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Non-elemental learning in honeybees: how specific?

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Learning allows individuals to make reliable predictions about connected events in their environment. Simple and unambiguous links between specific stimuli characterize elemental learning[1] (e.g. a stimulus A is associated with a reinforcement while stimulus B is not : A+ vs. B-). By contrast, ambiguity and non-linearity characterize non-elemental learning, thus making discriminations difficult. Despite the likelihood of foraging honeybees to encounter ambiguous learning situations, non-elemental learning has been poorly investigated under control laboratory conditions. Here we used the ofactory appetitive conditioning of the proboscis extension response in honeybees to determine the neural substrates of non-elemental olfactory learning and the impact of stress on this capacity. First, we asked whether specific brain centres, the mushroom bodies (MBs), are required for non-elemental olfactory learning. Following a study showing impaired reversal learning after inactivating of MB function by a local anesthetic[2], we asked whether the same applies to negative patterning, a form of configural learning where bees must discriminate a non-reinforced mixture of two odorants A and B from its reinforced elements (i.e. AB- vs. A+ and B+). Our results show that the function of MBs is required for the resolution of negative patterning. Second, we studied the impact of stress on non-elemental learning; our preliminary results suggest that, while stress impairs the capacity to solve elemental tasks without suppressing it[3], it has a more dramatic effect on non-elemental learning. We are currently performing experiments to confirm whether this is a general property of different forms of non-elemental learning. Altogether, our results indicate that non-elemental learning tasks differ from elemental ones, not only by their level of difficulty, but also by their neural substrates and their sensitivity to stress.

[1]Giurfa (2003) Curr.Opin.Neurobiol. 13:1-10 [2]Devaud et al. (2007) Eur.J.Neurosci. 26: 3193-206 [3]Urlacher et al (2010) Front.Behav.Neurosci. 4:157. doi: 10.3389/fnbeh.2010.00157