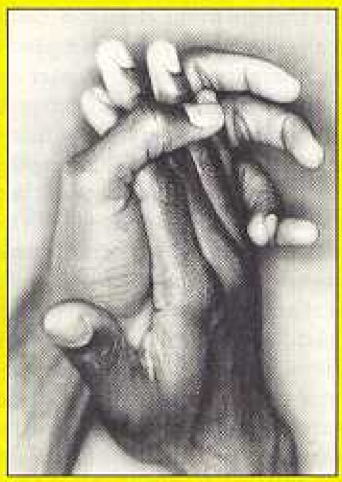
RHYTHM OF LIFE



INSIDE YOUR HEAD IS A METRONOME THAT HELPS YOU KEEP TRACK OF TIME, DANCE THE FANDANGO AND UNDERSTAND SPEECH. TRISHA GURA GETS INTO THE SWING

DON'T think about anything in particular. Just tap away with your finger and count the number of taps over a couple of minutes. The rate you fall into will probably be about one beat every 600 milliseconds—a little slower than one tap every half second.

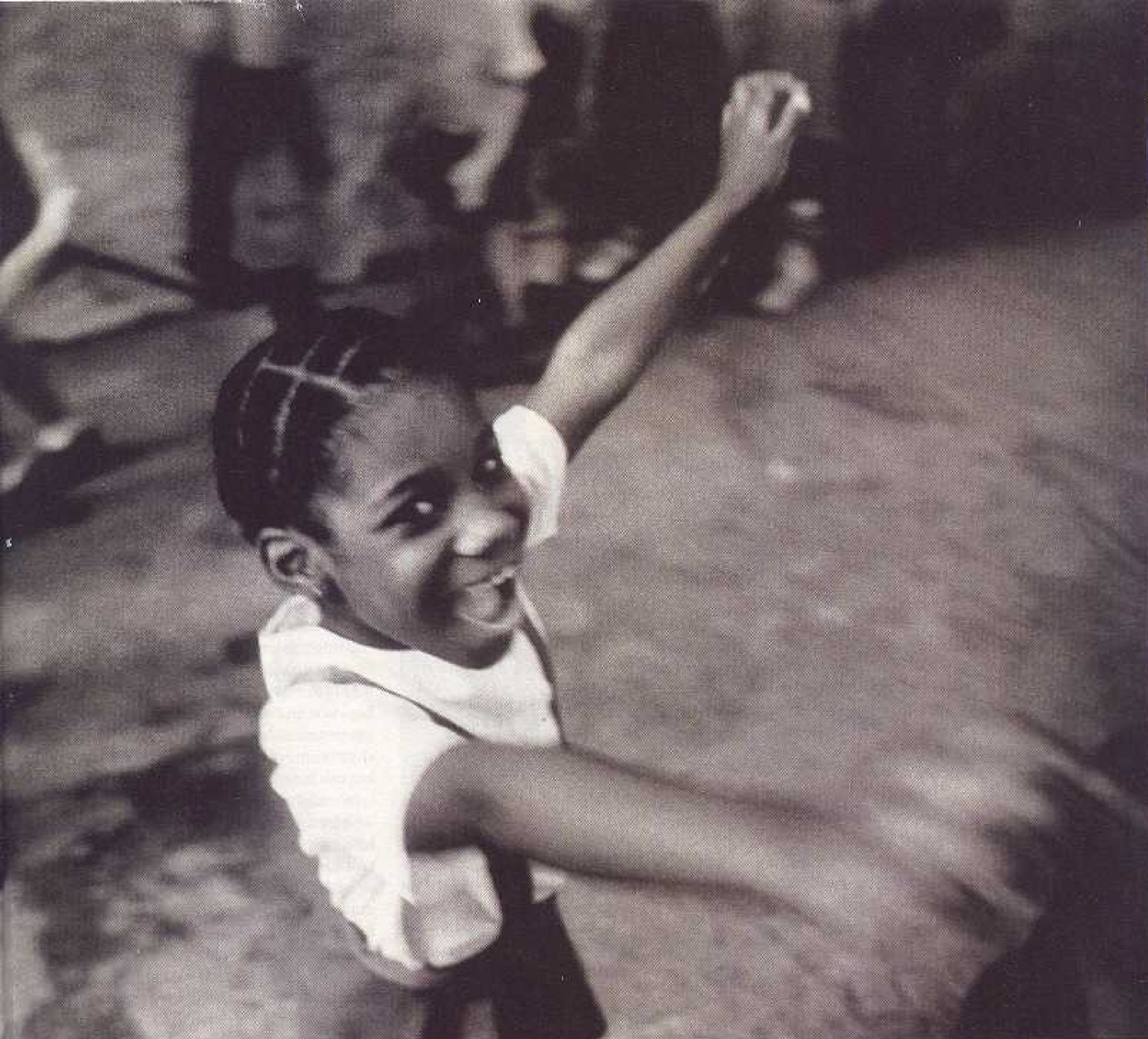
Why? Some researchers believe that the tapping rate echoes a primal pulse inside each of us. The beat, scientists say, is central to our existence. We use it not only to make music, but to coordinate our brains and bodies, keep track of time, and filter the stream of events that assail us in this unpredictable world.

