

Birth of the beat

Music's roots may lie in melodic exchanges between mothers and babies

By Bruce Bower

Photograph by Cary Wolinsky

At scientific meetings, psychologist Colwyn Trevarthen often plays a video of a 5-month-old Swedish girl giving her mother a musical surprise. Blind from birth, the girl reaches for a bottle and laughs appreciatively as her mother launches into a familiar song about feeding blueberries to a bear. As in baby songs everywhere, Trevarthen says, each line of the Swedish tune runs about four seconds and each stanza lasts about 20.

In a flash, the girl raises her left arm — an arm she has never seen — and begins conducting her mother's performance. The baby, named Maria, moves her arm just before many of the song's lines begin, leading her mother by about one-third of a second. In some cases, Maria synchronizes her hand movements with the rise and fall of her mother's voice.

Mom's face glows in response to Maria's playful directions.

"Babies are born with a musical readiness that includes a basic sense of timing and rhythm," declares Trevarthen, of the University of Edinburgh.

Scientists have been finding that these chubby-cheeked cherubs heed a musical sense that moves them and grooves them long before they utter a word. Within a day or two after birth, babies recognize the first beat in a sound sequence; neural signs of surprise appear when that initial "downbeat" goes missing. Classical music lights up specific hearing areas in newborns' right brains. Even more intriguingly, babies enter the world crying in melodic patterns that the little ones have heard in their mothers' conversations for at least two months while in the womb (*SN: 12/5/09, p. 14*).

But infants do much more than pick up beats and mimic melodies, says Trevarthen. An inborn musical knack gets parlayed by babies into emotional banter with attending adults, who possess their own musical feel for infant care. Adults around the world intuitively

"Itsy Bitsy Spider" and other sing-alongs may prepare babies to learn social rituals, scientists propose.



speak to infants using a singsong, vocally exaggerated mix of words and sounds known as motherese.

Trevarthen rejects the notion that babies passively absorb adults' googly-eyed gab. Instead, he holds, infants intentionally prompt musical exchanges with adults, and infants know when they're being invited by a grown-up to interact. Here, the currency of communication consists of coordinated exchanges of gestures, facial expressions, coos, squeals and other sounds. Trevarthen and like-minded researchers call this wordless conversation "communicative musicality." Babies' natural musical aptitude gets them in sync with mothers. Within weeks of birth, mom and baby compose brief musical vignettes that tune up a budding relationship.

"Our brains possess a storytelling sense that is an essential component of musicality from the beginning," says Trevarthen.

From his perspective, musical storytelling prepares infants to learn the rhythms and format of a native language. Adult forms of music, as well as dance and drama, spring from the intricately structured yarns spun by babies and mothers.

New research probing these early musical stories indicates that moms and tots vocally express and share emotions in finely calibrated ways that differ in some respects across cultures. Other findings suggest that mothers everywhere prod babies to sing and act out simple songs as a prelude to learning cultural practices.

And women who suffer from personality and mental disorders fail to connect musically with their babies, investigators find. Infants whose first relationship strikes a sour note may display social and emotional problems later in childhood.

But like healthy babies, Trevarthen notes, these unfortunate tykes try their darndest to relate musically with whoever is available.

Trevarthen's views draw criticism, though, from many cognitive psychologists and musicologists. They regard music as a universal practice, with still-mysterious evolutionary origins, that infants learn from their native cultures

without the help of an innate timekeeper. From their first days, babies seamlessly learn to keep a beat and to prefer the same melodies that adults do, from this perspective. Some critics suspect that Trevarthen and his colleagues, not babies and mothers, are telling musical stories.

Story time

Stephen Malloch has no problem with Trevarthen's take on communicative musicality. Malloch, a musicologist at the University of Western Sydney in Australia, coined the term in 1996.

While listening to the chatter of a mother and her 6-week-old daughter, who Trevarthen had videotaped 17 years earlier, Malloch noticed he was tapping his foot. As a trained violinist whose stage fright pushed him into research, Malloch was accustomed to feeling the beat of musical sounds.

"I sensed a rhythmic, melodious give-and-take to the mother's gentle promptings and the baby's pitched vocal replies," he recalls. A few weeks later, communicative musicality came to mind as a shorthand term for emotional exchanges based on musical principles.

