Jason Jones

Music and the mind

Musicians, scientists, and educators come together to discover the role music plays in defining who we are

By Gillian Wansbrough

It's been more than a decade since the "Mozart effect" grabbed the public's interest. But still the debate rages over whether music can actually boost brainpower, as suggested by the researchers who prompted the term.

Neurobiologists at the University of California, Irvine, reported in 1993 that listening to Mozart's music resulted in higher scores among college students on a spatial thinking test. Even though the study had nothing to do with children, parents seized the idea of playing the classics as a means of giving their children a head start.

While the findings and methodology of this study continue to be challenged, there is widespread support for the idea that music – both listening to it and playing it -- stimulates the brain and helps promote optimal development.

"The importance of music in individual development and in the health of communities is something that has really sparked the public interest in the last decade," says Laurel Trainor, professor in McMaster's Department of Psychology, Neuroscience and Behaviour. This may in part be explained by the recent use of brain imaging technology to shed more light on the effects of music training on the brain.

"At the individual level, does music make a child smarter? At the cultural level, does music help form good communities? Does music help teenagers bond with each other and promote positive experiences for them?"

These are just some of the questions that members of McMaster's new Institute for Music and the Mind (MIMM), headed by Trainor, aim to tackle. The university is bringing together musicians, scientists, and researchers to look at, among other things, the physical structure of music, the evolution of music, the neural processing of music, the performance of music, and the perception of music.

William Thompson, is one researcher who was inspired to delve further into the Mozart effect. His studies in the field of music cognition indicate that temporary shifts in mood and arousal accompany listening to music. "The experience of listening results in changes in our emotional state and mood that enable us to perform certain tasks more easily," says Thompson, director of the Institute for Culture and Communication at the University of Toronto and a member of MIMM.

Music is not just an auditory event, but a multisensory event, says Trainor, which explains the diversity in the backgrounds of researchers involved in MIMM. "If you look at the history of music in human cultures, it's always involved dance and movement. What we've shown in some of our research is that there are multisensory connections between different brain areas responsible for different kinds of processing, even in young babies."

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Trainor, who plays the flute, has a background in the sciences, psychology, and music performance. Her work focuses on auditory perception, including basic sound perception and the acquisition of music and language.

A study done by Trainor and her gradu-

■ Laurel Trainor (right) and research assistant Lisa Hotson place a "geodesic sensor net" on McMaster student Andrea Unrau. The net contains 128 electrodes that monitor changes in brain activity as music is played in the lab.

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■ McMaster researchers have found that how we move also shapes what we hear, even in babies.

ate student Jessica Phillips-Silver, published in Science in 2005 showed that movement influences how infants perceive rhythm. Seven-months-old were played an ambiguous rhythm pattern wherein the main beat could be perceived on every second beat as in a march, or on every third beat as in a waltz. Half the infants were bounced in the arms of an experimenter on every second beat, and half on every third beat.

"Those bounced on every second beat subsequently preferred to listen to the rhythm pattern with auditory accents every second beat, whereas those bounced on every third beat preferred to listen to the rhythm pattern with auditory accents every third beat. The two groups encoded the auditory pattern differently." Body movement and auditory rhythm processing were strongly connected. Trainor says the body's vestibular system, which is involved in balance and stimulated in infants by bouncing and rocking, may be the connection between the motor system and the auditory system.

In a University of Toronto at Mississauga study conducted by Glenn Schellenberg, also a member of MIMM, music lessons were shown to increase IQ points in six-year-olds who took weekly singing or piano lessons. The findings were published in 2004 in Psychological Science.

Music has been shown again and again to have therapeutic value. In people with autistic spectrum disorders, it's thought that the long-range connections between different brain regions are too sparse. Music therapy may be able to help with sensory processing as well as bolster the multiple brain connections involved in social interactions. "Anecdotally it's thought that music might be a route to change how the brain develops in these conditions," says Trainor.

