductors, composers, and arrangers together as based on the common denominator of inner hearing for the time being. Hence the bracketing of "conductor" in Figure 2. The reason is that conducting is virtually uncharted territory in musical giftedness research, much unlike musical performance, singing, and composing/arranging music. Conductors have thus far been studied more as historical and even mythical personalities rather than empirically teasing out what constitutes an expert conductor (eg. Kenyon, 1989; Lebrecht, 1992; Osborne, 1990).

One aspect of gifted musical thinking, more or less unique to giftedness in the performance domain, is affective Self-induction: Performers tend to "get into the mood" of a piece that they are about to perform by either remembering an emotional state, or conjuring up an event from memory which induces the desired emotional state (Persson, 1993; 2001). This strategy is much the same as actors do using the so-called Stanislavski Method of Acting, which teaches mood induction as a means of "getting into the role character" (cf. Cameron, 1999; Konijn, 1995; Stanislavski, 1991). However, induction by imagination is also a common and effective clinical strategy for inducing a hypnotic state (Westermann, Spies, Stahl, & Hesse, 1996). Performers, interestingly, learn such emotive skills intuitively. Composers, in comparison, seem not to be reliant on such self-induction, which is not to say that they are necessarily less impressed by, or moved by, the emotional cues contained in musical structures. I propose, however, that a flow state is more significant to a composer. Vagn Holmboe (1991), for example, typically argues that, "inner hearing is essential, but it turns to musical thinking only when you are activated mentally and are not merely listening to the sound of the words or the notes. You can mentally combine notes into constructive unities, connect them with varied rhythms and sonorities, have combinations of notes arise, resolve them and form new ones--you can develop them, shape and finalize their form in a purely mental process. Thus we can speak of musical thinking, and this process plainly parallel with the poet's or scientists thinking in words, images, formulae, or abstract concepts" (p. 51-52). Researchers have indeed discovered that the musically *creative* process in many ways is much like that of a scientist's (Collins, 2005; Root-Bernstein, 2001; Root-Bernstein & Root-Bernstein, 2004; Wille & Wille-Henning, 2008). Hence, while the gifted composer and arranger could be considered cognitively as a type of musical scientist, the performers tend to be cognitively more attuned to a global kind of emotional reality. It needs to be remembered also that in Western Classical music performers usually have very limited possibilities of being creative. They generate performances but performers tend not be creative by the same token as composers and arrangers are creative. Rather, they follow established performance norms, and are more accurately characterized as being *recreative* (Persson, 2004; Polony, 1995).

Unique to voice performers is acting/role playing. It is difficult to imagine any singer without a talent for also embodying role characters or physically expressing the meaning of sung texts. Flow states are importance also in acting as Martin and Jackson point out (2008), but the acting skill has been defined more or less as one of expert memory for lines and characters (Noice & Noice, 1997; 2006).

The model of gifted musical thinking contains a dynamic feedback mechanism relevant to all musical giftedness domains. Any performance (recreation) or creative process is constantly monitored by musicians to communicate, optimize emotional response and/or achieve certain ideals or norms continuously in accordance with the conceptualized musical reality, the unfolding of the musical structure, or with situational factors such as audience response, perceived expectations, and demands. Stage fright will affect gifted musical thinking and will change it dramatically: The evolutionary fight or flight response has precedence over flow and the unfolding of the positive emotion-based artistic expression (Fredrikson & Gunnarsson, 1992; Steptoe & Malik, 1995).

In conclusion, the presented model of gifted musical thinking is by no means complete. I have willfully been parsimonious when outlining the proposed domain constituents as well as the flow of functions (Figures 1 & 2). However, the advantage of this effort has been to add emotion to gifted musical thinking as well as placing emotion in a differentiated functional context. Hence, I have met with two important challenges in giftedness research: I have pointed out the inalienable significance of affective function as emotive skills in musical giftedness, and I have on a solid basis of increasing numbers of empirical studies also demonstrated that there is no such thing as *one* domain of musical giftedness. There are by necessity several! These are related to musical intelligence in a Gardnerian (1983) sense, but they are not the same as musical intelligence pertaining to a general population. Musical giftedness must be studied differentially and domain-specifically. These basic aspects of musical giftedness are paramount for further future cognitive, educational, neurophysiological studies of music.

References

Alexander, P. A. (2003). The development of Expertise: The journey from acclimation to proficiency. *Educational Researcher*, 32(8), 10-14.

Alexander, J. E., O'Boyle, M. W., & Benbow, C. P. (1996). Developmentally advanced EEG alpha power in gifted male and female adolescents. *International Journal of Psychophysiology*, 23, 25-31.

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., Raths, J., & Wittrock, M. C. (Eds.). (2001) *A taxonomy for learning, teaching, and assessing. A revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman,

Armstrong, T., & Detweiler-Bedell, B. (2008). Beauty as an emotion: the exhilarating prospect of mastering a challenging world. *Review of General Psychology*, 12(4), 305-329.

Arnheim, R. (1969). *Visual thinking*. Berkley, CA: University of California Press.

