various cartoon faces to the emotions they thought the music represented. Both age groups did very well at matching emotions to the music. More interesting, the five year olds did as well as the nine year olds. Therefore, emotional sensitivity to music is present at five years of age.[7]

Is this the lowest age? Apparently not. Marianna Kastner and Robert Crowder examined the responses of children of many ages, up to twenty-two years old.[8] They listened to four types of musical passages, relating to major and minor keys and harmonies. Cartoon faces were also used to match positive (happy or contented) and negative (sad or angry) intentions of the music, which had been rated separately by experts. For example, major modes were associated with positive, minor modes with negative emotions. Students did very well at matching. They did do somewhat better at older ages. But the youngest children tested also did very well, far above chance. They were only three years old !

What should be conclude about young children? Simply this. Music speaks the language of emotion to three year olds (maybe even younger children, who remain to be studied) as it does to adults. They are prepared at a very early age to "get the message", the "emotional message of music". Doesn't this say something important about music and emotion? Doesn't it speak not only of caution about estimating and underestimating young children, but perhaps of greater significance – that the "human animal" is a "musical animal", at a very early age. We need to be constantly reminded of this as parents, teachers, and citizens.

[CODA: Musical Training Increases Social Emotional Sensitivity]

We've covered a lot of ground about emotion and music Not all of it, too be sure (for related articles on emotion see *MRN*, Spring, 1996 and Spring, 1998 at www. musica.uci.edu or write us for copies). We have reflected on the particularly powerful ability of music to convey emotional meaning and to induce appropriate emotions in others. We have seen that emotions and music can be understood scientifically, that emotional reactions to music appear to be real, actual emotions rather than the judgement or recognition of intended emotions – so music really changes us physiologically --, gotten a good idea of just what musical features are used by performers to color music with specific emotional messages and to induce these same emotions in others, and found that three year olds readily get the right emotional messages in music. That's a lot, and one is tempted to stop here, assuming the good reader has reached this point. But there is a tantalizing bit of information which fits so snugly into this essay, and perhaps would fit poorly if at all in future issues of MRN, that I offer it as the proper ending for today.

Given that music and emotion make a special pair, a mode of expression and reception of the deepest feelings in human experience, often not adequately expressed in words, isn't it just possible that musicians themselves might be more emotionally sensitive to others than non-musicians?

Nilsonne and Sundberg, working in Sweden, obtained voice recordings of the same standard text read by patients when they were depressed or after they had recovered.[9] The actual words were electronically removed to eliminate obvious emotional cues but the basic pitch and rhythm of the voices was maintained. University students judged whether the resultant voice-like sounds came from people while they were depressed or normal. There were two groups of judges, law students and music students. The music students were significantly better than the law students at determining the emotional state of the patients!

Of course, one could argue that actually, the law students were particularly insensitive to the emotional states of others!! That is one reason I said that the results were "tantalizing". But the findings do suggest that musical training, so intimately related to the expression and reception of emotions, increases the ability to know how others are feeling. This potential for increased empathy as a "spin off" from learning to make music needs to be followed up.

N. M. Weinberger

[7]Giomo, C. J. (1993). An experimental study of children's sensitivity to mood in music., Psychology of Music, 21, 141-162.
[8]Kastner, M P. and Crowder, R.G. (1990). Perception of the major/minor distinction: IV. Emotional connotations in young children., Music Perception, 8, 189-201.
[9]Nilsonne, A. and Sundberg, J. (1985). Differences in ability of musicians and nonmusicians to judge emotional state from the fundamental frequency of voice samples. Music Perception, 2, 507-516.

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In this issue:

MuSICA research notes
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"Music produces a kind of pleasure which human nature cannot do without."
CONFUCIUS

"Music is the shorthand of emotion."
LEO TOLSTOY

Feel the Music!!

