Investigating Top-down Attention in Bumblebees

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Introduction

Processing sensory information is vital for functioning as a human being, but animals and insects are no different. The cocktail party problem can be applied to a female cricket, for example, who must filter through many potential mates to find a suitable one. It is predicted that insects may have evolved top-down attention mechanisms to increase their chances of foraging, mating, and ultimately surviving.

In this experiment, we investigated top-down attention in bumblebees using computer simulated artificial flowers of varying contrast and motivating them with sugar solutions of high and low concentrations. We hypothesised that bees would find it easier to detect low contrast flowers when given a high reward.

Methods

A healthy colony of bumblebees was allowed access to an enclosure containing a computer screen and three shelves in front of it. One bumblebee at a time was trained and tested using a MATLAB program displaying stimuli on the screen in three phases:

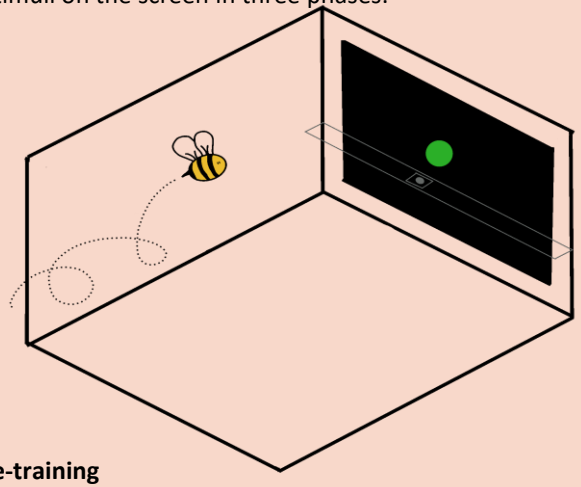


Figure 1

Phase 1: pre-training

Figure 1 shows the setup for pre-training, the bee was allowed to feed on 20% sugar solution with a black screen & then with a green circle

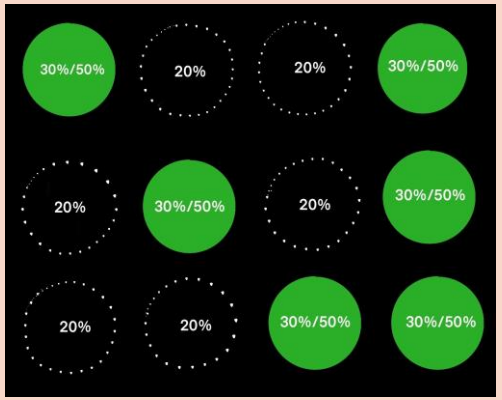


Figure 2

Phase 2: training

There are 12 possible positions for the bee to feed as shown in Figure 2.. Green circles have a higher concentration of sugar; 30% (low reward) or 50% (high reward) whereas black have 20%.. %. The bee is allowed to forage and once she has 80% accuracy in at least 20 trials, the bee has passed training.

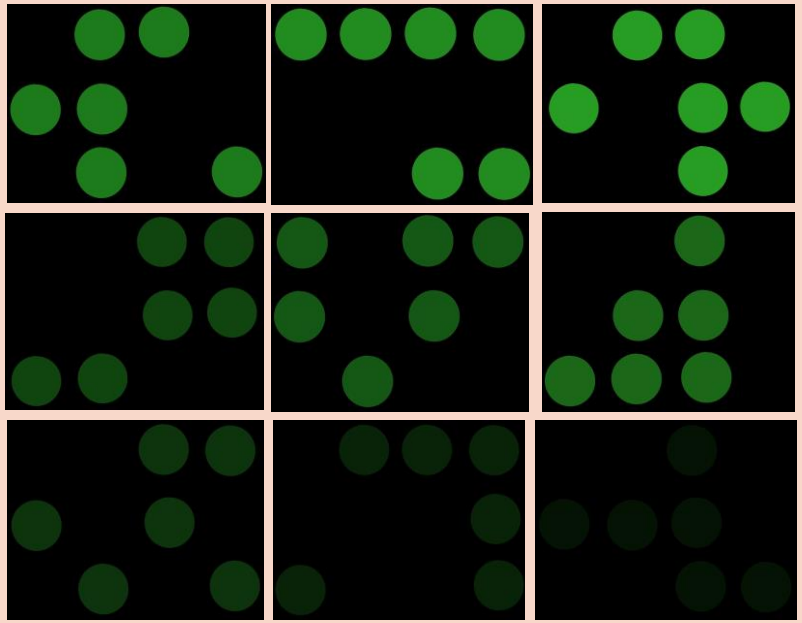
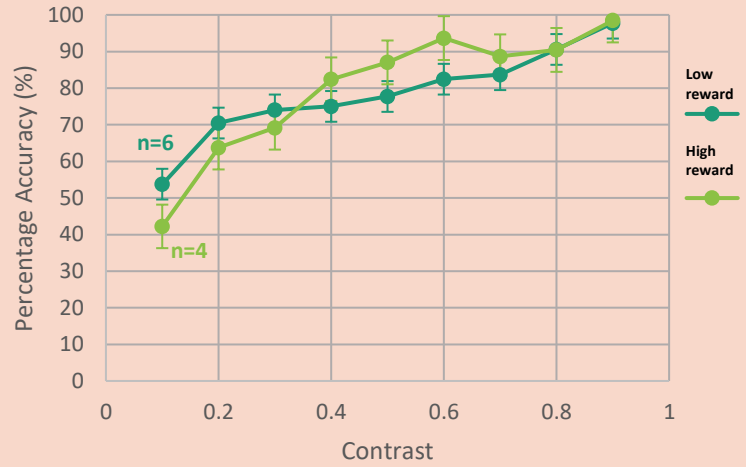


Figure 3

Phase 3: test

The same process is repeated as with training, except all chips contain distilled water. There are 9 tests, with a repeat of training between each test. In tests, the green circles vary in contrast between every test (figure 3)

Results



High reward bees performed better than low reward at 0.6 contrast at 94% compared to 82% accuracy, which coincides with our hypothesis. At contrast 0.1 there was better accuracy from low reward bees. There is ample overlap in the graphs for either rewards. A type 2 t-test gave a p-value of 0.88; therefore, the null hypothesis cannot be rejected, and we cannot confirm a difference in performance between high and low reward bees.

For this experiment the sample sizes were not just small but also unequal for the two groups. A bigger sample size could extrapolate the difference seen at contrast 0.6, and using the same sample size for both groups will make for a fairer test.

References:

Nityananda V. Attention-like processes in insects. Proc. R. Soc. B. 2016;283(1842).