Bamberger, C. (1989). *The conductor's art*. New York: Columbia University Press.

Bamberger, J. (1991). *The mind behind the musical ear. How children develop musical intelligence*. Cambridge, MA: Harvard University Press.

Bastian, H. G. (1989). *Leben für Musik. Eine Biographie-Studie über musikalische (Hoch-) Begabungen* [To live for music. A biographical study of musical high ability]. Mainz, Germany: Schott.

Bastian, H. G., & Koch, M. (2010). *Vom Karrieretraum zur Traumkarriere? Eine Langzeitstudie über musikalische Hochbegabte* [From dreams of a carrier to a dream carrier? A longitudinal study of musical high ability]. Mainz, Germany: Schott.

Blacking, J. (1990). *A commonsense view of all music*. Cambridge, UK: Cambridge University Press.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *A taxonomy of educational objectives. Handbook 1: Cognitive Domain*. New York: David McKay.

Boyd, J., & George-Warren, H. (1992). *Musicians in tune. Seventy-five contemporary musicians discuss the creative process.* New York: Fireside/Simon & Schuster.

Boardman, E. (1989). *Dimensions of musical thinking*. Reston, VA: Music Educators National Conference.

Brodsky, W., Henik, A., Rubinstein, B., & Zorman, M. (2003). Auditory imagery from musical notation in expert musicians. *Perception & Psychophysics*, 65(4), 602-612.

Brodsky, W., Kessler, Y., Ginsborg, J., Rubinstein, B. S., & Henik, A. (2008). The mental representation of music notation: notational audiation. *Journal of Experimental Psychology*, 34(2), 427-445.

Bruer, J. T. (2002). *The myth of the first three years. A new understanding of early brain development and lifelong learning*. New York: Free Press.

Cameron, R. (1999). *Acting skills for life* (3rd ed.). Toronto: Dundurn Press.

Campbell, P. S. (1989). Dalcroze reconstructed: an application of music learning theory to the principles of Jacques Dalcroze. In D. L. Walters & C. C. Taggart (eds.), *Readings in Music Learning Theory* (pp. 301-315). Chicago, Ill: GIA Publishers, Inc.

Chen, J. L., Zatorre, R. J., & Penhune, V. B. (2006). Interactions between auditory and dorsal premotor cortex during synchronization to musical rhythms. *NeuroImage*, 32, 1771-1781.

Collins, D. (2005). A synthesis process model of creative thinking in music composition. *Psychology of Music*, 33(2), 193-216.

Crofton, I., & Fraser, D. (1985). *A dictionary of musical quotations*. London: Routledge.

Cross, I. (2001). Music, cognition, culture, and evolution. *Annals of the New York Academy of Sciences*, 930, 28-42.

Csikszentmihalyi, M. (1992). *Flow. The psychology of happiness*. London: Rider.

Cuban, L. (1984). Policy and research dilemmas in the teaching of reasoning: unplanned designs. *Review of Educational Research*, 54, 655-681.

Deutsch, D. (1982). *The psychology of music*. San Diego, CA: Academic Press, Inc.

Dowling, W. J., & Harwood, D. L. (1985). *Music cognition.* San Diego, CA: Academic Press, Inc.

Dubé, L., Chebat, J-C., & Morin, S. (2006). The effects of background music on consumers' desire to affiliate in buyer-seller interactions. *Psychology and Marketing*, 12(4), 305-319.

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100(3), 363-406.

Estrada, C. A., Isen, A. M., & Young, M. J. (1994). Positive affect improves creative problem solving and influences reported source of practice satisfaction in physicians. *Motivation and Emotion*. 18(4), 285-299.

Eysenck, H. J. (1990). Biological dimensions of personality. In L. Pervin (Ed.), *Handbook of personality research and theory* (pp. 244-276). New York: Guilford Press.

Eysenck, H. J., & Barrett, P. T. (1993). Brain research related to giftedness. In K. A. Heller, F. J. Mönks & A. Harry Passow (Eds.), *International handbook of research and development of giftedness and talent* (pp. 115-131). Oxford, UK: Pergamon.

Finke, R. A., Ward, T. B., & Smith, S. M. (1992). *Creative cognition. Theory, research, and applications.* Cambridge, MA: The MIT Press.

Fiske, H. E. (1990). *Music and mind. Philosophical essays on the cognition and meaning of music.* Lewiston, NY: Mellen Press.

Fiske, H. E. (2005). *Connectionist models of musical thinking.* Lewiston, NY: Mellen Press.

Fiske, H. E., & Royal, M. (2002). Musical understanding: cognition and enculturaltion. In B. Hanley & T. W. Goolsby (Eds.), *Musical understanding: perspectives in theory and practice* (pp. 71-90). Sydney, Nova Scotia: Canadian Music Educators Association.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist*, 34(10), 906-911.

Flew, A. (1979). Thinking. In: *A dictionary of philosophy* (p. 353). London: Pan Reference.

Fredrikson, M., & Gunnarsson, R. (1992). Psychobiology of stage fright: the effect of public performance on neuroendpcrine, cardiovascular, and subjective reactions. *Biological Psychology*, 33(1), 51-61.