"Sounds like the blues are composed of feeling, finesse, and fear"
BILLY GIBBONS

I recently watched a Buster Keaton movie, a "silent movie" for those who have not had the pleasure of "knowing" Keaton's work and laughing uncontrollably at his actions as a comedic genius of film. As an actor, Buster Keaton's face never showed emotion, but was maintained as a sort of neutral mask, as he tried to solve the problems thrust upon him by circumstances and adversaries. This particular film involved his building a house for his betrothed, a lovely young women who finally preferred the character played by Keaton to that of another suitor. The movie was set in the 1920s, a time when you could order a prefabricated house from Sears and Roebuck, for less than a thousand dollars. The house was sent in a large quantity of carefully numbered crates; the sequence in which the parts were to be assembled was naturally critical to the proper completion of the house.

Unbeknown to the naïve, angelic Keaton, the vanquished suitor wanted revenge. So in the dark of the night, he re-numbered all of the crates. The next morning, Keaton assembled the house, with a lot of head-scratching, but in the firm knowledge that Sears and Roebuck, the most mighty of consumer retailers as it was then and for many years after, knew more about house construction than did the common man. Needless to say, the completed house looked like a three-dimensional jigsaw puzzle that hadn't been actually solved. Trying to walk up a stairs that he had installed mostly sideways, through a window where the front door should have been, is no easy task. Keaton managed it, with dedicated and hilarious effort. Subsequently, the house had to be moved, as Keaton had built it on the wrong lot. In crossing railroad tracks on the way to the correct location, the "house" was destroyed by a train, despite the best, frantic efforts of Keaton and his bride-to-be. The train's effect on the house appears to have been simultaneously a disaster and a relief.

[Organic Organ Music]

Silent movies provided the audience with two supplements to the non-existent dialogue; occasional full-screen "cue cards", such as "The Happy Couple Contemplate Their Future Bliss", and continual music, typically supplied by a theater organist.

We can readily understand the reason for helping the audience with words on the screen. After all, the actors are talking to each other; we just couldn't hear them before the invention of sound tracks. So the printed word substituted (a bit) for the spoken word.

But why the music? The story unfolds on the screen without the music. The crates get delivered, they get renumbered by skullduggery, Keaton assembles a topsy-turvy house, puts wheels under it and pulls it across the tracks (but not quite all of the way), and the locomotive runs right through it, all regardless of whether or not there is music. If you put cotton in your ears, or just turned off the sound when watching this movie as a video, as I did, nothing changes. So why

ABOUT MuSICA

MuSICA **is short for Music & Science Information Computer Archive, a lot of words for a simple idea: to gather scientific findings about music.**

The specific goals of *MuSICA* are to: (a) maintain a comprehensive and continually updated computer-based record of scientific research on music and its biological substrates, (b) to make this information available at no cost to promote research and cooperative efforts and (c) to increase general awareness and knowledge of the results of music research.

MuSICA **Research Notes is published to provide updates on research findings and new ideas about music in life. Each issue will reflect the spectrum of research, including educational aspects of music, the effects of music on behavior, age-related issues from birth through senescence, music perception & cognition, music and health, and the brain substrates of music.**

These topics will be presented in various formats: reports on a specific topic, brief discussions of individual findings, abstracts of particularly interesting findings that may be covered in more detail in a later issue, and an opinion column.

We hope that this format will provide a rich, interesting and useful ongoing view of music research. We specifically invite your comments and suggestions.