Malloch wasn't the first to have this idea. In 1981, European researchers Hanuš and Mechthild Papoušek asserted

that mothers and babies intuitively communicate using melodies and other musical sounds. Malloch developed a way to identify the musical stories that he thinks are created during these intimate encounters.

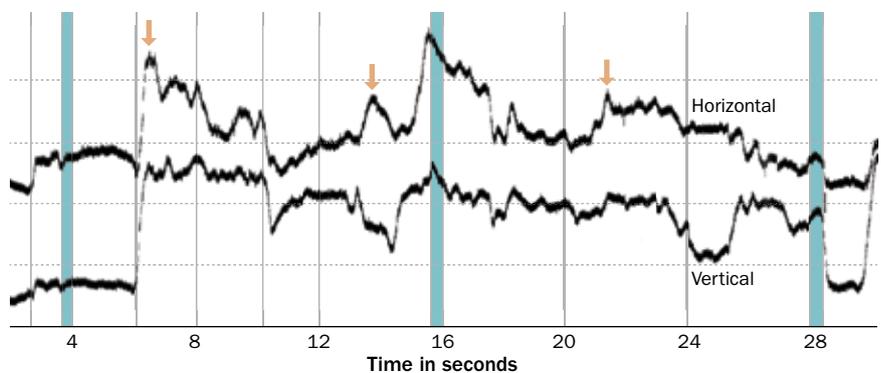
He probed mom-baby conversations by measuring sound waves, pitch patterns and timbre, or tone attributes, starting with those in Trevarthen's video. An acoustic analysis revealed three features of communicative musicality—pulse, quality and narrative.

Pulse refers to a timed series of sounds and words in an interaction. Each utterance by mother and daughter lasted about one and a half seconds, with little variation. Quality consists of emotional signals conveyed by voice and gestures. One example is the swoop of a mother's hand accompanying a dropping, then rising vocal pitch. In the recorded encounter, mother and daughter used the pulse and quality of the interaction to create musical narratives lasting no more than about 30 seconds.

One narrative begins with the mother uttering low-pitched phrases, such as "come on" and "that's clever," for five seconds. Her daughter's voice rises in response and the mother moves her vocal pitch an octave higher. Mom

Baby conductor Maria, a Swedish infant who has been blind since birth, showed scientists her sense of rhythm by lifting her arm and conducting her mother's singing. The figure below shows how Maria's left index finger moved (horizontally and vertically) throughout the familiar tune.

Index finger tip displacement



Brummell-brum, vem luf-sar där? Bus-kar-na kna-ka. En hund visst det är. Lur-vig är pålsen. Men Olle blir glad: "A, en kamrat, det var bra, se goddag!"

■ Maria moved her finger just before each phrase of the Swedish song began. In this way, she anticipated the movement in her mother's voice.

↓ Maria also synchronized finger movement when she heard sharp consonant sounds in words at the end of a line—"sar där," "visst det är" and "glad."

prompts responses from baby for about eight seconds. Their voices rise to a peak of intensity during a back-and-forth exchange that lasts another seven seconds. Mother and daughter then take six seconds to return to the mother's original, low voice pitch. So, Malloch says, each collaborative story contained an introduction, development, climax and resolution.

Feel the vowel

Musical storytelling of this kind largely depends on varying the pitch, timbre and rhythm of vowel sounds, which are more emotionally expressive than consonants, according to Trevarthen and University of Edinburgh psychologist Niki Powers. Mothers and infants in Scotland and Japan make these emotionally tinged sounds in culturally distinctive ways, the researchers say.

"Even with limited powers to produce learned sounds, infants in different countries express vocal emotions and parents intuitively respond to them," Powers says.

She and Trevarthen videotaped a dozen pairs of mothers and their 3- to 4-month-olds playing together at home, six in Scotland and six in Japan. The researchers' findings and those of several other teams appear in the 2009 book *Communicative Musicality*, edited by Malloch and Trevarthen.

Language and cultural differences shape emotional communication, says Powers. Occasional high-pitched vowel sounds, interspersed among a stream of low vowel sounds of moderate intensity, denoted emotional responses by Scottish mothers to their babies, she suggests. Each low sound usually lasted no more than three-quarters of a second.