Frijda, N. H. (1986). *The emotions. Studies in emotion and social interaction.* Cambridge, UK: Cambridge University Press.

Frijda, N. (2008). Emotions. In K. Pawlik & M. R. Rosenzweig (Eds.), *The International Handbook of Psychology*. Thousand Oaks, CA: Sage Publications. http://www.sageereference.com/hdbk_intlpsych/Article_n12.html

Gabrielsson, A. (2001). Emotions in strong experiences with music. In P. N. Juslin & J. A. Sloboda (eds.), *Music and emotion. Theory and research* (pp. 431-452). Oxford, UK: Oxford University Press.

Gabrielsson, A., & Lindström, E. (2001). The influence of musical structure on emotional expression. In P. N. Juslin & J. A. Sloboda (eds.), *Music and emotion. Theory and research* (pp. 223-248). Oxford, UK: Oxford University Press.

Gagné, F. (1999). Nature or nurture? A re-examination of Sloboda and Howe's (1991) interview study. *Psychology of Music*, 27. 38-51.

Gagné, F. (2009). Debating giftedness: pronat vs. antinat. In L. V. Shavinina (Ed.), *International handbook of giftedness* (pp. 155-204). Dordrecht, NL: Springer Science.

Gainotti, G., & Caltagirone, C. (1989). *Emotions and the dual brain*. New York: Springer-Verlag.

Gardner, H. (1983). *Frames of mind. The theory of multiple intelligences*. New York: Basic Books.

Gaser, C., & Schlaugh. G. (2003). Brain structures differ between musicians and non-musicians. *The Journal of Neuroscience*, 23(27), 9240-9245.

Geake, J. G. (2009). Neuropsychological characteristics of academic and creative giftedness. In L. V. Shavinina (Ed.), *International handbook of giftedness* (pp. 261-273). Dordrecht, NL: Springer Science.

Goodheart, D. E. (1985). Some psychological effects associated with positive and negative thinking about stressful event outcomes: Was Pollyanna right? *Journal of Personality and Social Psychology*, 48(1), 216-232.

Gordon, E. E. (1995). Testing musical aptitudes from preschool through college. In M. Manturzewska, K. Milkaszewski & A. Bialkowski (eds.), *Psychology of music today* (pp. 170-176). Warsaw, Poland: Fryderyk Chopin Academy of Music.

Guildford, J. P. (1967). *The nature of human intelligence*. New York: McGraw-Hill.

Halpern, D. F. (1998). Teaching critical thinking for transfer across domains: Dispositions, skills, structure training, and metacognitive monitoring. *American Psychologist*, 53(4), 449-455.

Hallam, S. (2001). The development of metacognition in musicians: implications for education. *British Journal of Music Education*, 18(1), 27-39.

Hanna, W. (2007). The new Bloom's Taxonomy: implications for music education. *Arts Education Policy Review*, 108(4), 7-16.

Hargreaves, D. J. (1982). The development of aesthetic reactions to music. *Psychology of Music*, Special Issue, 51-54.

Hargreaves, D. J., & North, A. C. (1999). The functions of music in everyday life: redefining the social in music psychology. *Psychology of Music*, 27, 71-83.

Harnischmacher, C. (1997). The effects of individual differences in motivation, volition, and maturational processes on practice behavior of young instrumentalists. In H. Jørgensen (ed.), *Does practice make perfect? Current theory and research on instrumental music practice* (pp. 71-87). Oslo, Norway: Norges musikkhøgskole.

Haroutounian, J. (2002). *Kindling the spark. Recognizing and developing musical talent*. New York: Oxford University Press.

Hassler, M. (1990). *Androgynie. Eine experimentelle Studie über Geschlechtshormone, räumlische Begabung und Kompositionstalent* [Androgyny. An experimental study of sex hormones, visuo-spatial talent, and giftedness for composing]. Göttingen, Germany: Hogrefe.

Hassler, M. (1992). Creative musical behavior and sex hormones: musical talent and spatial ability in the two sexes. Neuroendocrinology, 17(1), 55-70.

Hearnshaw, L. S. (1987). *The shaping of modern psychology. An historical introduction.* London: Routledge.

Hettinger-Steiner, H., & Carr, M. (2003). Cognitive development in gifted children: towards a more precise understanding of emerging differences in intelligence. *Educational Psychology Review*, 15(3), 215-246.

Hogarth, R. M. (2004). Deciding analytically or trusting your intuition? The advantages and disadvantages of analytical and intuitive thought. In T. Betsch & S. Haberstroh (Eds.), *The routines of decision making* (pp. 64-82). Mahwah, NJ: Lawrence Erlbaum.

Holmboe, V. (1991). *Experiencing music: a composer's notes* (Translated by P. Rapoport). London: Toccata Press.

Humphrey, G. W. (1951). *Thinking: an introduction to its experimental psychology*. London: Methuen.

