Reduced trophallactic activity in response to virus infection in automatically monitored honeybee colonies

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By automatically tracking behavior in colonies in which all individuals were fitted with barcodes, we recently demonstrated that honeybee trophallaxis networks may facilitate fast information transfer, but could also increase vulnerability to disease. To investigate whether honeybees might be able to get “the best of both worlds”, fast information spreading yet limited disease transmission, we monitored trophallaxis in colonies of up to 1000 bees as a function of viral infection. In each colony, 10-14% of the bees were orally infected with Israeli Acute Paralysis Virus (IAPV) and an equal fraction was sham-treated. All colony members were outfitted with a “bCode” barcode that enabled us to automatically track the position and identity of each individual at a temporal resolution of 1 s over five days. During that time, a custom machine learning algorithm detected 87% of all trophallaxis interactions with a false positive rate of 5%. Whether a bee was donating or receiving food was detected with 91% accuracy. The resulting data set revealed that the trophallaxis rate of virus-treated bees was lower than the trophallaxis rate of bees from the sham-treated control group. This difference was not due to lower activity of infected bees, because they moved faster and covered greater distances than controls. Moreover, automatically collected information about foraging effort revealed that infected bees foraged at a higher rate. Despite the decreased trophallaxis rate of infected bees, simulations on the directed empirical trophallaxis networks revealed that spreading dynamics were accelerated relative to randomized reference networks. Taken together, our results suggest that honeybees may be able to maintain a trophallaxis network that facilitates information transmission even when a sizeable fraction of their population is infected with IAPV, because affected individuals reduce their interaction rate.