Japanese mothers consistently made high, intense vowel sounds. Swings from short to long vowels helped the moms convey emotion to the infants, in Powers' view. These women held many vowel sounds for less than one-quarter of a second but articulated others for a second or more.

Infants in both countries tended to produce vowel sounds that lasted up to one second, much longer than vowels used in speech. Japanese babies emitted high-pitched, acoustically intense vowels, much as their mothers did.

In an upcoming issue of *Infant and Child Development*, Trevarthen marshals evidence suggesting that even newborns purposely coordinate vocalizations and movements with those of caretakers. An innate impulse to forge emotional ties with others drives such behavior, he posits. In the months after birth, babies build on this impulse by adopting a native culture's style of emoting vowel sounds.

Up the waterspout

At about the time that babies start to put emotional oomph into their voices, communicative musicality enters a ritualized arena dominated by simple tunes that must be performed, not just sung. Parents combine simple melodies and lyrics with activities that include knee bouncing, hand clapping and pantomime.

Physician Patricia Eckerdal of Sweden's Uppsala University Hospital and Björn Merker, an independent neuroscientist in Segeltorp, Sweden, have begun to chart the developmental trajectory of what they call action songs. Merker and Eckerdal videotaped 25 pairs of Swedish mothers and their infants playing together at home when the babies were 6, 9 and 12 months old.

The well-known sing-along "Itsy Bitsy Spider" is one example of an action song that babies learn as they grow. In its first incarnation, up to about age 3 months, the infant lies down as the adult does all the work. Mom forms a spider hand, makes it crawl it up the baby's body and tickles his or her chin at the "waterspout" ending of the first line. Mom spreads her fingers and runs them down the baby's body for "down comes the rain." At "out comes the sun," mom places her spread fingers in front of the baby's face. Gestures from the first line are then repeated with a final tickle.

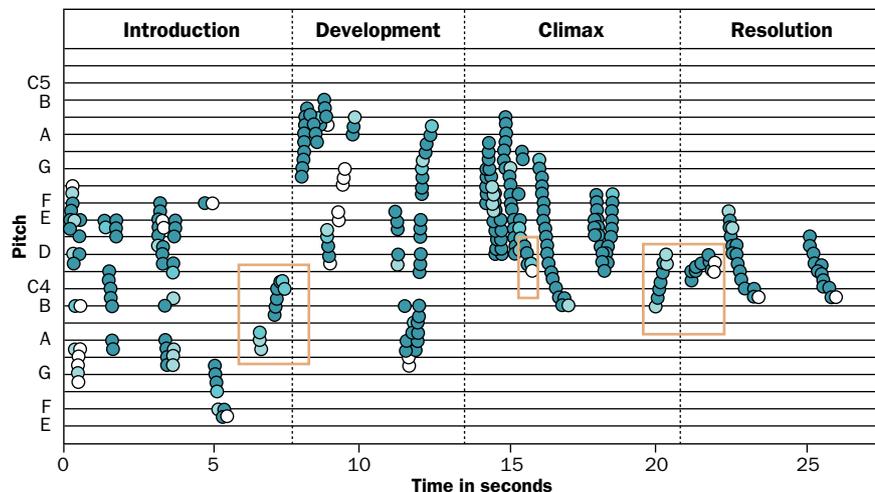
By 6 months of age, adult and infant sit close together so that the child's hands and arms can be gently guided through the pantomime sequence while singing. By 9 months of age, infants perform "Itsy Bitsy Spider" on their own.

In this way, infants practice performing intricately structured acts and discover what those acts mean, an essential skill for learning a slew of cultural rituals. It's a short hop from getting the hang of "Itsy Bitsy Spider" to mastering dinner table etiquette and conversational rules, the scientists hypothesize.

"Action songs are the 'baby rituals' of human culture," Merker says.

Only people, not singing birds or other musical animals (*SN: 5/23/09, p. 8*), incorporate musical communication into social rites, he and Eckerdal assert.

A story in song Musical conversations between mom and baby can take the shape of stories, some scientists propose. The figure below shows the rise and fall of one such exchange. Mom's voice increases in pitch and intensity as the story reaches a climax. Baby often makes sounds (highlighted in boxes) as the story shifts from one stage to another.