Hunt, E. (1997). Nurture vs. Nature: a feeling of dejá vu. In R. J. Sternberg & E. Grigorenko (eds.), *Intelligence, heredity, and environment* (pp. 531-551). Cambridge, UK: Cambridge University Press.

Jausovec, N. (2000). Differences in cognitive processes between gifted, intelligent, creative, and average individuals while solving complex problems: an EEG study. *Intelligence*, 28(3), 213-237.

Johnson, J. K., & Graziano, A. B. (2003). August Knoblauch and amusia: a nineteenth-century cognitive model of music. *Brain and Cognition*, 51, 102-114.

Jonassen, D. H., & Grabowski, B. L. (1993). *Handbook of individual differences, learning, and instruction*. Hillsdale, NJ: Lawrence Erlbaum.

Juslin, P. N. (2001). Communication emotions in music performance: a review and a theoretical framework. . In P. N. Juslin & J. A. Sloboda (eds.), *Music and emotion. Theory and research* (pp. 309-340). Oxford, UK: Oxford University Press.

Kay, S. I., & Subotnik, R. F. (2004). Talent beyond words: unveiling spatial, expressive, kinesthetic, and musical talent in young children. In E. Zimmerman (Ed.), *Artistically and musically talented students* (pp. 73-82). Thousand Oaks, CA: Corwin Press.

Kemp, A. E. (1996). *The musical temperament. Psychology and personality of musicians.* Oxford, UK. Oxford University Press.

Kenyon, N. (1989). *Simon Rattle. The making of a conductor*. London: Faber & Faber.

Kirsch, I., & Lynn, S. J. (1995, October). The altered state of hypnosis. Changes in the theoretical landscape. *American Psychologist*, 50(10), 846-858.

Koelsch, S. (2005). Neural substrates of processing syntax and semantics in music. *Current Opinion in Neurobiology*, 15, 1-6.

Konijn, E. (1995). Actors and emotions: a psychological perspective. *Theatre Research International,* 20, 132-140.

Kratwohl, D. R. (2002). A revision of Bloom's Taxonomy: An overview. *Theory Into Practice*, 41(1), 212-264.

Krathwohl, D. R., Bloom, B. S., & Masia, B. B. (1964). *Taxonomy of educational objectives. Handbook II: Affective domain*. New York: David McKay Co.

Kreger-Silverman, L. (2009). The measurement of giftedness. In L. V. Shavinina (Ed.), *International handbook of giftedness* (pp. 947-970). Dordrecht, NL: Springer Science.

Krippner, S. (1990). Psychedelics, hypnosis, and creativity. In C. T. Tart (Ed.), *Alterered states of consciousness* (pp. 324-349). San Fransisco, CA: HarperSanFransisco.

Krumhansl, C. (2002). Music: A link between cognition and emotion. *Directions in Psychological Science*. 11, 45-50.

Kuhn, D. (1999). A developmental model of critical thinking. *Educational Researcher*, 28(2), 16-26, 46.

Lamont, A., Hargreaves, D. J., Marshall, N. A., & Tarrant, M. (2003). Young people's music in and out of school. *British Journal of Music Education*, 20(3), 229-241.

Lebrecht, N. (1992). *The maestro myth. Great conductors in pursuit of power*. New York: Simon & Schuster.

Lewis, A., & Smith, D. (1993). Defining higher order thinking. *Theory Into Practice*, 32(3), 131-137.

Lohman, D. F. (2009). Identifying academically talented students: some general principles, two specific procedures. In L. V. Shavinina (Ed.), *International handbook of giftedness* (pp. 971-997). Dordrecht, NL: Springer Science.

MacCleod, A. K., & Moore, R. (2000). Positive thinking revisited. Positive cognitions, well-being and mental health. *Clinical Psychology and Psychotherapy*, 7, 1-10.

Machotka, P. (1982). Esthetic judgment warm and cool: cognitive and affective determinants. *Journal of Personality and Social Psychology*, 42, 100-107.

Manturzewska, M. (1990). A biographical study of the life span development of professional musicians. *Psychology of Music*, 18, 112-139

Martin, A. J., & Jackson, S. A. (2008). Brief approaches to assessing task absorption and enhanced subjective experience: examining 'short' and 'core' flow I diverse performance domains. *Motivation and Emotion*, 32, 141-157.

Mayer, J. D., Allen, J. P., & Beauregard, K. (1995). Mood inductions for four specific moods: a procedure for employing guided imagery vignettes with music. *Journal of Mental Imagery*, 19(1&2), 133-150.

McAdams, S., & Bigand, E. (1993). *Thinking in sound. The cognitive psychology of human audition.* Oxford, UK: Clarendon Press.

Merrian, A. P. (1964). *The anthropology of music*. Evanston, Il: Northwestern University Press.

Miell, D., Macdonald, R., & Hargreaves, D. J. (2005). *Musical communication*. Oxford, UK: Oxford University Press.

Molnar-Szakacs, I., & Overy, K. (2006). Music and mirror neurons: from motion to 'e'motion. *Social Cognitive and Affective Neuroscience*, 1(3), 235-241.