N.M. Weinberger

MuSICA
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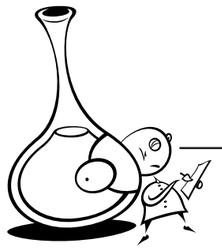
Editor: Dr. Norman M. Weinberger, Scientific Director MuSICA

MuSICA Research Notes is the newsletter of the Music & Science Information Computer Archive (formerly the Music and the Brain Information Center, MBIC). Articles in the newsletter draw on the contents of MuSICA, a comprehensive, updated compilation of citations and abstracts of scientific and related publications on music, including education, child development, psychology, brain sciences, clinical medicine and therapy. Access to this database is free either via the MuSICA Home Page at http://www.musica.uci.edu or via Telnet at : mbic@musica.cnlm.uci.edu. Comments and questions concerning MuSICA Research Notes are welcome and should be addressed to Dr. Norman M. Weinberger, Center for the Neurobiology of Learning & Memory, University of California, Irvine, CA, 92697-3800. MuSICA is supported in part by NAMM — International Music Products Association and the University of California Irvine. The contents of MuSICA Research Notes are independent of sources of support.



To the Point.

Understanding Music's Emotional Powers

Music seems to have a powerful ability to convey emotional meaning. Such emotional communication has been thought too complex for scientific study. Recent studies have shown that, indeed, the emotions intended by a performer (whether happiness, sadness or anger) actually are correctly recognized by listeners. Amazingly, children as young as three years old easily recognize intended emotions. However, many scientists believe that while people recognize emotional intent, music does not have the power to actually produce genuine emotional states. Contemporary experiments reveal that that emotional reactions to music are real, because music produces specific patterns of change in heart rate, blood pressure and other autonomic bodily reactions that are linked to different emotions. Also, we now understand which musical cues are used by instrumentalists to color music with specific emotional messages (see "Feeling the Music !!" in this issue of *MRN*). Finally, music training appears to promote the ability to correctly detect the emotional states of other people, i.e., music-making seems to increase sensitivity to others.

Infants Learn and Remember Music at an Early Age

Infants are attracted to hearing language but, less appreciated, they are also highly attracted to music. We are born with musical capabilities; they are a normal part of human nature. The details of infant music capabilities are now being worked out. Music memory is the key element in music ability at all ages because without memory, there can be nothing but individual experiences that immediately fade away. But when does the ability to learn and remember a piece of music begin? Most people assume that this starts to develop about the time that children can talk, after the first year of life. However, Jenny Saffran and her colleagues at the University of Wisconsin have discovered that specific memory for music begins much earlier in life.

Infants about seven months old were studied. They listened to the same 10 minute selection once a day for 14 days at home. The music was from piano sonatas of Mozart, but there is no reason to think that the findings are limited in any way to the music of Mozart. After the listening phase, the music was withheld for two weeks, to test for long term memory. Then, they were tested in the laboratory both with excerpts from the music previously heard, and from similar (novel) music from other Mozart piano sonatas. The amount of time the infants turned their heads toward different loudspeakers that played either the training music or the novel music revealed that they remembered the music, which they had heard at home. More remarkably, they recognized whether the musical excerpt came from the beginning or the middle of the familiar music! They preferred to hear music from the beginning of the piece.

These findings reveal that infants as young as seven months can learn music, form long term memory, and incorporate the structure of the music they have heard. Therefore, infants possess far greater sophisticated abilities for music than previously believed. We do not yet know the youngest age for such complex music memory or the duration of long term memory, as these were not tested in this important study. Therefore, future studies may show even greater musical learning and memory abilities in young infants. It seems that every new experiment with infants extends the boundaries of human musical abilities. (source: Saffran, J.R., Loman, M. M. and Robertson, R.R.W., (2000), Infant Memory for Musical Experiences, Cognition, 77, pg. B15-B23)

Music Training Improves Mental Imagery Ability

Interest in the mental benefits of music training is high and continues to increase. While this area of research is still in its early stages, recent findings have expanded the types of mental processes that are know to be positively affected by music. Andre Aleman and his co-workers at Utrecht University in the Netherlands, asked whether or not the ability to play a musical instrument affects the ability to have good mental imagery. Examples of mental imagery are the ability to "hear" sounds or music without their actual presence, such as in "mental rehearsal".