Seeking a definition Whether strummed by a guitarist who has gone platinum or sung by a mom who is playing with her child, music at its most basic level is a sequence of notes that can vary in a number of ways.

Pitch is determined by a sound's frequency. Notes that sit in different positions on a musical scale, called tones, have different pitches. Modern Western music, for example, combines 12 tones, with the A at the middle of a piano keyboard having a frequency of 440 hertz. Other cultures work with fewer tones. The first few notes of "Twinkle, Twinkle, Little Star" vary only in pitch.

Rhythm emerges because different notes can last for varying amounts of time. Notes with different durations are represented differently in written music: Some have little flags, dots or open circles. A quarter note, for example, is drawn as a closed circle with a vertical line; it lasts for one beat. The first several notes of the Beach Boys' "Barbara Ann" vary only in note duration.

Combining different pitches and rhythms allows for the creation of **melodies**, the same way the combination of words makes a sentence. And when different notes are played at the same time to create chords, rather than just successively, they can lead to **harmony**. Other factors mix in to affect the character of the piece. **Dynamics**, how loud each note is and how that loudness changes over the course of several notes, opens even more room for variation. And **timbre**, or tonal quality, distinguishes one instrument from another—a piano sounds different from a tuba, and Celine Dion sounds different from Macy Gray. **Tempo** characterizes the overall speed of a piece. Changing multiple factors at a time leads to endless musical possibilities, from "Für Elise" to "La Bamba."

"Twinkle, Twinkle, Little Star"



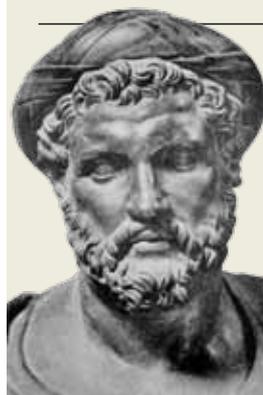
"Barbara Ann"



"Für Elise"



"La Bamba"



Considering beauty While some would argue that any variation of sound with the above features makes music, others say music is more than the sum of its parts. Perhaps sound has to be pleasing to qualify? Pythagoras, an ancient Greek philosopher, recognized that when notes with pitches forming simple ratios are played together, they sound pleasant. Using a single string with a movable bridge—which allowed him to pluck two notes at once—he found that when one side of the string was half the length of the other, it created two notes that sound lovely together. (In Western music today, if a string producing the note A at 440 hertz is halved, it creates another A an octave higher.) A pleasing blend also occurred when one side was two-thirds or three-fourths the length of the other. Using these ratios, Pythagoras built a seven-note scale, and his ideas still help musicians understand why some music sings and other tunes fall flat. —Elizabeth Quill

Unhinged melody

Some babies, though, face a form of ritualized rejection that would test even an itchy-bitsy spider's determination. Their mothers feel so alienated and alone that efforts to pull mom into melodic exchanges are like trying to grab fistfuls of water.

Psychologist Maya Gratier of Université Paris X-Nanterre and psychiatrist Gisèle Apter-Danon of Université Paris Diderot have examined communication breakdowns that afflict babies born

to mothers diagnosed with borderline personality disorder. This condition revolves around a tendency to form intense, unstable relationships.

People with borderline personalities act impulsively, feel emotionally empty and constantly fear abandonment. Many have survived severe child abuse and neglect.

Gratier and Apter-Danon codirect a project that has tracked the interactions of about 150 pairs of French mothers and their babies from birth to about

age 5. Many mothers qualify as having borderline personality disorder. Others have obsessive-compulsive personality disorder, paranoid personality disorder or no mental ailments.

In brief laboratory exchanges, these mothers awkwardly repeat one phrase over and over or produce strings of unusual sounds, such as tongue clicking and whistling. No rhythmic flow characteristic of typical baby talk emerges. It's almost as if a baby isn't there at all.

That leaves infants unable to get a

sound in edgewise. They withdraw from mothers with borderline personalities, vocalize little or get fussy and upset.

One 3-month-old boy in the French study tried his best to spark an emotional dialog with his mother during a 27-second encounter, Gratier says. The woman drearily repeated the same line from a French nursery rhyme four times. Her son then blurted out “ahhh!” just as she launched into a fifth rendition. Caught off guard, the woman exclaimed “What?” before regaining composure and resuming her dry recitation.

