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She Said No, Pass Me a Beer

Troy Zars

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luminal cargo proteins to form a luminal-asymmetric complex; this species does not interact with p24-family proteins.

The model of Čopič *et al.* raises important questions about the potential biological importance of steric-crowding effects (particularly for highly asymmetric membrane proteins) in other processes that entail membrane deformation. To what degree might steric interactions of asymmetric membrane proteins influence the energetics, and even the mechanism, of membrane bending at other steps in vesicle trafficking or other membrane functions? Can local concentration of asymmetric membrane proteins promote, rather than hinder, membrane bending in some contexts, such as in the budding of enveloped viruses from the plasma membrane? Steric pressure in biological membranes should also cause highly asymmetric proteins to spontaneously distribute unequally between membrane regions with different local curvatures. Such effects could play a physiological role in sorting of asymmetric membrane proteins during trafficking. There are clearly many places to look for new and important ways in which the crowded nature of membranes may influence their biological functions.

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PHYSIOLOGY

She Said No, Pass Me a Beer

Sexual rejection or deprivation is connected to ethanol consumption in *Drosophila*.

Troy Zars

Sex is widely recognized as rewarding across the animal kingdom, but rejection of sexual advances or even deprivation can have negative effects. Behavioral studies indicate that sex can be positive—that is, viewed as a reward—in some learning experiments. Rejection of a sexual advance can also have lasting effects on physiology and behavior. How the success or failure of courtship behaviors are linked to other behaviors has been difficult to address. On page 1351 of this issue Shohat-Ophir *et al.* (*1*) assess the connection between the rewarding properties of sex and the effects of sex deprivation in the fly *Drosophila melanogaster*. The authors discover a neural system defined by a specific neuropeptide that unexpectedly couples courtship rejection or sex deprivation to a rewarding behavior—ethanol consumption.

What happens when a male fly courts a female? In most laboratory experiments, two flies are put into a cramped empty space with bright lights and a camera focused on every move (*2*, *3*). Perhaps surprisingly under these conditions, the male will almost immediately pursue the female, using all of his courtship tools to entice her to copulate. A male will vibrate one wing in a love song, tap her abdomen with his foreleg, and touch her genitalia with his proboscis (a structure that includes some olfactory and taste sense organs), and if the conditions are right, attempts at copulation will not be rejected. The courting takes less than 10 min under optimal conditions; copulation lasts about 20 min. Afterward, the two flies part ways, she to lay her eggs and he to court again.

Shohat-Ophir *et al.* investigated whether the rejection of courtship advances would alter a different rewarding behavior—ethanol consumption. Reward seeking is a fundamental behavior in which an animal will do something to make things better, such as eating when hungry. When given a choice between food with 15% ethanol and normal food slurry, mated male flies consumed about equal amounts of either type ("mated" males were those combined with virgin females at a ratio of 1:5 for several hours, with a new cohort of females every day for 4 days). By contrast, when male flies were rejected (non-virgin female flies strenuously reject new copulation attempts), the males later showed a strong preference for the ethanol-spiked food. This preference was also evident in virgin male flies and males that had been in the presence of decapitated virgin females (males will court a headless female, but copulation attempts are rarely successful) (*3*). If, however, rejected males copulated at a later

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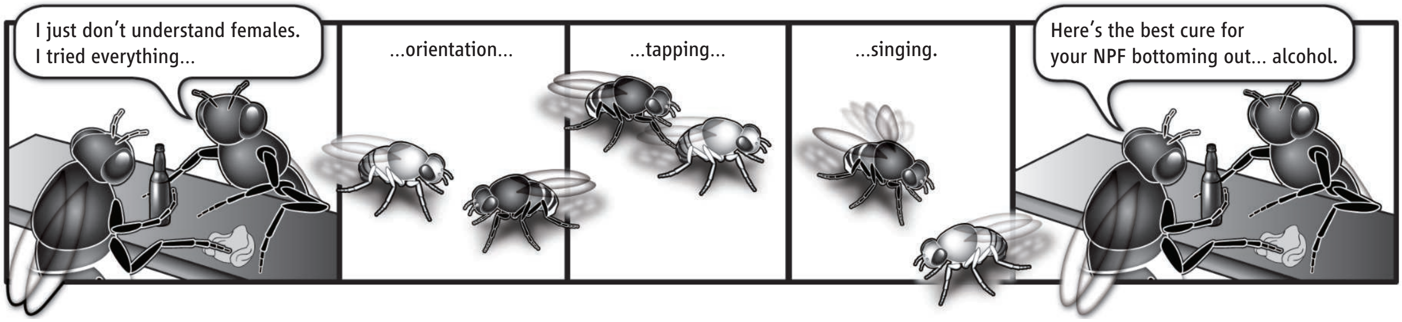

Neural system for reward behavior. After an elaborate courtship ritual by a male *Drosophila*, rejection by a female, or sexual deprivation, reduces the amount of neuropeptide F in the male fly brain. This correlates with the male's increased preference for ethanol, a behavior associated with reward and reward seeking.