Monin, A. S. (1992, July). On the definition of the concepts of thinking, consciousness, and conscience. *Proceedings of the National Academy of Sciences of the United States of America,* 89, 5774-5778.

Morgenstern, S. (1956). *Composers on music. An Anthology of composers' writings from Palestrina to Copeland*. New York: Pantheon Books.

Münte, T. F., Altenmüller, E., & Jäncke, L. (2002). The musician's brain as a model of neuroplasticity. *Nature Neuroscience*, 3, 473-478.

Nakamura, J. (1988). Optimal experience and the uses of talent. In M. Csiszentmihalyi & I. Selega-Csikszentmihalyi (Eds.), *Optimal experience. Psychological studies of flow in consciousness* (pp. 319-326). New York: Cambridge University Press.

Nakamura, J., & Csikszentmihalyi, M. (2005). The concept of flow. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of Positive Psychology* (pp. 89-105). New York: Oxford University Press.

Nielsen, S. (2001). Self-regulating learning strategies in instrumental practice. *Music Education Research*, 3(2), 155-167.

Noice, T., & Noice, H. (1997). *The nature of expertise in professional acting: A cognitive view*. Mahwah, NJ: Erlbaum.

Noice, H., & Noice, T. (2006). Studies of actors and acting can tell us about memory and cognitive functioning. *Current Directions in Psychological Science*, 15(1), 16-18.

Ödman, M. (Ed). (1990). *Om kreativitet och flow* [On creativity of flow]. Stockholm: Brombergs.

Ortony, A., Clore, G. L., & Collins, A. (1990). *The cognitive structure of emotions.* Cambridge, UK: Cambridge University Press.

Osborne, R. (1990). *Conversations with Karajan*. Oxford, UK: Oxford University Press.

Ostatnikova, D., Laznibatova, J., Putz, Z., Matasje, A., Dohmamyiova, M., & Pastor, K. (2000). Salivary testosterone levels in intellectually gifted and non-intellectually gifted preadolescents: An exploratory study. *High Ability Studies*, 11(1), 41-54.

Parsons, L. M., Sergent, J., Hodges, D. A., & Fox, P. T. (2005). The brain basis of piano performance. *Neuropsychologia*, 43, 199-215.

Patel, A. D. (2008). *Music, language, and the brain.* New York: Oxford University Press.

Peretz, I. (2001). Listen to the brain: a biological perspective on musical emotions. In P. N. Juslin & J. A. Sloboda (eds.), *Music and emotion. Theory and research* (pp. 105-134). Oxford, UK: Oxford University Press.

Peretz, I., & Zatorre, R. (2009). *The cognitive neuroscience of music*. New York: Oxford University Press.

Persson, R. S. (1993). *The subjectivity of musical performance. An exploratory music-psychological real world enquiry into the determinants and education of musical reality* (Doctoral dissertation, School of Human and Health Sciences, University of Huddersfield). Boston Spa, Wetherby, UK: The British Library Document Supply Centre.

Persson, R. S. (2001). The subjective world of the performer. . In P. N. Juslin & J. A. Sloboda (eds.), *Music and emotion. Theory and research* (pp. 275-290). Oxford, UK: Oxford University Press.

Persson, R. S. (2004, December). Where tradition may get in the way of musical development: The case of learning an instrument. *Education Today,* 54(4), 4-7.

Persson, R. S. (2009). The elusive muse: understanding musical giftedness. In L. V. Shavinina (Ed.), *International handbook of giftedness* (pp. 727-750). Dordrecht, NL: Springer Science.

Persson, R. S. & Robson, C. (1995). The Limits of Experimentation: On Researching Musicians and Musical Settings. *Psychology of Music. 23(1), 39-47.*

Persson, R. S., Pratt, G., & Robson, C. (1996). Motivational and influential components of musical performance: a qualitative analysis. In A. J. Cropley & D. Dehn (Eds.), *Fostering the growth of high ability: European perspectives* (pp. 287-301). Norwood, NJ: Ablex.

Peters, J. T., Hammond, K. R., & Summers, D. A. (1974). A note on intuitive vs analytic thinking. *Organizational behavior and human performance*, 12, 125-131.

Petsche, H., Richter, P., Von Stein, A., & Etlinger, S. C. (1993). EEG Coherence and musical thinking. *Music Perception*, 11(2), 117-151.

Petsche, H., Von Stein, A., & Filz, O. (1996). EEG aspects of mentally playing an instrument. *Cognitive Brain Research*, 3, 115-123.

Polony, L. (1995). Krystian Zimerman's reproductive art. In M. Manturzewska, K. Miklaszewski & A. Bialkowski (Eds.), *Psychology of music today* (pp. 295-302). Warsaw, Poland: Fryderyk Chopin Academy of Music.

Reece, G. J. (2007). Critical thinking and cognitive transfer: implications for the development of online information literacy tutorials. *Research Strategies*, 20, 482-493.

Revers, W. F., Fink, E., & Kerenyi, K. (1979). *Mensch und Musik. Ein Festschrift für Herbert von Karajan* [Man and music. In celebration of Herbert von Karajan]. Salzburg, Austria: Otto Müller Verlag.