Undaunted, the boy immediately belted out a louder sound. That stopped his mother long enough so that he could utter a cooing sound, with a few emotionally tinged pitch changes, for about as long as the nursery rhyme’s initial phrase.

Gratier and Apter-Danon interpret the 3-month-old’s behavior as an attempt to lure his mother into a musical exchange. It briefly worked, they say. The woman imitated his cooing sound once with her characteristic flat tone. Then she returned to her signature line.

Once again, the boy became an observer, not a participant.

“The interactions of borderline mothers with their babies appear more like compilations of isolated moments that probably impede the creation of shared musical story lines,” Gratier says.

Depressed mothers offer a more varied verbal diet to their babies than borderline mothers, but in an unusually low, unexpressive voice devoid of rhythmic timing, according to studies directed by psychologist Lynne Murray of the University of Reading in Eng-



Not just a pleasant sound

When people use music to share stories, comfort peers or worship gods, it takes on new meaning. Music’s roles vary depending on time and place.

Bonding: Battle hymns, national anthems and alma maters unite people for a common cause and make them feel that they are a part of something larger. Marching bands (above), for example, can rile up crowds and promote pride at sporting events.

Relaxation: Mothers in almost all societies sing lullabies to put little ones to sleep. Called a *huluna* in the Philippines province of Batangas, the lullaby is so popular there that almost every mother has composed at least one for her child. And in Denmark, writing lullabies is an art form. A classic Danish lullaby, “The Sun is So Red, Mother,” was written by a novelist, playwright and poet named Harald

Bergstedt and arranged by famous composer and violinist Carl Nielsen.

Creative expression: The Chopi people of Mozambique are known for their *timbila* music, played on xylophones. The music and accompanying dance is developed like a symphony and also has room for individual players to improvise and show their creativity. Like music elsewhere, *timbila* helps the Chopi share who they are and where they come from.

Meditation/Trance: Music is believed to provide a way for shamans (one shown above in British Columbia) to enter a trance state and get in touch with the spiritual world. The Sami, indig-

enous people of northern Europe, have a traditional form of song called *yoik* said to open the door for communication with animal spirits. Drumming helps the shamans enter the spiritual world.

Learning: The “Alphabet Song,” among other simple rhymes, helps children learn and remember facts. Some researchers believe that early songs, such as “Itsy Bitsy Spider,” may also prepare infants to learn cultural rules and practices.

Revolt: Music can represent the emergence of a subculture that turns against traditional ways. All-night dance parties popular in the 1980s offered a way for people

to let loose, experiment and declare their independence. In the early 1990s, municipalities across the United States and United Kingdom passed bylaws to limit the organization of these raves.

Worship: A wide range of religions employ music. In Indian tradition, *bhajans* express love for God (holy men shown above). Gospel music helps Christians praise God. And, though music is not a large part of Islamic tradition, five times a day Muslims are called to prayer as a muezzin chants in praise of Allah from the top of a mosque’s minaret.

Social pressure: In rural Sudan, women known as *hakamas* (shown above) use chant-like songs to motivate men to fight in wartime and to call people to brotherhood during times

of peace. In a society where men hold higher status than women, the songs empower women: Going against the songs is considered shameful.

Mourning: Dirges are an integral part of funerals for the Akpafu of southeastern Ghana. A ceremony begins when drums are beaten to announce the death to various clans. While clans are assembling, women begin to sing the first funeral dirge. Each activity of the burial ceremony has special dirges. And 30 to 40 different songs may be heard while family keeps watch over the body.

Declarations of love: The *ncas*, a brass mouth harp, is played by Hmong men outside the wall of a lover’s house. Though the men may also whisper softly during courting,

land. Infants interact hesitantly with depressed mothers, mimicking their low, flat vocal delivery.

Borderline personality disorder and depression alike deprive women of the flexibility and expressiveness needed for communicating musically with babies, Gratier holds. When there's no room for playful musical exchanges, interactive sync is sunk. In their long-term study, Gratier and Apter-Danon find that disrupted musical communication between mothers and babies heralds social difficulties for these children in preschool.



they will inevitably switch to the ncas to woo a chosen gal. Lloyd (John Cusack) may have had the same idea in *Say Anything* when he lifted a boom box playing Peter Gabriel's "In Your Eyes" above his head.

