Birdsong in the music hall

Their music has been found to be the real thing, says s ananthanarayanan

WHILE birdsong and other sounds in nature have often inspired musicians, the question of whether birdsong can be classified as music has not been answered. While some birdsong is distinctly lyrical, research has even revealed patterns in pitch and rhythm, which are the hallmarks of musical passages. But a study (by ecologist Marcelo Araya-Salas of New Mexico State University in Las Cruces) recently concluded that despite specific patterns being repeated, the sounds in birdsong do not reveal formal arrangements, comparable with the 12-note scale used in music as we understand the term. And the question remains open.

Sarah E Earp and Donna L Maney of the Department of Psychology, Emory University, Atlanta, took a fresh approach – that sounds were music or otherwise, not because of their own qualities but because of how they were perceived. For if the 12-note progression within an octave, which is common to most musical systems in the world, has been woven into concerts and operas, the rules that composers follow are derived from the effects of the sounds upon and the appreciation by the listeners.

Earp and Maney followed up on work of imaging the effect of music on nerves and brain cells on humans to see if birdsong had similar effects on the corresponding structures in the brains of songbirds. And they report in their paper in the journal *Frontiers of Evolutionay Neuroscience* that birdsong and music seem to affect the same neural mechanisms in the listeners they are intended for.

European starling.

Pied flycatcher.

Hearing response

Earp and Maney see birdsong as a signal, which has a sender and a receiver. What matters is not the structure of the signal but what effect it has on the receiver. One way of comparing birdsong and music, they reason, could thus be what the receiver experiences and how she or he responds, in the two cases. The case of music is evident — listeners love hearing music and will pay for tickets to go to the concert. In fact, the evolution of music is the story of refining and enriching its form to be more and more a rewarding experience for the listener.

The behaviour of birdsong listeners is similar – many species of songbirds react by moving towards the source of birdsong that comes from others of the same species. The female pied flycatcher and the European starling will fly up and enter nest-boxes where recordings of male song are played and the female zebra finch can be trained to peck a key to hear a song. In fact, male zebra finches show a learning phase when they imbibe sound patterns from other finches, usually the father, and even young males can be trained to switch on recordings, like the females.

The overt behaviour of the listener is one effect of the sound upon the listener. But behaviour can be modified by more signals than music. A more illuminating effect of sound, which is now available for study, would be the actual activity of nerve tissue within the brain when sounds are heard. PET and MRI are techniques of scanning the brain, layer by layer, and building up a 3-D image. When coupled with the *Blood Oxygen-Level Dependant* change, the imaging pinpoints which portions of nerve tissue are "lighting up" with activity.

Using these methods, it is possible to look for increased activity and identify specific areas in the brain that react to the presence of a stimulus whose effect is being studied. These studies have shown time and again that the pathways in the brain that respond to pleasure and, hence, act as rewards to produce learning or repetition of the behaviour that brought the reward are stimulated by music that is liked and more so at the portions of the music which creates intense pleasure.

Response of birds

Earp and Maney checked out whether there were similar responses in the brains of birds to different kinds of birdsong. But as birds' brains are smaller in size, the areas that correspond to the music-sensitive areas of human brains are not practically accessible. The researchers hence used alternate markers — the proteins that arise from the effect of stimuli, rather than oxygen supply — to identify neuronal activity in birds. This alternative has been shown to correspond to the results of Bold response and is a reliable means of mapping the portions of the brain that have been stimulated.

The study was carried out to quantify the neuronal responses in the relevant brain areas of male and female white-throated sparrows, when exposed to birdsong from males of the same species. "This species sings a particularly musical-sounding song with heavy use of whistles with a sustained pitch," say the researchers in their paper. They explain that in normal times, song is used by both sexes of this species to establish and maintain dominant (mainly territorial) relationships. But during the breeding season, the response to song is different for males and females. A female hearing a male song is being courted while a male hearing the song hears a challenge – either by a territory holder asking intruders to keep out or an intruder trying to muscle in.

The researchers proposed that females should react in the same way as a human hearing music, while this would not be the case with a male white-throated sparrow. The female response should also rise with the level of hormones that peak during breeding, while in the case of males, their reaction to the song, which was to sing back, should depend on the level of testosterone, the male hormone.

With this functional and behavioral dependence of response to birdsong on the state of hormones of the birds in mind, the experimenters studied the level of stimulation of nerve cells along the pleasure and reward pathways in the brain as the level of hormones were artificially varied. As increasing the levels in females should enhance their response, as to music, of females, the measurement of neuronal activity in response to birdsong should rise with hormone levels in females while in the case of males, the music type response is already low and should not be affected by changes in the level of testosterone.

Zebra finch.

The results of the study confirmed that it was in female songbirds with breeding season levels of hormones that the response in the reward pathway in the brain was significantly greater to songs from other birds than to irrelevant control sounds. But this difference was not there in non-breeding females treated with a placebo, nor in the case of male birds.

"We found that the same neural reward system is activated in female birds in the breeding state that are listening to male birdsong, and in people listening to music that they like," says Sarah Earp. "Both birdsong and music elicit responses not only in brain regions associated directly with reward, but also in interconnected regions that are thought to regulate emotion.

That suggests that they both may activate evolutionarily ancient mechanisms that are necessary for reproduction and survival," she adds.

white-throated sparrow.

The writer can be contacted at simplescience@gmail.com

Sarah E Earp.

Donna L Maney

They really do make women look good

As New Year parties beckon, roger dobson **reports on new academic research that reveals how high heels affect every part of a woman's body**

THEY are not called killer heels for nothing. Pinchy, uncomfortable and, occasionally, downright dangerous, the high-heeled shoe is a source of ambivalence. But the millions of women who will squeeze their feet into them to grace New Year bashes can at least take comfort from scientific confirmation that high heels really do make them look good.