Carolyn Drake of CNRS, René Descartes University in Paris is one researcher who beleives we have an internal beat. She asks people to tap their fingers just like in the exercise above and finds that adults' tapping rates are remarkably consistent—not only during each session, but also a week or a month later. What's more, Drake says, "when you look at the rate people walk, their heartbeat and infant suckling rates, they are all in the same range." Without an external cue, each activity tends to follow the same drummer.

The first person to notice this preferred timing was cognitive psychologist Paul Fraisse in the 1940s and 1950s. Then in the 1970s, neuropsychologist Mari Reiss Jones of Ohio State University in Columbus suggested that the physical tempo corresponds to an internal pulse that regulates our attentions. Other neuroscientists have been slow to accept the idea, but now they are starting to come round.

One reason is the phenomenon of "absolute tempo". Some conductors can beat 60 to the

Image State Elsby May/Stone Hans Neleman/Image Bank



minute, or any other tempo you ask for, with astonishing accuracy. Daniel Levitin of McGill University in Montreal thinks we all have this ability. He asks people to sing a well-known song that they have only heard in one version, and finds that they get the tempo just right. Hard to explain if we don't have some precise internal metronome to guide us.

But apart from making music, what is the timekeeper for? There must be cultural advantages in being able to join in a knees-up or a hoedown, but it goes a lot deeper than that.

Reiss Jones and Drake believe that we perceive the world in pulses, rather than as a stream of consciousness, and that our internal metronome sets the pace. Senses such as sight and hearing rely on the idea of contrast, because it's more efficient to confine your attention to places where things change—the edge of an object, for example. The same is true of time, says Drake. She believes we sample the world roughly twice a second, checking on each sense to see if sounds or sights have changed. She goes on to suggest that we perceive the world best during these pulsed check-ups. It's how we filter out information that would otherwise overwhelm us.

The internal pulse also marks out time, suggests Drake. "How otherwise can you appreciate the fact that one event comes after another, or the fact that one note is twice the length of another?" Without instinctive rhythm, we would be lost in a confusing world where everything happens at once.

We can, of course, deviate from a 600-millisecond pulse when we need to. Lots of

'THEY BELIEVE THAT WE PERCEIVE THE WORLD IN PULSES, RATHER THAN AS A STREAM OF CONSCIOUSNESS'

'YOUNG BABIES SEEM TO CONCENTRATE ON THE RHYTHM OF LANGUAGE, WORKING OUT WHAT THE SIGNIFICANT SOUNDS ARE'

important things happen on longer and shorter timescales. So our internal beat must somehow adapt, shifting when external rhythms change, or when we focus on a different tempo. "There may be a very complex dance between an organism and the organism's environment," says Reiss Jones.

That's why people are good at picking out rhythms. According to Ed Large of Florida Atlantic University in Boca Raton, we often mistakenly think rhythm is solely a feature of the music. "You listen to a piece of music and you hear a rhythm," says Large, who studies neural networks and sidelines as a jazz musician. What really happens is that as you listen, the pattern of notes and rests triggers an oscillation in the brain. After enough oscillations, the brain "gets it", and the dominant pulse in the mind shifts to match one of the periods in the music. This "entrainment" might even trigger the body to move, tap or gyrate in time.

According to Bjorn Merker of the Royal University College of Music in Stockholm, more complicated rhythms are merely variations on simple cadences that humans can entrain to. You have to start with the beat—the subdivision of time that makes the next downstroke of the conductor's baton predictable. "Beneath different kinds of rhythm is a very simple thing, a steady dub, dub, dub," he says. "If it is not there, the rest falls apart quickly."

