Tuning the instrument: Spider webs as vibration transmission structures

September 6 2016

Dew on a spider's web in the morning. Credit: Wikipedia/Luc Viatour/Lucnix.be

Two years ago, a research team led by the University of Oxford revealed that, when plucked like a guitar string, spider silk transmits vibrations across a wide range of frequencies, carrying information about prey, mates and even the structural integrity of a web.

Now, a new collaboration between Oxford and Universidad Carlos III de Madrid has confirmed that spider webs are superbly tuned instruments for vibration transmission - and that the type of information being sent can be controlled by adjusting factors such as web tension and stiffness.

Researchers from the Oxford Silk Group, along with collaborators in Oxford's Department of Engineering Science and Universidad Carlos III de Madrid's Department of Continuum Mechanics and Structural Analysis, have studied the links between web vibration and web silk properties.

Their report in the *Journal of the Royal Society Interface* concludes that spider web vibration is affected by changes in web tension, silk stiffness and web architecture, all of which the spider is able to control.

Web-dwelling spiders have poor vision and rely almost exclusively on web vibrations for their 'view' of the world. The musical patterns coming from their tuned webs provide them with crucial information on the type of prey caught in the web and of predators approaching, as well as the quality of prospective mates. Spiders carefully engineer their webs out of a range of silks to control web architecture, tension and stiffness, analogous to constructing and tuning a musical instrument.

In order to study how vibrations propagate through a web, a combination of cutting-edge techniques was employed by the interdisciplinary and multinational team. High-powered lasers were able to experimentally measure the ultra-small vibrations, which allowed the team to generate and test computer models using mathematical finite element analysis. The combination of these techniques probes the links between the propagation of vibrations and silk material properties.

These new observations propose that the spider can use behaviour and silk properties to control the function of its web instrument. These

control mechanisms could alter vibration filtering, as well as orientation to and discrimination of vibration sources in the web.

Dr Beth Mortimer, lead author of the report, which made use of the garden cross spider Araneus diadematus, said: 'Spider orb webs are multifunctional structures, where both the transmission of vibrations and the capture of prey are important.'

Professor Fritz Vollrath, Head of the Oxford Silk Group, added: 'It is down to the interaction of the web materials, a range of bespoke web silks, and the spider with its highly tuned behaviour and armoury of sensors that allows this virtually blind animal to operate in a gossamer world of its own making, without vision and only relying on feeling. Perhaps the web spider can teach us something new about virtual vision.'

More information: Tuning the instrument: sonic properties in the spider's web, *Journal of the Royal Society Interface*, rsif.royalsocietypublishing.or … .1098/rsif.2016.0341

Provided by University of Oxford