Root-Bernstein, R. S. (2001). Music, creativity, and scientific thinking. *Leonardo* 34(1), 63-68.

Root-Bernstein, R., & Root-Bernstein, M. (2004). Artistic scientists and the scientific artists: the link between polymathy and creativity. In R. J. Sternberg, E. L., Grigorenko, & J. L. Singer (Eds.), *Creativity: From potential to realization* (pp.127-151). Washington, D.C.: American Psychological Association.

Russ, S. W. (1993). *Affect & creativity. The role of affect and play in the creative process.* Hillsdale, NJ: Lawrence Erlbaum.

Scherer, K. R. (2004). Which emotions can be induced by music? What are the underlying mechanisms? And how can we measure them? *Journal of New Music Research*, 33(3), 239-251.

Scherer, K. R., & Zentner, M. R. (2001). Emotional effects of music: production rules. In P. N. Juslin & J. A. Sloboda (eds.), *Music and emotion. Theory and research* (pp. 361-392). Oxford, UK: Oxford University Press.

Schlaug, G., Jäncke, L., Huang, Y., Staiger, J., & Steinmetz, H. (1995a). Increased corpus callosum size in musicians. *Neuropsychologia*, 33, 1047-1055.

Schlaug, G., Jäncke, L., Huang, Y., Staiger, J., & Steinmetz, H. (1995b). In vivo evidence of structural brain asymmetry in musicians. *Science,* 267, 699-701.

Schneider, P., Scherg, M., Dosch, H., Specht, H. J., Gottschalk, A., & Rupp, A. (2002). Morphology of Heschl's Gyrus reflects enhanced activation in the auditory cortex of musicians. *Nature Neuroscience*, 5 (7), 688-694.

Seashore, C. E. (1967). *Psychology of music*. New York: Dover Publications.

Simonton, D. K. (2001). Emotion and composition in Classical music: historiometric perspectives. . In P. N. Juslin & J. A. Sloboda (eds.), *Music and emotion. Theory and research* (pp. 205-222). Oxford, UK: Oxford University Press.

Singh, H., & O'Boyle, M. W. (2004). Intehemispheric interaction during global-local processing in mathematically gifted adolscents, average-ability youth, and college students. *Neuropsychology*, 18(2), 371-377.

Shore, B. M., & Dover, A. C. (1987). Metacognition, intelligence and giftedness. *Gifted Child Quarterly*, 31(1), 37-39.

Shuter-Dyson, R., & Gabriel, C. (1981). *The psychology of musical ability* (2nd ed.). London: Methuen.

Sloboda, J. A. (1985). *The musical mind. The cognitive psychology of music*. Oxford, UK: Clarendon Press.

Sloboda, J. A. (1986). Cognition and real music. The psychology of music comes of age. *Psychologia Belgica*, XXVI(2), 199-219.

Sloboda, J. A., & Juslin, P. N. (2001). Psychological perspectives on music and emotion. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion. Theory and research* (pp. 71-104). Oxford, UK: Oxford University Press.

Stanislavski, C. (1991). *An actor prepares* (Translated by E. Reynolds-Hapgood). London: Methuen Drama.

Steptoe, A., & Malik, F. (1995). The impact of stage fright on student actors. *British Journal of Psychology*, 86(1), 27-40.

Sternberg, R. J. (1997). *Thinking styles*. New York: Cambridge University Press.

Strongman, K. T. (1987). *The psychology of emotion* (3rd ed.). Chichester, UK: John Wiley & Sons.

Subotnik, R. (2004). Transforming elite musicians into professional artists: a view of the talent development process at The Juilliard School. In L. V. Shavinina & M. Ferrari (Eds.), *Beyond knowledge. Extracognitive aspects of developing high ability* (pp. 137-166). Mahwah, NJ: Lawrence Erlbaum.

Swanson, H. L. (1992). The relationship between metacognition and problem solving in gifted children. *Roeper Review*, 15(1), 43-54.

Tart, C. T. (1990). *Altered states of consciousness* (3rd ed.). San Fransisco, CA: Harper SanFransisco.

Tikhomirov, O. (1984). *The psychology of thinking* (Transl. by Natalia Belskaya). Moscow: Progress Publishers.

Thompson, P. M., Cannon, T. D., Narr, K. L., van Erp, T., Poutanen, V., Huttanen, M., Lönnqvist, J., Standertskjöld-Nordenstam., C., Kaprio, J., Khaledy, M., Dail., R., Zoumalen, C., & Toga, A. (2001). Genetic influences on brain structure. *Nature Neuroscience*, 4, 1253-1258.

Warshaw, A. (2007). *Locomotion-encoded musical patterning: a terminology for the composer*. Proceedings of the International Conference “Composer au XXIe Siecle - Processes and Philosophies”, Montreal, Canada, 28 February to 3 March.

Westermann, R., Spies, K., Stahl, G., & Hesse, F. W. (1996). Relative effectiveness and validity of mood induction procedures: a meta analysis. *European Journal of Social Psychology*, 26, 557-580.