Most people prefer fairly simple rhythms, because they are easy to entrain to. Drake's experiments suggest that when there is a main beat of 400 milliseconds, for example, the brain automatically sets up other oscillations at multiples and fractions of this—100, 200, 800 and 1600 milliseconds. So when each second or fourth beat of a bar is emphasised, for example, two pulses can easily be excited in the brain. More complicated rhythms such as 5/3 need other multiples, so they may fall outside the average listener's ability to discriminate, and the less able performer's ability to play.

Another reason to reset your metronome is to join in with a group. From an evolutionary perspective, coordinating rhythms with other animals can have real benefits. When a group of chimps hoot in unison, for example, the sound is far more likely to reach a potential mate, say, than shouting alone, says Merker, who has studied the way male chimps call and dance in synchrony during their carnival displays. Even insects can entrain to the sounds and sights of their neighbours. Cicadas, crickets and fireflies buzz or beam together as part of clever mating games.

Mass communication

Although humans might not shout and whoop in chorus to attract a mate—except perhaps in nightclubs—we do communicate en masse. Physicist Albert-László Barabási from the University of Notre Dame in Indiana and his colleagues studied crowds applauding at the end of opera and theatre performances (*Nature*, vol 403, p 849).

Audiences lapsed into synchronised clapping at roughly half the average initial rate of individual members of the crowd. This seemed odd to Barabási's team, since the average noise intensity decreased with such a slowing—not a good way to convey enthusiasm. But the volume of each clap rose greatly, the scientists noted. Just like chorusing chimps, audience members seem to realise unconsciously that they have a larger impact as a group working in synchrony. We probably use the same mechanism to coordinate group activities such as rowing, dancing and marching.

The rhythm instinct may also enable us to learn language. Infants seem to concentrate on the rhythm of language, first simple patterns, then more complex ones, long before putting the significant sounds together into meaningful words and sentences.

Frank Ramus at France's national agency for scientific research in Paris took phrases spoken in different languages and replaced each syllable with the sound "sa". He then asked native speakers to articulate these strings of sa-sa sounds with the rhythm of the original phrase, and played the gibberish back to infants. He found that infants as young as two months can tell the difference between the rhythms of their native language and those of another. "Sensitivity to rhythm may be built into babies' brains to initiate language acquisition," Ramus says.

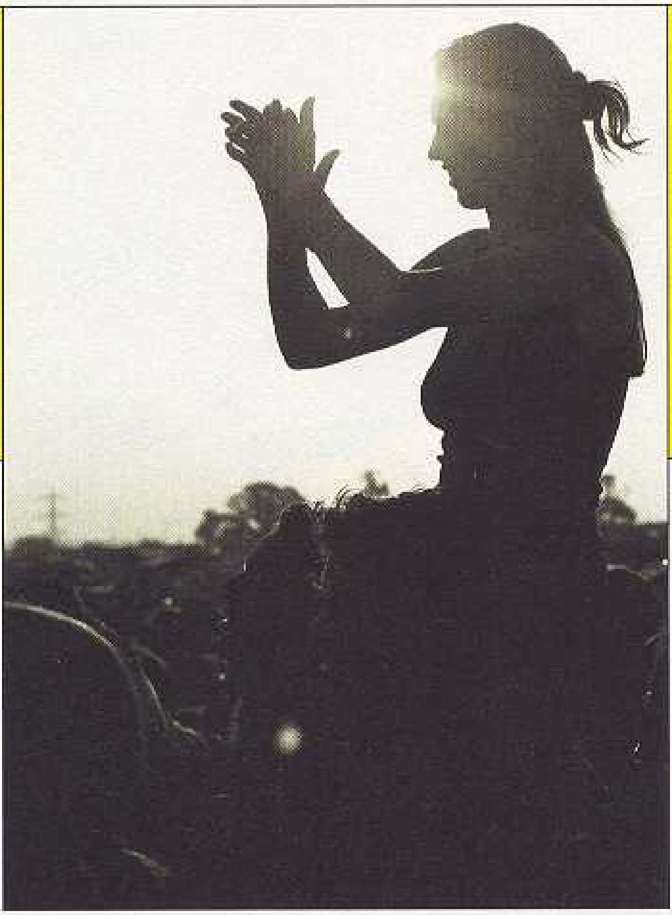
We might have to go back even further in development to find the origins of adults' intrinsic, 600-millisecond beat. Reiss Jones and her supporters once thought that a single cluster of neurons in the brain, dubbed an internal oscillator, supplied this frequency. This seems to be true of insects and other lower organisms, but it can't be true of people. A single oscillator wouldn't be able to change its frequency by more than about 10 per cent, says Drake, so this can't explain entrainment to the wide range of beats in music, for example.

