

Food odor enhances male flies' attractiveness

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Mating *Drosophila* couple on an apple. Credit: Benjamin Fabian / Max Planck Institute for Chemical Ecology

Vinegar odor boosts the perception of a male sex pheromone in the brain of unmated female *Drosophila melanogaster* flies, as a team of scientists from the Department of Evolutionary Neuroethology has now discovered. The researchers were able to identify the underlying

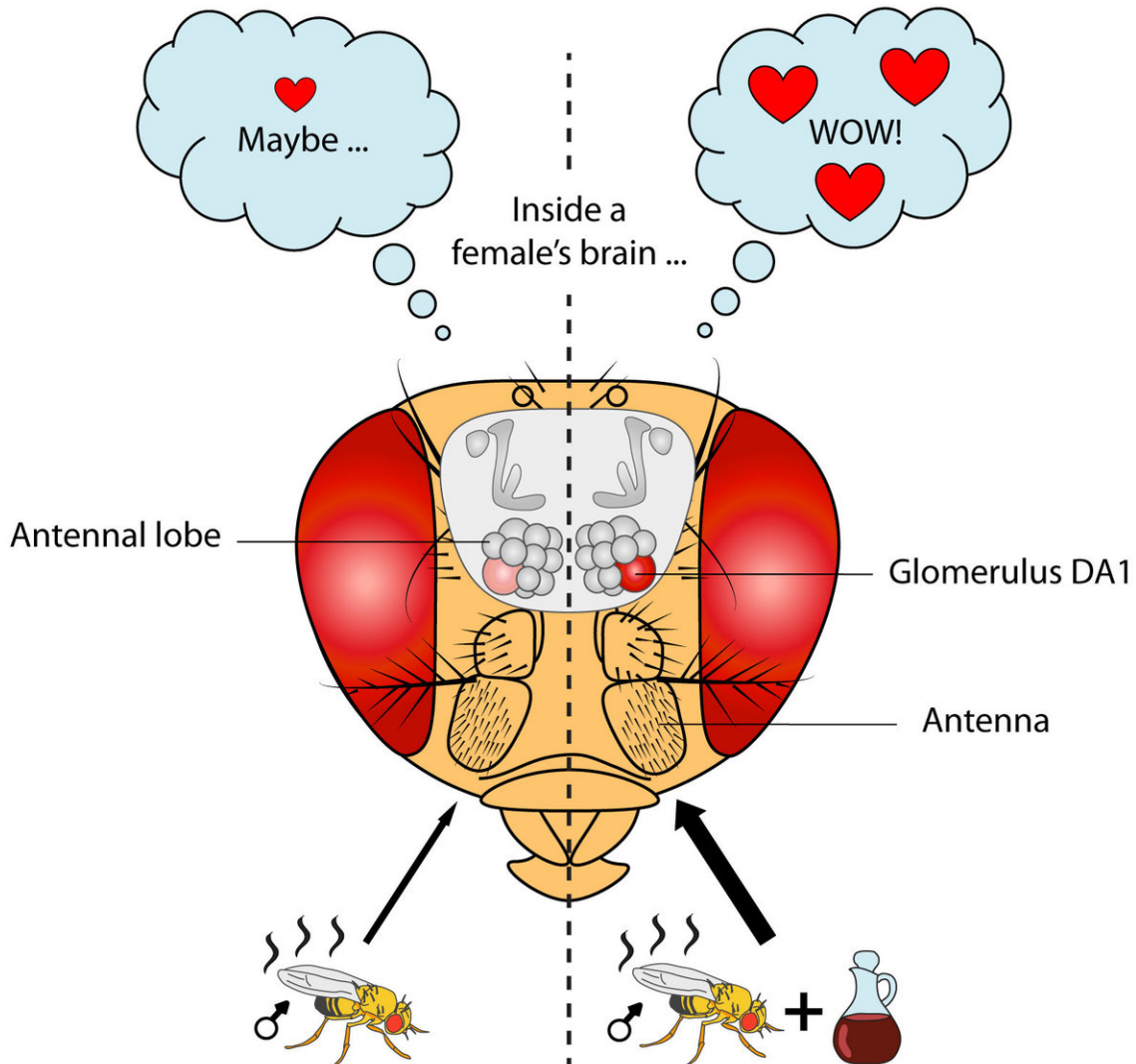
neuronal mechanism in the brain of *Drosophila* flies. Previous experiments had revealed that the male pheromone cis-vaccenyl acetate activates the glomerulus DA1 in the brains of female flies. Glomeruli are spherical functional units in the antennal lobe, the olfactory center in the fly brain.