College students who had about 5 years of instrumental training, or students who had no musical training, were studied in two auditory tasks. In a musical auditory imagery test, they were shown the words to a song and asked to decide whether, of two highlighted lyrics, the pitch of the second was higher or lower than that of the first lyric. To solve this problem, one has to "hear" the music mentally, and then make the judgement. Perhaps not surprisingly, the music students were significantly better than the naïve students. The second auditory imagery task was not musical but concerned everyday sounds. Students were shown three cards with the names of common sounds, such as "crying baby", " laughing baby" and "meowing cat". They had to imagine the sounds, and then pick the one that was most different from the other two. In the present example, "laughing baby" is the correct answer because a crying baby and a meowing cat sound more similar; (try this type of exercise yourself). The music students also were superior for this non-musical task.

Thus, learning to play an instrument may produce a greater capability to mentally imagine and process sounds in general, perhaps even speech. It will be interesting to perform brain imaging studies to seek the neural bases of this increased mental ability. (source: Aleman, A., Nieuwenstein, M. R., Bocker, K.B.e. and de Haan, E. H.F., (2000), Music Training and Mental Imagery Ability, Neuropsychologia, 38, 1664-1668.

"Matters of Opinion" will not appear in this issue.

did every theater get equipped with an elaborate and expensive organ? Why the added expense for the organ and for the organist?

Well, actually, something is very different without the music -- the audience is different. Not in the sense of being physically replaced, but rather something is missing without the music -- the viewers' emotional reactions and involvement.

If you shift your attention a bit from the story, and the compelling antics of Buster Keaton, you notice that the nature, tempo and intensity of the music are being matched to the mood of the scene and the presumptive emotions of the actors and actresses. While Buster Keaton managed to maintain a "poker face" as a characteristic of his on-screen persona, even in the most outlandish of situations, the audience has no such constraints. We react emotionally, and appropriately so, guided or even controlled by the music.

The organ and organist supply the otherwise missing element, emotion. "Emotion" is indeed an "organic" human reaction and state, as natural to our nature and existence as breathing, eating and sex. Music clearly results in emotions, but whether these are "genuine" emotions or only empathetic recognition of intended emotions is another story that we'll consider a bit later. But for now, since music produces emotional reactions, and emotions are part and parcel of what we are as humans, just how important is music? It can't be essential, can it, because life doesn't require music. To this, Dr. Jack Orbach, a psychologist who has recently written an interesting book entitled "Sound and Music: For the Pleasure of the Brain," says:

"Musical activity may be like sexual activity ..., essential for the survival of the species but unnecessary for the survival of the individual." [1]

[Music May (In Some Sense) Be Like Sex, But Do We Need It in the Movies?]

Silent films are no longer made (unless you want to include "Silent Film" by Mel Brooks several years back ... I wouldn't). We now have the full dialogue and sound with action, in natural color, and have had for most of the last Century. We have the voices of realistic people, with the their full intensities, emphases, expressions, nuances, words, sentences, exclamations, meanings, plus all of the sound effects that can now be conjured by audio specialists and modern computers. We have Dolby sound, often very loud sound. We have sound "moving" from the front to the back of the theater, sound "moving" left and right, sound "surround". Don't we have all the sound we need? Apparently not, because we still have music in the movies.

It's pretty curious isn't it? "Real life" is not accompanied by a music track. Real life doesn't even have sound as good as you get in the movie house. Yet real life is often every bit as dramatic, as intense, as potentially consuming as the movies. Even more so, real life is "for keeps", so it's importance and impact on us all can hardly be downplayed. Why, then, do movies which portray real life need music? Perhaps just because they are not the "real thing" and of course we all know it. Lacking the truth of real life, movies appear to need music to supply the actual emotional states and feelings without which the film would lack the reality that it tries to create. Without the emotions, the audience may be witness to the action but unable to identify with it or with the characters involved. In short, music appears to substitute for reality and thus makes the movies more compelling. And why need the movies be more compelling? Presumably to draw an audience. We want not merely to view but to "live" the movie. It is noteworthy that the commercial success of movies appears to be so dependent on the moods and emotions induced by movie music. This is just one commercial proof of the emotional power of music.