Work: Sea chanteys are onboard working songs, the rhythm of which helps synchronize the repetitive movements of sailors. There are different songs that provide the right tempo for hoisting sails, hauling nets and pulling up anchors.

Social interaction: Much of African music takes the form of call and response, meaning the activity is participatory. A leader will sing or play an instrument and the rest of the group will respond with hoots, hollers, clapping or a traditional refrain. In this

way, much of the music becomes cyclical, with no clear end.

Mythology: Among Aboriginal Australians, each clan may share songs that tell stories about the journeys that mythical ancestors took as they carved valleys and built mountains to create the Earth's landscape. The songs trace ancestral history, tie the people to the land and lay down rules of conduct.

Entertainment: Music is a whole-body phenomenon. In some cases, it lightens the mood or passes the time. From noh, a traditional form of Japanese musical theater that dates to the 14th century, to the pop concerts of today, watching others make music makes people feel good. —Elizabeth Quill

Musical divide

Under better circumstances, mom and baby embark on a maiden voyage of improvisation, says Ellen Dissanayake, a professor of art and music at the University of Washington in Seattle. Musical ad-libbing of this type relies on timing techniques similar to those used by jazz musicians, Dissanayake proposes. A regular beat and timed melodic passages provide a structure for jazz instrumentalists to synchronize their playing and take turns soloing. Like jazz musicians, mothers and babies negotiate novel twists and turns in the flow of communication, building up emotional tension that they resolve together.

Scientists already knew, she notes, that 4-month-olds who coordinate pauses, turn taking and other conversational rhythms with mothers — without becoming rigidly synchronized and unable to adjust — interact well with others at age 1 (*SN*: 6/23/01, p. 390). That's consistent with the idea that mothers and babies employ just enough musical structure in their encounters to enable creative storytelling, thus grooming the child to deal flexibly with others.

Dissanayake theorizes that musical communication between mothers and babies emerged roughly 2 million years ago in the *Homo* genus, well before the emergence of language. With the evolution of physically helpless babies needing years to grow big brains, nonverbal exchanges that bonded infants to their mothers became essential.

In her view, Stone Age foragers transformed two-way musical communication into the temporal arts — singing, playing instruments, dancing, making expressive gestures, reciting poetic stories, clapping hands and beating out rhythms. In small-scale societies, she says, the temporal arts convey messages in ritual ceremonies, such as the need to appease gods believed to control vital resources. Such practices lessen worries about life's uncertainties and fuel group cohesion.

By creating stories out of precisely timed sounds and movements, Stone Age mothers and babies laid the

groundwork for spoken language, says Dissanayake.

Today's music, from Ludwig van Beethoven to Lady Gaga, has transformed the temporal arts into a commercial enterprise that can still draw people from around the world into tribes bound by shared feelings and rituals (*SN*: 4/11/09, p. 14), Dissanayake asserts. Consider the pilgrimages that far-flung opera lovers take to hear famed vocalists and the popularity of all-night raves.

Her evolutionary scenario, like communicative musicality itself, stands defiantly outside mainstream music research. "This mother-infant stuff seems a little squishy to many scientists," Dissanayake says.

Trevarthen and colleagues weave a fanciful story around a threadbare body of data, asserts psychologist Sandra Trehub of the University of Toronto at Mississauga, a pioneer in studying infants' music perception. Music's evolutionary origins remain unknown, she emphasizes (see "Songs from the Stone Age," Page 28).

"According to its proponents, communicative musicality has boundless scope, so it's an idea than can neither be proven nor falsified," Trehub says.

Babies notice rhythmic downbeats and react to melodies with wondrous expressions even when by themselves, "so social communication is unlikely to provide a complete answer to early musicality," adds psychologist Marcel Zentner of the University of York in England.

Trevarthen remains undeterred. The next scientific step, he says, is to devise a measure of musical interactions that combines facial expressions and gestures with vocalizations.

Eventually, Trevarthen insists, researchers everywhere will tap their feet to the sounds of music reverberating in mother-baby chatter. ■

Explore more

■ S. Malloch and C. Trevarthen, eds. *Communicative Musicality: Exploring the Basis of Human Companionship*. Oxford University Press, 2009.