"We were able to show in our study that vinegar odor enhances the reactions of female flies to the male sex [pheromone](#) significantly. Both odors together intensify the activation of DA1," explains Silke Sachse, head of the "Olfactory Coding" research group. The scientists observed this effect only in unmated virgin flies; it was absent in males and mated females.

Analyzing the underlying neural mechanisms, the neurobiologists were able to elucidate how the odor signals were processed in the fly brain and determine which brain areas were activated. They used functional imaging techniques to monitor and visualize brain activity induced by the sex pheromone, by vinegar, and by both odors together.

Transgenic fly lines were crucial for the experiments. In these flies, selected electrical synapses—connections between specific classes of nerve cells—had been silenced. The various lines helped researchers pinpoint the neurons involved in signal transfer and to precisely locate the neuronal site of the interaction of two odors. "We were able to show that the enhanced activation of the glomerulus DA1 is mediated by a so-called "lateral excitation" in a particular class of neurons. Different neighboring glomeruli in the [brain](#) respond to the odor of vinegar, and the excitation from those glomeruli is transmitted to DA1 via electrical synapses," says first author, Sudeshna Das, who came to the Max Planck Institute as a fellow from the Alexander von Humboldt Foundation. The male sex pheromone, in contrast to the vinegar, activates DA1 directly through the specialized olfactory receptor Or67d. Thus both odors activate the same olfactory glomerulus, just through different neuronal