Wille, R., & Wille-Henning, R. (2008). *The mathematical in musical thinking*. Proceedings of “The Sixth Conference on Concept Lattices and Their Application”, Olomouz, The Czech Republic, 21-23 October (http://sunsite.informatik.rwth-aachen.de/Publications/CEUR-WS/Vol-433).

Winner, E. (1996). *Gifted children*. New York: Basic Books.

Winner, E., & Martino, G. (2000). Giftedness in non-academic domains: the case of visual arts and music. In K. A. Heller, F. J. Mönks, R. J. Sternberg & R. F. Subotnik (eds.), *International handbook of giftedness and talent* (2nd ed.) (pp. 95-110). Oxford, UK: Pergamon.

Zhukovskiy, V. I., & Pivovarov, D. V. (2008). The nature of visual thinking. *Journal of Siberian Federal University. Humanities & Social Sciences*, 1, 149-158.

Ziegler, A., & Raul, T. (2000). Myth and reality: a review of empirical studies on giftedness. *High Ability Studies*, 11(2), 113-136.

Table 1. *The Multidimensional Model of Musical Giftedness (Persson, 2009). An outline of musical giftedness domains and their domain specific skills.*

Giftedness domain	Domain specific key skills	Type
Voice performance		
	Voice quality	Physiological
	Voice motor function	Physiological
	Acting skills	Personality
	Auditory skills	Cognitive
	Musical memory	Cognitive
	Emotive skills	Personality
Instrument performance		
	Motor function	Physiological
	Appropriate physical attributes	Physiological
	Auditory skills	Cognitive
	Musical memory	Cognitive
	Emotive skills	Personality
Composing/Conducting/Arranging/		
	Auditory skills	Cognitive
	Inner hearing	Cognitive
	Creativity	Personality
	Emotive skills	Personality

Table 2. *The result of database searches performed on 16 April 2010. Only published studies and conference papers were included in the search. Education studies were excluded unless focusing specifically on cognitive processes.*

Database	**Relevant hits**	**Total number of hits**
PsychInfo *(search words music + thinking)*		67
	9 empirical or theoretical studies	
MedLine *(search words music + thinking)*		0
	None (but 68.071 studies using search words music + brain)	
Google Scholar *(search words music + thinking)*		1.370.000
	10 empirical and theoretical studies and papers	