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time, the ethanol preference disappeared. Thus, rejection or deprivation of sex leaves male flies in a state that increases the preferential consumption of ethanol. Copulation overrides the deprived state and ethanol preference is reduced.

In mammals (e.g., rats and mice), neuropeptide Y (NPY) influences ethanol-related behaviors (*4*). For example, elimination of NPY expression in the mouse increases ethanol consumption. The homolog of NPY in *Drosophila* is neuropeptide F (NPF) (*5*, *6*). In no animal model has the NPF/NPY neural system connected sexual experience to ethanol-related behaviors. Shohat-Ophir *et al*. discovered that courtship rejection reduced the amount of NPF produced in the male fly brain. They also found that reduced signaling by the NPF receptor (by decreasing NPF receptor expression with RNA interference) resulted in males that preferred ethanol-spiked food even after mating (these flies did not have the NPF signaling effect of sex). Extrinsic activation of NPF-expressing neurons (by triggering the opening of TRPA1 cation channels) in virgin males decreased their preference for ethanol intake—ethanol intake was similar to that of males that had previously copulated.

Could the NPF neural circuit in the fly brain be part of a reward system? Pairing of ethanol exposure (at inebriating concentrations) with an odor leads to a long-term memory and preference for that odor in *Drosophila*, suggesting that ethanol experience is rewarding (*7*). Shohat-Ophir *et al*. observed that pairing of male flies with virgin female flies in the presence of an odor (there is presumably some copulation taking place) led to a later preference of those males for the odor. These results suggest that sex is rewarding. Extrinsic activation of the NPF-expressing neurons in the presence of an odor, the same technique that decreases ethanol consumption, increases flies' preference for that odor. The data of Shohat-Ophir *et al*. suggest that the NPF neural circuit is part of a reward system that adjusts reward-seeking behavior (ethanol intake) appropriately.

Although it is titillating to think about the relationship between spurned advances and ethanol consumption (anthropomorphizing the results from flies is difficult to suppress, but the relevance to human behavior is obviously not yet established), the study of Shohat-Ophir *et al*. study should not be taken lightly. The authors provide new insights into a neural circuit that links a rewarding social interaction with a lasting change in behavior preferences. Identifying the NPF system as critical in this linkage offers exciting prospects for determining the molecular and genetic mechanisms of reward and could potentially influence our understanding of the mechanisms of drugs of abuse.

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GEOPHYSICS

Monitoring Volcanoes

Despite technological advances, volcano monitoring around the world is woefully incomplete.

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The ascent of magma in volcanoes is typically accompanied by numerous small earthquakes, the release of magmatic gases, and surface deformation (*1*). Systematic volcano monitoring to detect these phenomena began in 1845 with the completion of the Osservatorio Vesuviano. Other volcano observatories soon followed, such as the Hawaiian Volcano Observatory, which celebrates its 100th anniversary this year. Today, the World Organization of Volcano Observatories has 80 members. The range and sophistication of the detection systems has increased dramatically, and advanced models of volcanic processes are helping to interpret monitoring data. Yet, key problems remain both with distinguishing volcanoes that will erupt from those that will not and with global data coverage.

Seismic signals remain a key aspect of volcano monitoring. As magma moves toward the Earth's surface, stress changes in the volcanic edifice, as well as magma rupture and stick-slip motion of the magma body, lead to highly regular seismic patterns, often referred to as volcanic tremor (*2*). The signals are typically very weak and may be missed by regional networks, requiring a dedicated network of seismometers near the volcanic edifice. Seismic monitoring is therefore at the heart of every volcano observatory.

Early attempts to interpret seismic signals on volcanoes used methods adopted from earthquake seismology. Simple event counts or amplitude estimates were used as crude indicators for the level of volcanic activity. In the past 20 years, broadband seismic sensors have enabled detection of seismic signals from volcanic earthquakes in a wide frequency range, allowing volcano seismologists to distinguish between different types of volcanic events and to attribute different signals to different volcanic processes (*3*). Conceptual models help to detect and quantify magma or fluid movements, or to identify stress changes in the volcanic edifice. Hence, short-term forecasting can be achieved by interpreting systematic changes in seismic energy release as changes in magma ascent rates and changes in seismic patterns and spectral characteristics as indicators of critical changes in magma properties.

Compared with global seismology, where data exchange is routine, volcano observatories are more independent and less willing to share data. Particularly during a crisis, raw seismic data are often confidential, such that only the local observatory can give advice. Some observatories have established links to research institutions. However, it is crucial that advice to authorities is channeled through the observatories or official scientific advisory committees; maverick interpretations from outside groups can be a problem.

Most volcanic eruptions are preceded and accompanied by ground deformation. Methods to measure surface movements include high-precision leveling, electronic distance measurement with lasers, ground tiltmeters, and—in the past 20 years—the Global Positioning System (*4*). These methods are typically used in combination. Strain meters in boreholes (*5*), one of the world's most sensitive geophysical instruments, are used at very few volcanoes. Deformation data were long interpreted with a simple point source model, the Mogi model (*6*), but today's numeri-

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