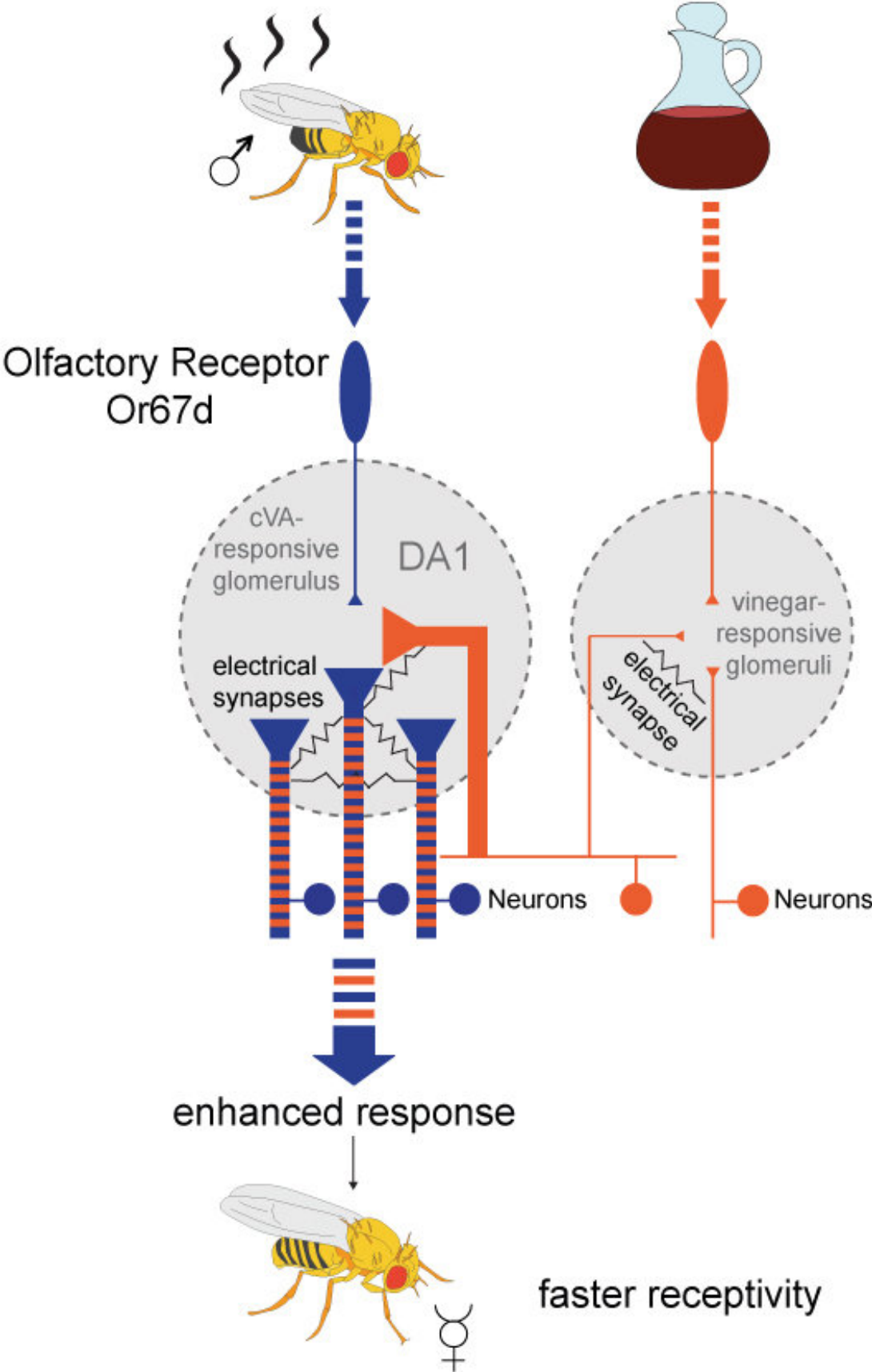
pathways. Together, the scents evoke an enhanced behavioral response in virgin females, increasing their willingness to mate.



In virgin *Drosophila* flies vinegar odor intensifies the effect of a male sex pheromone. Activation of the glomerulus DA1 is enhanced, the females become more receptive towards courting males. Credit: Silke Sachse / Max Planck Institute for Chemical Ecology

From an ecological perspective, this mechanism is extremely important, because it accelerates mating when sufficient food is available for the females and for their offspring. "We were surprised that this strong response enhancement of the pheromone response by [vinegar](#) is completely absent in mated female flies. However, after discovering the behavioral relevance for courtship we realized that this effect only makes sense in virgin females," says Silke Sachse.

The increased willingness to mate in the presence of sufficient food is important with respect to reproductive success, which is probably why this rare synergistic interaction between the responses to two different odors has evolved. "A synergistic interaction of two odors is extremely rare and has hardly been observed so far. The more general rule is that different odors rather inhibit each other and lead to mixture inhibition which allows the olfactory system not to become saturated when more than one [odor](#) is perceived," Silke Sachse emphasizes.



Synergistic effect of the male sex pheromone cis-vaccenyl acetate (cVA) and vinegar. Credit: Graphical presentation modified from Das et al., *PNAS*

The results have also further ecological relevance: "In nature, female flies only perceive little amounts of the male sex pheromone. From an evolutionary point of view it seems useful that they evolved a mechanism which enhances the effect of the pheromone without the males having to release higher concentrations. If you consider that *Drosophila* flies have a pretty short life span during which they are constantly threatened by predators, infections or toxic food, accelerated mating and reproduction is very important for their survival," says Sudeshna Das. [AO/KG]

More information: Sudeshna Das et al., "Electrical synapses mediate synergism between pheromone and food odors in *Drosophila melanogaster*," *PNAS* (2017).

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