1. PROJECT DESCRIPTION

We propose to investigate the benefits of infant-and-parent music programs for perceptual, cognitive and social development in at-risk populations. Music is an integral part of every known human society, past and present. And every society appears to have special songs for infants. Long before infants understand words, their mothers are communicating to them with music, calming them with lullabies and arousing them with playsongs. During this period, basic perceptual, cognitive, and emotional circuits develop in the brain, and all future development builds on and is affected by what happens during this initial period. We have documented that adults can distinguish songs for infants from songs for adults, even from foreign cultures, that songs for infants have particular characteristics such as simplicity of structure and narrow pitch range, that mothers use a particular performance style with infants, including a loving tone of voice and improvisation style that responds to the infants' reactions, and that mothers sing differently to convey different emotions and caretaking goals, singing lullabies to soothe and calm infants and playsongs to rouse and stimulate infants. Importantly, infants prefer infant-directed over non-infant directed singing styles, particularly the high pitch and loving tone of the former.

Young infants develop some musical skills very early through passive exposure to music. For example, infants prefer consonant intervals over dissonant intervals, remember simple melodies for periods of weeks, recognize melodies in transposition, distinguish metrical structures, and integrate movement and auditory information in extracting the meter of ambiguous rhythms. But, not surprisingly, formal musical training has effects and benefits far beyond passive exposure. The brain responses of adult musicians differ substantially from those of non-musicians. Schellenberg et al. showed that IQ increases more in children randomly
assigned to music lessons for a year than in children assigned to drama lessons. These general benefits appear to be mediated by the effect of musical lessons on general attention and memory function. Given that the brain is most open to change early in development, that infants are attracted to music, and that music is an important part of the mother-infant bond, early directed music classes have the potential for wide-ranging benefit.

2. RESEARCH QUESTION

We will test whether 7 months of participation in a Suzuki Early Childhood Education Program by parents and infants who could not otherwise afford such classes results in improved perceptual, cognitive, and social development.

3. RESEARCH APPLICATIONS and SIGNIFICANCE

The proposed scientific research is aimed at showing that directed musical experience in infancy has a positive effect on perceptual, cognitive and social development. This outcome has the potential to revolutionize early music programs and policies related to funding for music education. These results may be particularly important for children at risk. The research is unique in (1) being directed at infants, whose brains are most plastic and open to change, and (2) involving parents as learning partners, because it is the parents who must continue to ensure that their child maintains an optimal developmental trajectory over the next few years.

4. METHODOLOGY

Participants and General Design (see Time Line for details)

Through our partners, Today's Family and the Wesley Urban Ministries, we will recruit 80 parents with infants between 6 and 12 months of age at the onset of classes. Forty of the infant-parent dyads will participate in music classes and 40 in a control group gym program (see Programs, below). Outcome variables will be measured before and after this training (see details
of the tests, below). These tests will take about 2 hours to complete and will be conducted individually with each infant over 2 or 3 sessions by the research assistant and graduate student. The training will take place at two Hamilton locations of the Ontario Early Years Centres, one operated by Wesley Urban Ministries and the other by Today’s Family, located in lower Hamilton and the central escarpment area. These centres are sponsored by the Government of Ontario and provide play-based problem solving for children, parent support, education programs and information, and referral services for families of children up to 6 years of age. Many of the families that utilize these centres are newcomers to Canada and/or on the lower end of the socio-economic scale.

The Training Programs

The Musical Program. Infants in the music group will receive 7 months of the Suzuki Early Childhood Education program, developed by Dorothy Jones, past president of the Suzuki Association of the Americas (see letter of support). Through listening, singing, and movement, participants learn a repertoire of songs and musical activities designed to develop their musical abilities through participation and observation. Repetition is central, which is important for memory and attentional development. Important as well, is that parents are encouraged to be active participants in the learning. The curriculum emphasizes singing, movement, infant/parent bonding as well as awareness of infant development, making it an ideal choice for the population with which we will be working. Sharon Jones (see biography) will consult with us on the research and supervise the delivery of the program. All teachers in the program will be rigorously trained, including mentoring with actual infants and mothers in classroom settings.

The Control Group Gym Program. In order to ensure that any effects we obtain are due to the music classes and not just the result of participation in any class where mothers can talk to other
parents and get positive reinforcement for being with their child, we will follow a parallel set of
infant-parent dyads who will participate in a weekly gym where infants are encouraged to crawl,
walk and engage in somersaults and other fun activities.

**Outcome Variables (measured before and after the training)**

**Background Questionnaire:** Covers family background, number of children, language(s)
spoken in the home, music and athletic background, music heard in the home, etc.

**Perception:** We will use preferential listening tests (see Addendum, Figure 1) to measure:

**Test 1. Scale knowledge.** We will test whether infants prefer to listen to music with occasional
wrong notes going outside the key or to correct versions.