Researchers at the University of Portsmouth say heels change the way the entire body moves, including the pelvis, hips, legs, knees, feet and even the shoulders, to emphasise femininity. Women wearing heels are rated as more attractive than when wearing flat shoes, even when those making the judgment are unable to see faces or bodies.

The researchers, whose study appears in the scientific journal *Evolution and Human Behavior*, suggest that "evolution may partly explain the continuing popularity of high heels as an article of the female wardrobe. If wearing high heels emphasises some sex-specific aspects of the female form they may make women more attractive, and one motivation, which may be conscious or unconscious, for wearing heels is that it is part of mate selection".

The women who took part in the research had an average of around 10 pairs of heels, and wore them at least once a week. They were filmed walking for four minutes wearing identical flat shoes and six-centimetre heels.

To avoid the rating of attractiveness being influenced by anything other than high heels, the researchers used a process known as point-light display: lit markers are placed on key parts of the body and the raters or judges see only the patterns of these lights as the woman walks.

Men and women viewed 30-second video clips of the point-light displays of the walkers in high heels and flat shoes moving towards them. They then made judgments for femininity and attractiveness. All the women were rated as more attractive when wearing heels, and women judges rated them as more attractive than did the men.

In a second experiment, people were asked to judge whether the point-light display of women walking towards them was a man or woman. When the women were wearing flat shoes they were nearly twice as likely to be viewed as a man.

The researchers also analysed how women walked when wearing heels. They found that an average woman walked more quickly, changing from 106 to 110 steps a minutes, but with shorter strides: from 1.24 to 1.20 metres. "Judges rated the displays of the walkers in high heels as significantly more attractive than the same walkers in flat shoes," say the researchers. "Women in high heels walked in a fashion more characteristic of female gait. The results are consistent with the idea that wearing high heels makes women look more attractive."

They suggest this is part of the reason why high heels have endured. "Fashions by their very nature are ephemeral, but fashions that endure, such as high heels, may emphasise sex-specific aspects of the body."

The Independent, London

Vital functions

tapan kumar maitra explains how the cytoplasmic vacuolar system works

THROUGH cytologic evolution, the cytoplasm of a cell has been pervaded by numerous intracellular membranes that have subdivided it into numerous compartments and sub-compartments. The membrane system forms a vast network of open cavities that subdivide the cytoplasm into two main compartments — one enclosed within the membrane; the other situated outside (the cytoplasmic matrix). The spaces that are enclosed by the intracellular membranes are known as vacuoles and they often remain intercommunicated.

The cytoplasmic vacuolar system was observed first in cultured fibroblast cells by KR Porter in 1945.

The vacuolar system remains absent in bacteria, erythrocytes, eggs and undifferenciated embryonic cells. It becomes more and more developed with the differentiation of the cell. In the well differentiated animal and plant cells, the cytoplasmic vacuolar system usually has two types of membranes — agranular (ie, without ribosomes); and granular (ie, with attached ribosomes). The cytoplasmic vacuolar system is polymorphic and includes the following organelles:

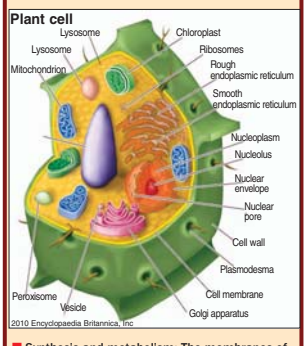
- Endoplasmic reticulum;
- Golgi complex;
- Nuclear envelop;
- Vacuoles (eg, contractile vacuoles of the ciliate protozoan, Paramecium and vacuoles of other animal and plant cells); and
- Vesicular components of the centrosphere.

Consequently, a cell can no longer be considered a bag containing enzymes, ribonucleic acid (RNA), deoxyribonucleic acid (DNA) and solute surrounded by an outer membrane, as in the most primitive bacterium.

Numerous membrane-bound compartments are responsible for vital cellular functions, among which are the separation and association of enzyme systems, the creation of a diffusion barrier, the regulation of membrane potentials, ionic gradients, different intracellular pH values and other manifestations of cellular hydrogeneity.

The cytoplasmic vacuolar system performs various vital cell functions, namely:

- Mechanical support: By dividing the fluid contents of the cell into compartments, the system provides supplementary mechanical support for the colloidal structure of the cytoplasm;
- Exchange: The membranes of the vacuolar system regulate the exchange between the compartments and the cytoplasmic matrix. Osmosis, diffusion and active transport may occur across the membranes of the system, as in the plasma membrane;
- Circulation: The system acts as an intracellular circulatory process and it circulates a variety of substances inside and outside of the cell. The flow of substances in the vacuolar system is supposed to be performed by its membranes;



- Synthesis and metabolism: The membranes of the system have been found to be rich in a variety of enzymes. Its membranes segregate the enzyme systems from the cytoplasm and keep them contained. The enzymes are used in the metabolism of steroids and phoilpids. Moreover, a variety of products, such as glycogen, lipids, steroids, etc, are synthesised in the vacuolar system. Further, the proteins for export, such as tropocollagen, etc, are secreted by the ribosomes of granular membranes of the vacuolar system;
- Storage: The most important function of the cytoplasmic vacuolar system is the storage of its synthetic products. The vacuolar system in animal cells store the glycogen, enzymatic and structural proteins, etc. In plant cells, the vacuoles of the vacuolar system contain water, phenol, flavonols, anthocyanins, alkaloids, fats, sugars and proteins; and Osmoregulation:

The vacuolar system in certain unicellular organisms such as Paramecium regulates the internal osmotic pressure of osmoregulation of the cell.

The writer is associate professor and head, Department of Botany, Ananda Mohan College, Kolkata