Geoff Hall, PhD, assistant professor in Psychiatry and Behavioural Neuroscience at McMaster, notes that some children with autism present with highly developed skills in the area of music. "Studying something as simple as pitch discrimination may help us understand some of the areas of deficit seen in these children," he says, things like cognitive inflexibility and difficulty consolidating information from various sources.

"These children have difficulty processing emotion. Music -- vocal prosody (the study of speech rhythms), tone, and tempo -- can provide us with the tools to explore this deficit further." He looks forward to being able to explore the status of the nervous system in autism at particular developmental time points using imaging tools such as magnetoencephalography (MEG) and electroencephalography (EEG).

While the health benefits of listening to music may need more research, it's clear that playing a musical instrument has many benefits. "You're not just learning to play notes, you're learning how to work with others, be a team player, and problem solve," says flutist David Gerry. "Performing in public gives you confidence and poise. There's a direct connection between your effort and what your efforts bring."

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Gerry, adjunct professor, McMaster School of the Arts, is an internationally known music educator and performer. He is an expert in the teachings of Suzuki flute pedagogy and travels worldwide to share his expertise. The Suzuki approach focuses on learning music at an early age and learning to play by ear.

Gerry teaches both children and McMaster students. He's excited to be working with researchers at MIMM to evaluate the Suzuki methodology, to see what works and what doesn't by studying music education programs. He hopes to determine whether repetition in learning is valuable, how much listening is valuable, and whether the timing of these common Suzuki approaches is significant.

Gerry also wants to teach more complex, non-Western rhythmic patterns. "When I'm teaching in South America, the kids are performing much more complex rhythms than our kids are, because that's what they hear in their folk music. Our music tends not to be so adventurous rhythmically." He wants to see more whole body movement and exposure to all kinds of music incorporated in music teaching.

Exploring motor control and movement systems falls into Digby Elliott's realm. Through MIMM, the McMaster professor of kinesiology will look into the kinds of movement people have to learn to play music and the visual motor interactions that have to take place are of interest.

"My main interest is what changes take place in the central nervous system as people acquire skills and how they use different sources of information." Elliott's work involves three-dimensional movement analysis, tracking limb trajectory with optoelectric technology using markers on various body parts. In the musical realm, he aims to track how fingers, elbows, and wrists move as musicians play.

Imaging tests showing how changes in motor performance relate to what's going on in the brain have never been done before. They could help explain, for example, why music is helpful in teaching language to individuals with Down syndrome, says Elliott.

William Thompson developed an interest in experiential aspects of music after

McMaster Institute for Music and the Mind

JD Howell

The new McMaster Institute for Music and the Mind (MIMM), which officially came into being in January 2006, will truly be a gem in the university's offerings and a real reflection of the innovative leanings of the school.

The brain child of Laurel Trainor, the goals of the Institute are to integrate the arts and sciences by conducting and promoting the scientific study of music; provide specialization in music cognition at the undergraduate and graduate level, as well as teacher training; promote music education through partnerships with local music schools and school boards; and enhance the local community through partnerships and artistic events.

The latter goal was supported by an inaugural event held last year titled Does Music Make you Smarter? Lecturer Glenn Schellenberg examined the scientific literature on this topic. Performers included pianist Valerie Tryon, soprano Mary Lou Fallis, flutists Suzanne Shulman and David Gerry, and the John Laing Singers. Educator Jane Easden also discussed teaching music to young children and the resulting effects.

"McMaster's approach to the study of music cognition is very synergistic, involving six faculties and the integration of a wide cross-section of scientists and musicians committed to excellence in research and teaching," says David Shore, associate professor in McMaster's Department of Psychology, Neuroscience and Behaviour. Members include music theorists, musicians, psychologists, neuroscientists, mathematicians, kinesiologists, health scientists, and engineers.

That, coupled with the developmental, health, and neuroscience focus, as well as a focus on community involvement, make this innovative project unique.