[Chills, Thrills and Free Wills: Demystifying Musical Emotions]

Of all human experiences, emotions often seem to be the most mysterious. We experience them in a highly personal way, but it seems that we can't really share emotional states the way that we can share truths, such as that $2 + 2 = 4$, or facts, like Iowa City is north of St. Louis south of Minneapolis west of Moline and east of Des Moines. They seem to be too subjective, individual and personal. Nonetheless, emotions can be studied scientifically and thus the role of music in emotions can be understood in principle. Our discussion concerns purely instrumental music, for there is little mystery as to why certain lyrics convey certain emotions; the lyrics essentially tell us the emotions of the singers.

Sometimes music produces obviously physical effects. We actually"feel" sensations, like "chills", "thrills" or "tingles running down the spine". John Sloboda of the University of Keele in England conducted a survey of British adults on this very question. More than 80% reported that music caused physical responses such as thrills, laughter, tears or a "lump in the throat" feeling.[2]

Are these kinds of response evoked by any type of music or by specific aspects of music? Studies at Bowling Green State University in Ohio by Jaak Panksepp reported that the stronger the emotional content of a piece of music, the more likely one is to experience "chills". Moreover, these reactions were most probable when music produced feelings of sadness.[3]

Of course, many if not most emotional reactions don't have to involve thrills or chills. Workers have concentrated on four emotional states produced by music: in addition to sadness, they are happiness, anger and fear. Do certain aspects of music produce different emotions? Apparently so. For example, Patrik Juslin at Uppsala University in Sweden asked

[1]Orbach, Jack (1999) "Sound and Music: for the Pleasure of the Brain", New York: University Press of America, pg. 76.
[2]Slobda, J. A. (1991). Music structure and emotional response: some empirical findings. Psychology of Music, 19, 110-120.
[3]Panksepp, J. (1995). The emotional sources of "chills" induced by music. Music Perception, 13, 171-207.

guitarists to play the same musical selection at four different times, to express each of these four different emotions. Tapes of these performances were played to adults who, in this case, had a moderate amount of instrumental musical training. The performers were successful in communicating emotions because the listeners correctly labeled each tape by the intended emotion. This agrees with our everyday expectations, i.e., that music conveys emotions. But note in this case that the music was always the same piece, just played differently. So in this situation, it wasn't the composer's emotional intention that was converted into the language of music, but that of the instrumentalist

So the question is how did the specific emotional message get across? Juslin analyzed the detailed structure of each performance and found that two musical dimensions could explain the transfer of emotional content: tempo and articulation.[4] Tempos were either fast or slow while articulations were either staccato (very brief notes, separated by brief silences) or legato, i.e., playing so that one note glides into the next without interruption. Here are the results --

