six adult males were injected at 17 months of age in October, when songs undergo seasonal modifications. Two additional males, slightly more than 4 years old, entered the experiment in October.

Canaries injected in October generated significantly more projection neurons in the song-control center than did the May group. Moreover, the 4-year-old October duo displayed considerably more new projecting neurons than did the 1-year-old May quartet. Either a lower rate of cell production or a higher rate of cell death may account for the slower generation of new projection neurons in May, the researchers maintain.

Testing of six adult male zebra finches, which do not modify their songs, revealed projection neuron increases roughly comparable to those observed among canaries injected in May.

Although the October neuron increases in adult canaries apparently stemmed from learning new songs, even zebra finches experienced noticeable, unexplained jumps in neuron generation, the scientists report.

Nottebohm says his team plans to investigate possible ways to boost the natural process of self-repair and neuron generation in the brains of adult birds. Little evidence exists for new cell growth in the forebrains of mammals, he adds. But if scientists eventually extend the avian observations to mammalian species, they can then seek methods of reversing neuron degeneration in memory-destroying conditions such as Alzheimer's disease, Nottebohm suggests.

– B. Bower

Stronger support for equivalence principle

The equivalence principle – a cornerstone of the general theory of relativity – dictates that all forms of matter and energy fall with the same acceleration in a uniform gravitational field. Researchers can test this principle by comparing the accelerations of the Earth and moon toward the sun, but there's a catch. Such experimental tests are accurate only if no long-range, nongravitational force interferes with the measurements in a way that happens to mask any anomalous gravitational effects.

Scientists have now closed that loophole. Drawing on precise laboratory experiments designed to ferret out a nongravitational, "fifth" force, Eric G. Adelberger and his colleagues at the University of Washington in Seattle conclude that such a force – if it exists – would be too feeble to affect significantly the results of experiments designed to detect differences in the accelerations of the Earth and moon toward the sun.

Tests of the equivalence principle hinge on the idea that the moon's orbit would be distorted in a particular way if the Earth's gravitational binding energy, which contributes about 5 parts in 10^{10} to the Earth's total mass, doesn't behave in the same way as other forms of mass and energy. The effect should be large enough to appear in precise measurements of variations in the distance between the moon and Earth – if no other, unknown force gets in the way.

The new analysis, reported in the Sept. 20 NATURE, shows that a nongravitational, fifth force would contribute no more than 1 part in 10^{12} to an acceleration difference. So far, lunar-ranging measurements – which involve bouncing laser beams off a reflector on the moon's surface – have established that these accelerations are identical to within 14 parts in 10^{12}, in agreement with the equivalence principle and general relativity.

"We've been working in this whole business of trying to detect a long-range [fifth] force for a long time," Adelberger says. "It has to be very, very weak compared to gravity, and it's interesting that it has to be so weak that it wouldn't upset, for example, a test of the moon and Earth falling toward the sun."

Because any potential contribution from a long-range fifth force would be small at best, researchers can now try to improve the precision of lunar-ranging data without having to worry about some unknown force negating their efforts to test the equivalence principle with greater precision. The new findings also furnish encouraging news for researchers interested in pursuing high-precision, space-based tests of the equivalence principle.

At the same time, laboratory experiments sensitive to the existence of a fifth force are bound to improve (SN: 10/1/88, p.214). "We anticipate about a factor of 10 improvement," Adelberger says, "and it will probably get better than that."

– I. Peterson

Strong quake expected east of Rocky Mountains

Easterners who fantasize about California sliding into the sea may be in for a jolt. Chances appear high that a damaging quake will strike east of the Rocky Mountains in the next 30 years, according to new calculations.

"We wanted to tell people in the East that there is a level of earthquake hazard here. While it's nowhere near California's and you shouldn't be frightened or alarmed, you should be aware that the hazard is probably greater than you think," says G.A. Bollinger of the Virginia Polytechnic Institute and State University in Blacksburg.

He and Stuart P. Nishenko of the National Earthquake Information Center in Golden, Colo., have formulated the first estimate of earthquake risk for the eastern half of North America by analyzing historical records going back to 1727 and seismographic data accumulated over the last 15 years. Using the frequency of past quakes, they calculated the chances of a shock occurring within coming decades.

The region east of the Rockies stands a 40 to 60 percent chance of experiencing an earthquake of magnitude 6 or greater before the year 2020, the seismologists conclude in the Sept. 21 SCIENCE. Noting that seismic waves travel particularly well through the less-fractured rock in the eastern half of the continent, Nishenko and Bollinger say this region faces about two-thirds California's risk of suffering a damaging earthquake within 30 years.

Their forecasts do not predict where earthquakes might occur, but seismologists are keeping a close watch on several seismically active areas, including New Madrid, Mo. (which spawned the country's most violent known earthquakes in the winter of 1811-1812), Quebec's St. Lawrence River (site of five strong quakes in the last three centuries) and Charleston, S.C. (severely damaged in 1886).

Archibald C. Johnston, a seismologist at Memphis State (Tenn.) University, says Nishenko and Bollinger's forecasts probably underestimate the East's quake hazard. Johnston has analyzed seismic activity around New Madrid and calculated a 40 to 60 percent probability that this fault will produce a magnitude 6 earthquake within 15 years.

Bollinger says the discrepancy underscores the primitive state of earthquake risk estimates for eastern and central North America. Geologists cannot directly study faults in this region because they lie buried deep below ground, whereas many California faults break the surface. Eastern faults also accumulate stress more slowly and can remain quiet for several hundred years, further hampering study.

Despite the difficulties, seismologists have succeeded in convincing some state and municipal officials of the earthquake hazards in their areas. In the last several years, many states and cities east of the Rockies have incorporated seismic regulations into their building codes for the first time. New York City is currently considering its own set of seismic standards.

– R. Monastersky