Medical Xpress

Songbirds offer clues to highly practiced motor skills in humans

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The melodious sound of a songbird may appear effortless, but his elocutions are actually the result of rigorous training undergone in youth and maintained throughout adulthood. His tune has virtually "crystallized" by maturity. The same control is seen in the motor performance of top athletes and musicians. Yet, subtle variations in highly practiced skills persist in both songbirds and humans. Now, scientists think they know why.

Their finding, reported in the current issue of *Nature*, suggests that natural variation is a built-in mechanism designed to allow the nervous system to explore various subtle options aimed at maintaining and optimizing motor skills in the face of such variables as aging and injury.

While the study was conducted in the adult male Bengalese Finch, a perky fellow who uses his song to woo females, the finding has implications, the scientists say, for understanding the way in which adult humans perform and retain well-learned motor skills. More broadly, the study provides insights that could inform strategies for rehabilitating patients following strokes and other damage to the nervous system.

"Many neuroscientists have thought that the nervous system simply didn't have the ability to control movement at a highly precise level," says lead author Evren Tumer, PhD, a postdoctoral fellow in the laboratory of senior author Michael Brainard, PhD, UCSF assistant professor of physiology. "After all, we're not machines. But our study suggests that subtle variation can serve a purpose and contribute to the maintenance of motor skills."

"If a golfer had a perfect swing, and all the conditions within him and the external environment were static, this wouldn't be necessary," he says. "But there are always changes – muscles get tired or are fresher, neurons die or change with age. There is always a bit of change somewhere in the system."

"To keep tuned up," says Brainard, "the nervous system constantly needs to experiment, to continually correct for deviations."

The tune of songbirds is a complex skill, produced in highly stereotyped fashion from one rendition to the next. Juveniles learn their song over a period of months, first memorizing their father's tune and then, weeks later, embarking on a period of vocal exploration, in which they initiate their fledgling renditions while comparing them to the memory of their father's tune, laid down in their neural circuitry. This process, using auditory feedback, involves a continuous fine-tuning of the bird's melody, culminating in a stable, nearly "crystallized," song.

Adult songbirds, meanwhile, rely on auditory feedback to maintain their song, and previous studies by Brainard have shown that if the birds are deaf, or receive garbled auditory feedback via a computer-based intervention, the fidelity of their song gradually deteriorates.

Scientists have not known, however, whether modulation in adult birdsong can be driven, in a predictable way, through auditory feedback. In the current study, the team examined this possibility.

They used a computerized system to monitor small natural variations in the pitch of targeted elements of the birds' song, and then delivered disruptive auditory feedback to a subset of the vocalizations, or "syllables." The disruption was in the form of a short burst of white noise - a static “chh!-chh-chh!” sound. Higher pitched renditions received a short burst of white noise, while lower pitched versions were left undisturbed.

The response was nearly immediate. Birds receiving the white noise feedback rapidly shifted the pitch of their vocalizations to avoid the sound. The changes were restricted precisely to the targeted syllable. “It was quite dramatic,” says Tumer. “We were able to make the bird sing a particular syllable with a higher pitch.”

“This data provides the first evidence that you can take this really stereotyped behavior that people have assumed was crystallized and change it in a predetermined way.”

Notably, when the white noise bursts were stopped, the pitch reverted to its original range, indicating that the nervous system retained a representation of the initial song and that there was “some drive to return to it.”

The scientists also examined whether more dramatic remodeling of the birds’ song was possible. They explored this possibility by creating conditions in which escape from white noise required the birds to make progressively larger shifts in pitch. Under these conditions, the scientists were able to incrementally drive large changes to the point that syllables were produced in a range that did not overlap with the baseline range.

“This showed you can drive really big changes in this normally stereotyped behavior but you have to do it incrementally,” says Tumer. “This could have implications for rehabilitation strategies in humans.”

In support of the current findings, previous work by Brainard’s team and others has revealed that when male songbirds sing alone there is greater variability in their song than when they sing to females.

The theory, says Brainard, is that the birds can afford to experiment, and thus practice their tunes, when the pressure is off. This process, he suggests, is not occurring at a conscious level. Rather, it is likely driven by neurochemicals released under varying circumstances that are then acting on a region of the nervous system known as the basal ganglia, which is critical to song learning and maintenance.

“You could imagine,” says Tumer, who is also a member of the Keck Center for Integrative Neuroscience at UCSF, “that when wooing a female bird – or stepping onto the green for the Masters golf tournament -- neuromodulatory systems would be more engaged than if the bird were on a lonely tree branch or the athlete on a sleepy Sunday afternoon round of golf with friends.”

Source: University of California - San Francisco