Reiss Jones now thinks that people are born with many oscillators. She and others hypothesise that, perhaps because of early experiences, infants begin to focus heavily on certain well-used tempos, while leaving others dormant.

Drake played a series of evenly spaced beeps at a particular tempo to suckling infants between 2 and 4 months old. Initially, babies find such sounds interesting, and turn their heads towards them, but eventually they get bored and stop turning. If they hear a new tempo, however, they turn again.

Drake found that the infants were more likely to notice and respond when the speed changed to around 3 beats per second—a pulse every 300 milliseconds, to be precise. Babies also seemed to prefer a second pulse

'MUSICIANS ARE LESS CONSTRAINED IN THE DETAIL THEY HEAR. NON-MUSICIANS GET BORED QUICKLY BECAUSE IT ALL SOUNDS THE SAME'



If you're happy: clap your hands along with a crowd and your internal beat changes to match the group rhythm

at 600 ms, more in time with adults and, Drake notes, the heartbeat of the mother. Whether infants process at these rates because they are born with a particular anatomy that picks it up, or they simply use those tempo detectors that are closest to what they first hear, Drake can't say. "It's a chicken-and-egg argument at the moment."

After this, the preferred tempo appears to slow with age. Drake played two simple but different tempos and asked volunteers aged between 4 and 20 to tell her which was the faster of the two. Children chose most accurately when there were intervals of around 400 milliseconds between the beats, and adults at around 600-millisecond intervals.

As people age, Drake suggests, they have to coordinate more complex chunks of information. Many different kinds of information are needed to drive a car or dance the Lindy Hop, so to give the brain enough time to process each chunk in between samplings, the time between pulses must be stretched out.

I got rhythm...

Musical experience also seems to slow the preferred pulse down, and add to its flexibility. In her tapping experiments, Drake found that musically inclined adults spontaneously focus on two distinct slower tempos, 800 and 1600 milliseconds, and can shift these tempos a long way if they need to. It seems musicians' acoustic palettes are like those of experienced wine tasters. "Musicians are much less constrained in the details they can hear," says Drake. "Non-musicians, on the other hand, focus on intermediate rhythms rather than fast or slow ones. They get bored relatively quickly because it all sounds the same."

If rhythm is built into our brains, are there any clues about where? Neurologist Stephen Rao and his colleagues at the Medical College of Wisconsin in Milwaukee used a brain-scanning technique called functional magnetic resonance imaging to pinpoint which areas are active when people make split-second decisions about rhythms they hear. The researchers played two tones at one tempo and then a second pair of tones at a different tempo. Next, 17 volunteers were asked which pair was quicker. As they answered, two brain regions became active: the basal ganglia, a collection of small regions deep inside the brain which help to coordinate our movements; and the parietal lobes, which are important in spatial awareness and language. Rao and his colleagues believe these regions hold the neurons that perceive rhythm.

The same regions may monitor the passing of time. Mind-altering drugs seem to disrupt people's ability to keep track of short periods of time, either slowing or speeding our ability to count off a minute or two. Parkinson's disease also alters the sense of time passing and, interestingly, the illness severely affects the basal ganglia (*New Scientist*, 1 November 1997, p 52). So the stretching of the pulse as we age could even have something to do with the way time seems to pass more quickly the older we are. Whether time passes faster for musicians, though, might be hard to test.

Others disagree with the idea of a specific pacemaker limited to one or two brain regions. Scott Kelso of Florida Atlantic University in Boca Raton, who makes mathematical models of oscillating brain regions, says the concept is too simplistic. "In different situations, different parts of the brain can express different rhythmic behaviours," he says. When Kelso asked people to tap in sync with a beat provided on a metronome, he found that their left-central and anterior parietal areas of their brains—as well as other regions involved in sensory-motor coordination—were active. However, these activity patterns shifted to include many more frontal areas as people were asked to tap between the downbeats of the metronome—a syncopated rhythm. There seem to be other timekeeping areas needed to perform more difficult tasks like this.

But even if Kelso is right, and the primal beat doesn't come from a single drum, it seems to be inescapable. Whatever disastrous music lessons or dance classes you might have suffered in the past, take heart. You've got rhythm. □

Michael Banks/Stone Image State Alistair Berg/FPG

Trisha Gura is based in Cleveland, Ohio