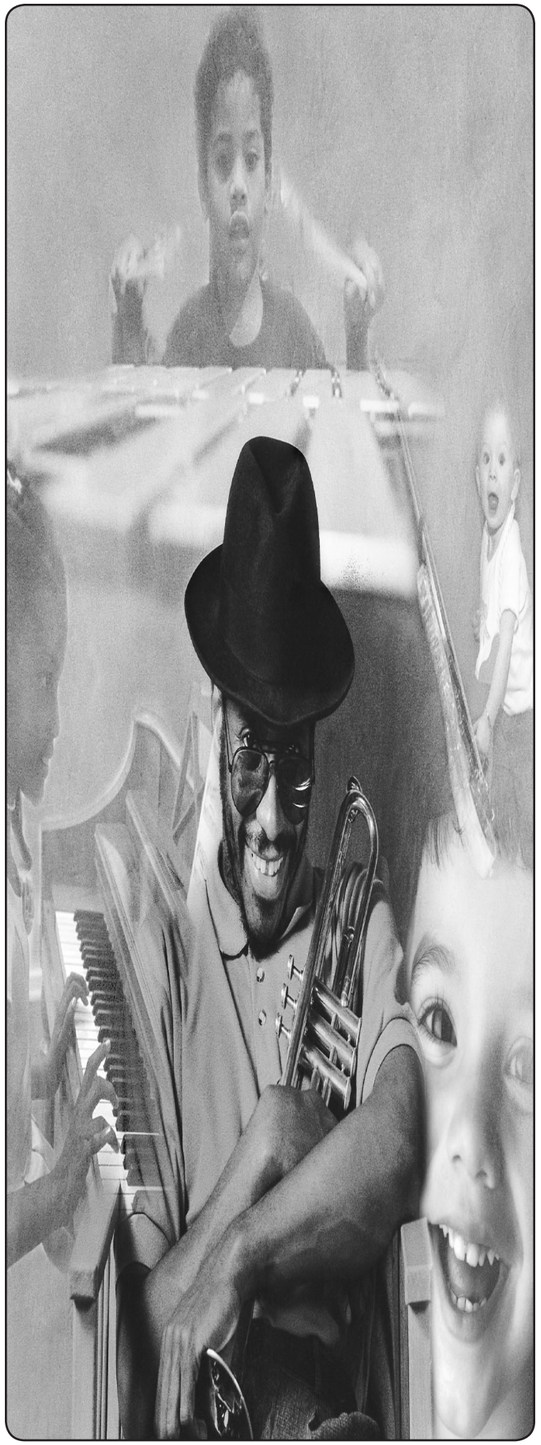
- **happiness = fast, staccato**
- **sadness = slow, legato**
- **anger = fast, legato**
- **fear = slow, staccato**

Happiness and anger were associated with being louder and sadness and fear with softer music, but these were not as important in conveying specific emotions. But perhaps the most important "take home" message is that the same performance cues (tempo, articulation) that performers use to convey emotion are the same cues that listeners use to receive the intended emotion.

We have talked about "chills" and "thrills", but what about "free wills". I'm taking some liberty with words here. I don't refer to a lawyer drawing up a will free of charge, but rather one of our most deeply held beliefs, that we each have "free will", and behave according to our own intentions. No one believes that they, themselves, are robots.

On the other hand, we ought to think about how music affects our emotions. Do we really "choose" when and how a piece of music elicits are own emotional reactions? Do we react to loud, fast music, such as a march by John Phillip Sousa, by going into a state of sweet and blissful meditation? Can we really listen to a funeral march and become overwhelmed with feelings of happiness? (Perhaps at the passing of an evil enemy… there are always exceptions.)

Thus, we have to confront the possibility that we are not in complete control of our emotional states in response to music. To the extent that this is



[4]Juslin, P. N. (2000). Cue utilization in communication of emotion in music performance: relating performance to perception., J. Experimental Psychology, 26, 1797-1813.

true, there seem to be limitations on our "free wills", sometimes accompanied by "chills" and "thrills".

[Our Bodies Know Musical Emotions, Even if Our Brains Don't]

In the study just described, listeners correctly reported each of the four emotions intended by the performers. This raises the question of whether or not the emotions "received" were "real" or merely "correct guesses" of the performer's intentions. In fact, there has been a longstanding and still current argument about this very question. Some people claim that music doesn't actually produce genuine emotions in listeners. Rather, they argue, that listeners can recognize the emotion intended in music, but do not themselves experience a true emotion in response to music. This view has been summarized by the eminent music scholar Professor L.B. Meyer:

"… when a listener reports that he felt this or that emotion, he is describing the emotion which he believes the passage is supposed to indicate, not anything which he himself has experienced." [5]