Researchers at the Institute hope to explore a number of areas such as how the auditory and motor systems interact to produce music, how performers synchronize with each other, how people encode and recognize music, and how groups in society are defined by the music they play.

At the moment, the Institute is virtual, but plans are afoot to set up common labs to integrate research. Securing a Canada Foundation for Innovation grant, along with support from individuals, corporations, foundations, and the community, will be key to making MIMM's goals a reality.

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"The research infrastructure we envision will be really unique in the world. It will bring together a diverse set of tools for studying the neuroscience behind musical perception, performance, enjoyment, and learning," says Trainor, who praises McMaster administration for getting behind the idea so quickly.

She notes that support is specifically needed for undergraduate and graduate education (scholarships), new faculty positions, infrastructure (e.g., labs), and community/University interactions (endowments for music education in schools, concert/lecture series, and a performance venue on campus).

doing his PhD on how people perceive the music of Bach, in particular the melody in relation to the harmony. He is curious about what we experience as we listen to music -- changes in mood, attention, and energy – and whether things like loudness, pace of music or tempo, or pitch level might cause these changes.

"It's not just sound but movement and vision, how we see the performer, the kind of expression he has, and the gestures he makes," says Thompson, who also composes music for film and theatre. "The visual aspects of music are actually far more important than we initially anticipated."

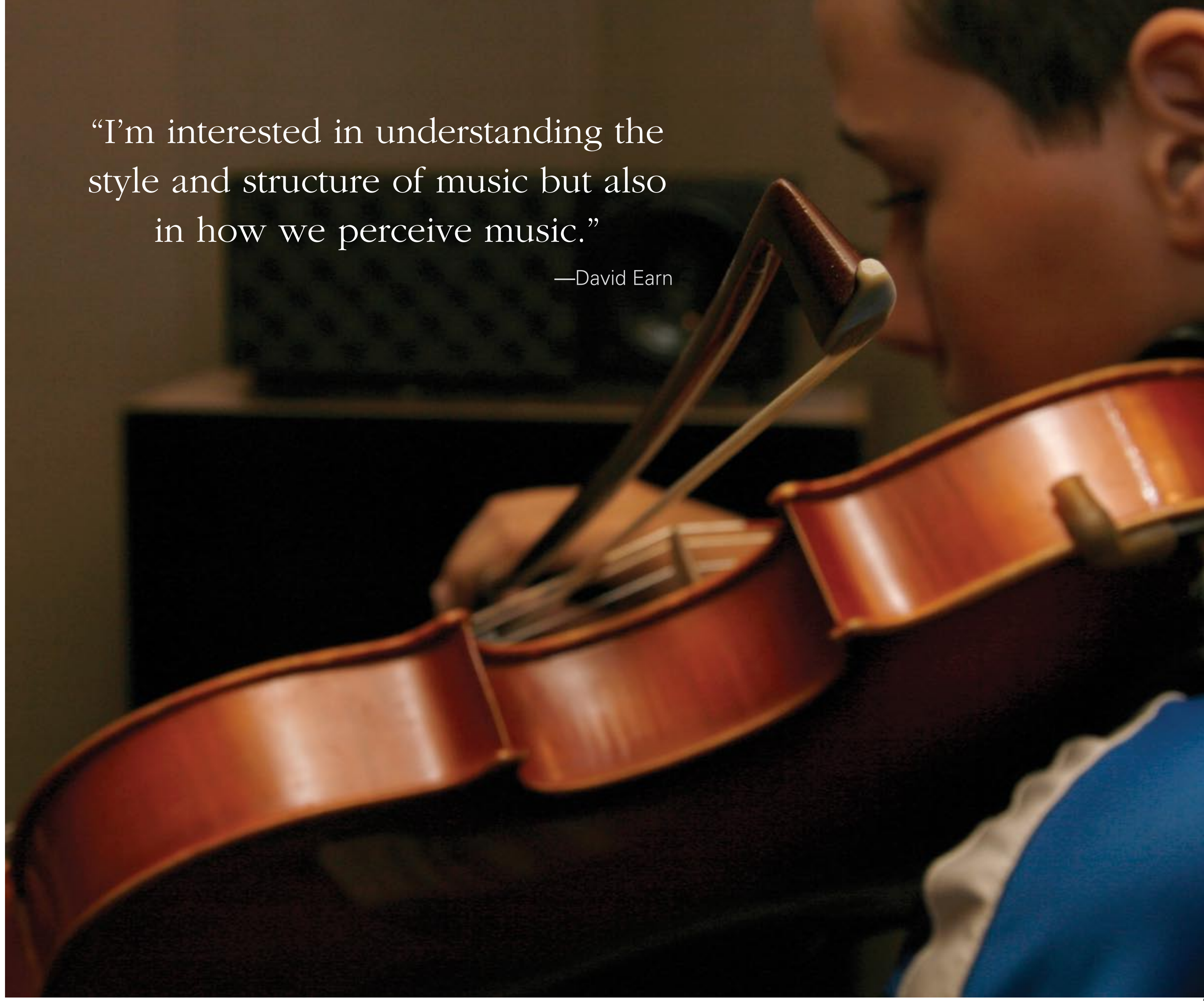
Facial expression can convey not only emotional aspects of the music but aspects of the musical structure itself. Pitch relationships, tonality, and harmony are encoded in the faces. He and colleagues have documented this by observing professional singers and viewing video recordings of greats like B.B. King and Judy Garland. Audiences can interpret melodic intervals (the distance between two tones) with no sound. Eyebrows and head movements are important cues. An innovative use of EEG will be to measure audience response to music.