**Test 2. Esthetic knowledge.** We will test whether infants prefer to listen to a piano piece played
(a) expressively or (b) unexpressively but accurately by synthesizer.

**Hypotheses.** We expect more music learning and therefore stronger preferences only in the
music group after training for (1) correct versions and (2) expressive renditions.

**Cognition:** We will examine language development and memory formation as follows:

**Test 3. Language development.** We will use the standardized MacArthur Communicative
Development Inventories to assess language development¹⁰.

**Test 4: Memory trace formation in the brain using EEG.** See Addendum, Figure 2 for a
description of our brain measures of memory trace formation in infants.

**Hypotheses.** We expect the music group to exhibit more advanced language skills, and more
robust EEG measures of memory trace formation, but only after training.

**Social Development:** We will conduct the following tests.

**Test 5. Temperament.** Parents will complete the standardized Infant Behaviour Questionnaire
(IBQ-R) to determine the tempermental style of their child.
Test 6. Attachment. The security of attachment will be measured in the Strange Situation Task which monitors reactions to a stranger in the presence and absence of the mother.

Test 7. Joint attention. Advances in social behavior involve the ability of an infant to jointly attend to an object with a parent (see Addendum, Figure 3 for measurement details).

Hypotheses. We expect a decrease in the music group in the number of infants with difficult temperamental style (Test 5). We expect that after training infants in the music group will show more secure attachment and higher levels of joint attention than infants in the gym group.

Data analysis. We will use standard methods of univariate and multivariate statistics to characterize the differences between the two groups before and after training.

5. KEY PERSONNEL

Project Directors: Dr. Laurel Trainor & David Gerry, McMaster University,
Suzuki Educators: S. Jones (Consultant) & J. Webb (Teacher), Thames Valley Suzuki School
Research Assistant: Lisa Hotson, Auditory Development Lab, McMaster University

6. CITATIONS

ADDENDUM

Figure 1. Preferential listening test. The infant controls how long they listen to two different sound stimuli by his or her looking behaviour. A light is flashed from the box under the speaker on one side of the infant illuminating. When the infant looks, the experimenter presses a button causing the computer to play one of the two musical stimuli. When the infant looks away, the light and sound turn off. The next trial occurs on the other side and consists of the other sound stimulus. Such trials alternate, and statistical tests are done to determine whether the infant listened longer to one compared to the other stimulus. (See reference 4).

Figure 2. Measuring memory traces using EEG. An electrode net with 128 sensors is placed on the infant's head (left panel). One sound (a standard stimulus) is played over and over in a continuous stream. Occasionally the sound is changed (deviant stimulus). EEG waves are recorded. These are the voltage fluxuations that are seen at the surface of the head when large numbers of neurons depolarize and fire synchronously in the brain. EEG waves in response to the standard stimuli are averaged separately from those to the deviant stimuli (middle panel). When the two waveforms are subtracted, a mismatch negativity (MMN) is evident about 200 ms after onset of the deviant tones. The size and latency of this MMN component is a measure of how robust the memory trace is for the standard sound. Data from He, Hotson & Trainor11.

|---------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------|---------------------------------------------------|-------------------------------------------------|-------------------------------------------------|

Figure 3. Joint Attention. We will use the six categories of Spencer12 as shown in the chart. We will videotape infants and parents playing with a series of toys. The tapes will be coded offline and the proportion of time each dyad is engaged in each state will be determined. With increasing social ability, infants will engage more in coordinated joint attention.
**TIME LINE**

**April 2008–May 2008.** All of the tests will be set up on computer and the approval for the research protocol will be obtained from the McMaster Research Ethics Board.

**June 2008–August 2008.** Parents with children at the appropriate age of 6 to 12 months at the onset of classes (September, 2008) will be contacted at the participating Ontario Early Years Centres in Hamilton, ON and asked if they would be interested in participating in one of two new programs, a gym program and a music program, to be offered at their local Centre. They will be informed that they would be randomly assigned to one or the other program. They will be told that if they decide to participate, they need to commit to doing the set of tests with their infant before the classes start and after the classes are done. They will need to attend the program regularly for 6 months, but that the program will be given to them free of charge. Each class will have approximately 10 infant-parent dyads for a total of 4 music and 4 gym classes. The questionnaires and tests (see Outcome Variables section) will be administered by the research assistant and graduate student.

**September, 2008–March, 2009.** The parent-infant dyads will attend the weekly classes which will be delivered under the supervision of Sharon Jones.

**April, 2009–June, 2009.** The perceptual, cognitive, and social outcomes will be measured again in the infants and their parents.

**June, 2009-August, 2009.** The data will be analyzed and written up for publication and dissemination.