EXERSITY OF ENVIRONMENT AND SUSTAINABILITY INSTITUTE An ESI Creative Exchange between Dr Lauren Holt,



Oak Matthias, Arnia and Professor Juliet Osborne



Bee Health: Audio Immersion

Pollinators, including honey bees, face unprecedented pressures through accumulated stress in response to disease, combined with exposure to environmental toxins. It is these multi-factoral stresses that have contributed to the current high rates of colony mortality.

In this Creative Exchange, academics from the University of Exeter facilitated a representation of honey bee data into a contemporary cello piece. Classical cellist and Falmouth University Fine Art student Oak Matthias has created a cello interpretive piece of music for both healthy and adversely affected hives. The two tracks were created using two data sources each: the first from the University of Newcastle⁽¹⁾, and the second from bee-monitoring company Arnia.

By representing the data from bee hives in a novel way and going beyond language, we hope to tap into a fundamental way of experiencing a phenomenon to convey differences between healthy honey bees and those experiencing a number of stressors.

The data used from University of Newcastle consisted of a subset from research that examined how continued exposure to acetylcholinesterase (AChE) inhibitors commonly used in pesticides and disease treatment affected honey bee motor functio⁽¹⁾. Major changes in the nature of the bee's within-hive chemical environment can occur as a result of the use of AChE inhibitors used to target the parasitic mite, Varroa destructor (Fig 1). Such pesticides accumulate inside the hive, reaching high levels in the comb wax as well as being present in the hive food stores.

Adult foraging worker honeybees were fed sub-lethal concentrations of these compounds in sucrose solution for 24 hours. Walking, standing still, grooming, flying, and turning upside-down were recorded. At a 10nM concentration, all the AChE inhibitors used in the study caused similar effects on behaviour, notably increased grooming activity, abnormal abdominal spasms and decreased locomotion.



Fig 1. Varroa destructor mites

This data was fed into a program (Box 1), where each behaviour was represented by a pre-recorded cello sound, with negative behaviours such as abdominal spasms or grooming represented by more disharmonious notes, and healthy behaviours such as walking and trying to fly represented by more harmonious notes. This provided the base upon which the melodic line was built. Each track contains data from three bees exposed to either the AChE inhibitors or sucrose solution as a control. The behaviours are represented in an animation as the track is played.

Modified improvisational performances:

Oak Matthias' process for the melodic line was to improvise, listening to the sounds created within the Max Patch as he played. He then sculpted the end result from these recordings whilst keeping the data in temporal order.



Reference: ⁽¹⁾ Williamson, S.M., Moffat, C., Gomersall, M.A., Saranzewa, N., Connolly, C.N. and Wright, G.A., 2013. Exposure to acetylcholinesterase inhibitors alters the physiology and motor function of honeybees. Frontiers in physiology, 4.

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Box1: MaxMSP/Jiiter [Max] is a visual programming language for music and multimedia. Max is a modular program, using objects that behave in different ways connected to each other, 'patches' are constructed with huge potential of diversity. Here, data is in the form of numbers and letters and the patch reconstructs the timeline and plays one of six cello recordings. When played together, the three bees' data running in parallel create the chords you hear. The bees in effect, create the sonic experience.

Arnia are a research and development company that design and build hive monitoring equipment. Accelerometers and other sensors placed in the hive can reliably and remotely monitor Spring colony build up, brood state, queen status, track forager activity, accurately map nectar flow, nectar processing and monitor weather conditions at the apiary. They provide mobile alerts for robbing, if Nosema apis and Nosema ceranae are microsporidians, small, uni-cellular parasites recently reclassified as a fungus. It causes nosemosis, also called nosema, which is the most common and widespread of adult honey bee diseases, affecting the lining of the middle intestine of worker bees, queens and drones.

the bees swarm, if the hive becomes broodless, if

the hive needs to be fed or ventilated during the winter months, if its time to add or remove a super, or simply when the bees have collected a lot of nectar that day. In the case of swarming for example (Fig 2) the soundscape recorded by the accelerometer detects specific changes, with a recognizable warble produced before the hive swarms.

Using bee acoustics to diagnose disease:

Arnia have concluded that behavioral or health issues could potentially be identified from a specific acoustic signature in a similar way to swarming (above), During their experiments they noticed anomalies in the soundscapes of bees with Varroa and Nosema (Fig.3). Additionally, factors like flight noise, the amount the bees are fanning, even the total amount of noise is a good indication of colony strength and health which can be useful in diagnosis. The recordings from a healthy hive, and one with suspected Nosema infestation are included in the respective tracks.



Fig 2. The acoustic signature of swarming

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