Ian Bruce, PhD, is also interested in using EEG to learn more about how people perceive and process music, and how, for example, elements like consonance and dissonance are represented in the brain.

An assistant professor in McMaster's Department of Electrical and Computer Engineering, his main interest is how the ear and brain process sound to give us perception of those sounds. His lab develops mathematical models to run computer simulations of how the ear takes a sound and converts it to neural activity. "We're trying to relate neural activity to perception, what people perceive from basic sound to speech perception."

In the area of hearing loss, a better understanding of how impairment results in the degradation of the neural representation of sound could have applications for the design and improvement of hearing aids and cochlear implants. His research also looks at understanding tinnitus, the phantom perception of sound. Major changes in the information the brain receives as a result of hearing loss seems to result in substantial reorganization in the connectivity of the auditory cortex, which likely generates the ringing sound in ear, he explains.

Feature Story



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■ The audio lab, located in the Psychology building, tests the ability of people to discriminate various musical sounds and speech and how these skills change with age and musical experience.

Findings of this research may shed some light on some of the training and learning mechanisms that Trainor and others are looking at in terms of the development of music skills and other perceptual abilities, how music training affects development, and how highly trained musicians are able to perceive things better.

Analyzing all the data from the various disciplines will require the use of mathematical modeling. David Earn, associate professor, McMaster's Department of Mathematics, builds and analyzes mathematical models of biological systems. He works primarily on ecological and epidemiological issues, but the mathematical techniques he uses can be applied to a wide variety of problems.

He wants to apply his tools to model the structure and evolution of music and the processes of music perception. "I'm interested in understanding the style and structure of music but also in how we perceive music, what makes us think something is music versus a sound, and especially how different people perceive music and sound differently," says Earn.

"One area of focus is how people perceive pitch. Most people can identify a higher or lower pitch but a select group of people can perceive pitch absolutely, in other words have perfect pitch. Understanding different pitch perception systems can potentially lead to the building of neurological mathematical models of how the neural system works."

Excited to be broadening his research areas to include music, Earn calls the Institute "absolutely fantastic. It's drawing together people in a lot of different areas to think about music in a variety of different ways and perspectives. I think as the Institute itself develops and blossoms, it will lead to some very exciting research." ■