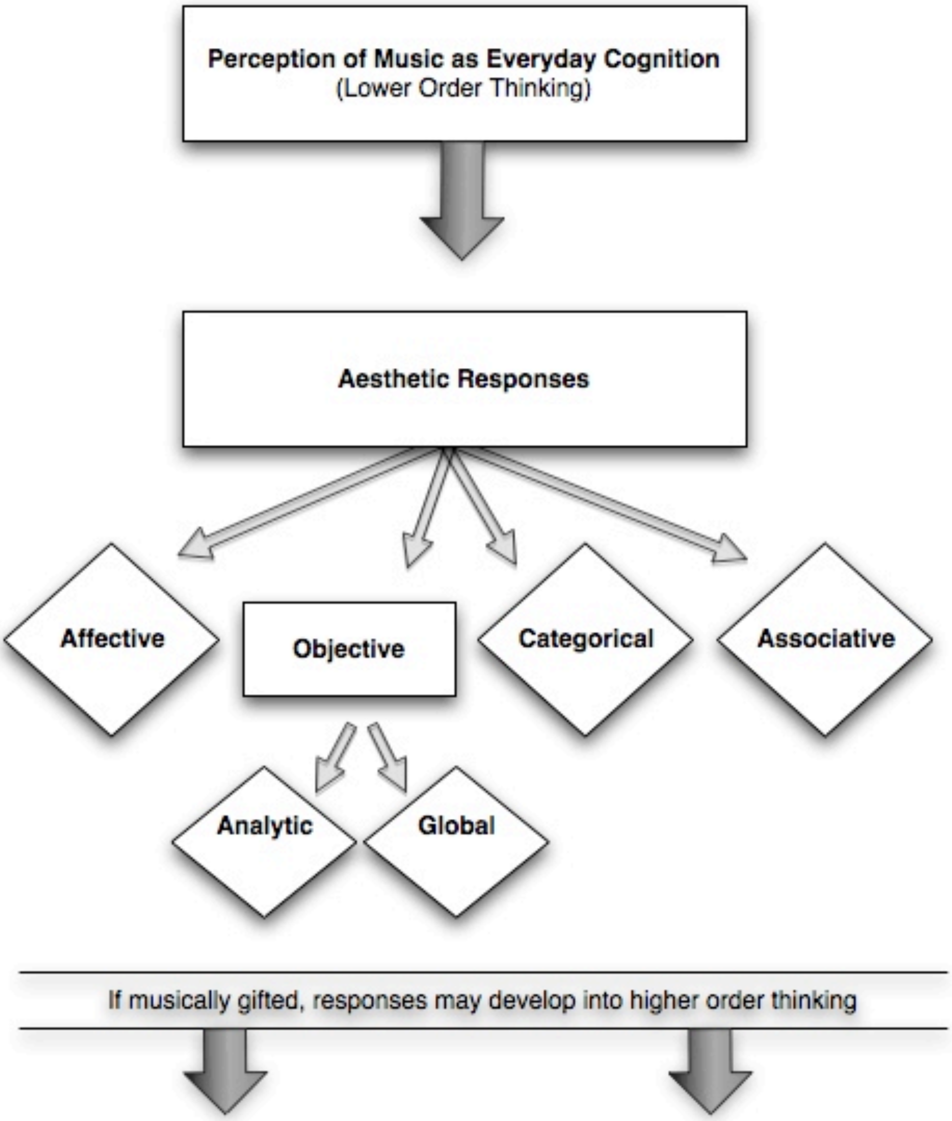

Figure 1. *A flow chart suggesting musical thinking as aesthetic response according to the Hargreaves (1982) aesthetic reaction taxonomy.*

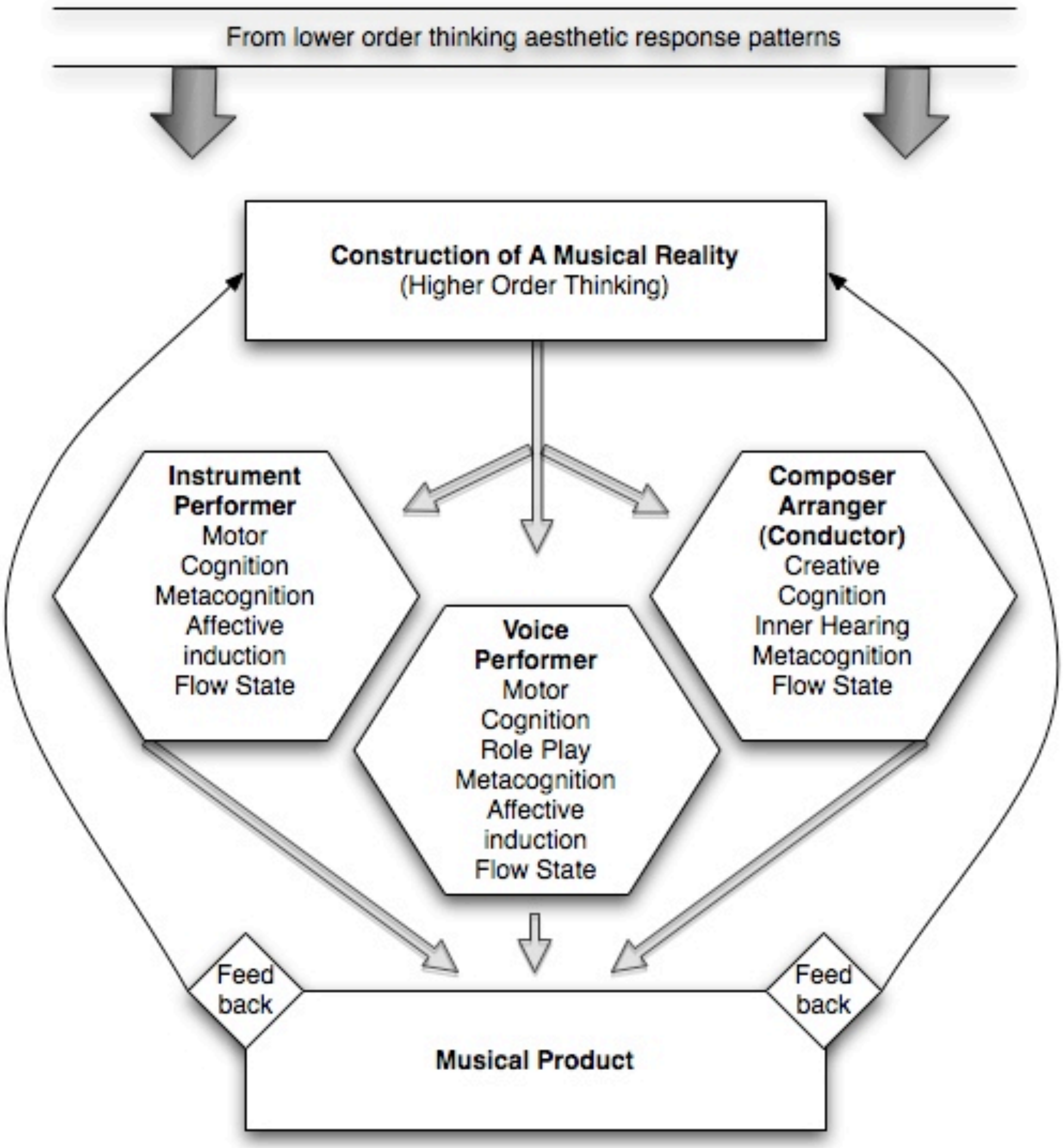

Figure 2. *An outline of higher order musical thinking contents/functions as pertaining to the Multi-dimensional Model of Musical Giftedness (Persson, 2009).*