Why would anyone doubt that a listener's report of an emotional reaction to music is not the same as the real emotions that we experience as we go about out somewhat fragile daily lives, with their dangers, worries, frustrations and, not as often as we hope for, satisfactions? There are good reasons. First, it is actually difficult for someone to distinguish between judging a sense of e.g., happiness in heard music from an actual happy feeling. People will label the same music in both instances as "happy". Second, physiological measures of emotion appear to be too unspecific to be tied to a specific emotion. For example, heart rate or blood pressure changes may appear to be the same for different emotions, such as anger and happiness. Lacking specific, objective bodily responses to music, it seemed impossible to settle the issue. because people would simply continue to claim a genuine emotional experience without any way to verify it.

In the past few years, along with greatly increasing interest in the importance of music in human life, investigators have taken up the problem anew, this time with detailed physiological measures of emotions. For example, at Cornell University, Carol Krumhansl recorded different physiological measures while listeners (college students who had about seven years of instrumental training) heard music that had been independently judged to be one of three moods: "happy", "sad", "fear".[6] Not surprisingly, they correctly matched the music to the emotions. But this doesn't answer the question of whether they recognized the emotions or felt them.

Krumhansl's approach was to measure more physiological responses than previously done, to see if the overall patterns of response were different for different emotional reactions. She used twelve different actions of the autonomic nervous system, which may react "automatically" without purposive, conscious attention. We can simplify her measures to five for our purposes: heart rate, blood pressure, rate of blood flow, respiration and skin temperature. Professor Krumhansl did find that the directions of change were the same for all three emotions: e.g., heart rate decreased, blood pressure increased, rate of breathing increased and skin temperature decreased. These findings seem to negative, that is, to show that different emotions cannot be separated by bodily, physiological responses. However, this was not the whole story.

The data also were analyzed to determine the magnitude of changes, not merely the direction of changes. This revealed distinct patterns. "Happy" involved largest changes in respiration; "sad" involved greatest changes in heart rate, blood pressure and skin temperature; "fear" was associated maximal changes in the rate of blood flow. In other words, the findings favor two facts: first, different genuine emotions can be physiologically defined according to autonomic, bodily functions and second, the emotional reactions produced by music are the "real thing". Thus, music doesn't simply convey intended emotions that we can recognize, but rather induces genuine emotions in the listener.

[Young Children Are Emotionally "Smarter Than We Think"]

Probably the most underestimated groups in society are infants and young children. We adults know that they are not miniature adults … they are often far too logical for that! They seem to occupy some strange "developmental space", just waiting out the time when they will grow old enough to become "real people", meanwhile getting to mainly play and have fun. Actually, their lives are just as important to them at their ages as ours are at our ages. Although they are unable to express themselves well in language, or by playing a musical instrument, their restricted "output" does not begin to reveal their thinking and learning. They are working "full time" to make sense of the world in which they find themselves. A lot of what they do is conscious imitation … doesn't it make good sense to try be like the people who feed you?

Our underestimation of the abilities of the young human extends to our conceptions of their emotional sophistication.; we generally act as though they don't have much. Little do we realize that they are almost constantly watching, listening, learning, remembering. So the question arises, "Since music conveys emotional meaning, at what age does this ability begin?" Earlier than we would suppose.

In one study, by Carla Giomo in Mesa, Arizona, five and nine year olds listened to twelve selections of classical music that had been divided into groups expressing different emotions. To avoid language/vocabulary limitations of the five year olds, while using the same response measure, the children matched

Continued on page 8...

[5]Meyer, L.B. (1956). "Emotion and Meaning in Music", Chicago: University of Chicago Press.

[6]Krumhansl, C. (1997). An exploratory study of musical emotions and psychophysiology., Canadian J. of Exper. Psychol., 51, 336-352. Examples of selections were Spring from The Four Seasons by Vivaldi (happy), Adagio for Strings by Samuel Barber (sad) and Night on Bald Mountain by Mussorgsky (fear).