Podcast Interview: Joel Levine

PNAS: I’m Sandeep Ravindran, and welcome back to Science Sessions. Group behavior and social interactions play a major role across the animal kingdom, but there is still a lot we don’t understand about their genetic and molecular underpinnings. To tease apart the mechanisms underlying sociality, University of Toronto professor Joel Levine studies social behaviors in a genetically tractable model animal, the fruit fly. In a recent PNAS paper he described the social interaction networks formed by fruit flies, and identified how they form these networks. Levine aims to find the genetic pathways involved in fruit fly sociality, and says some of them may be shared with other species, including humans. Levine talks to PNAS over the phone about his research, and starts by describing what got him interested in studying the social behavior of fruit flies.

Levine: We’ve known for a long time that flies court each other and mate, and that there are behavioral components associated with those things, and we know that they fight and we know that when they feed they often come together in groups both in nature and in the lab, and so the general question about whether this insect that’s thought to be a solitary insect might have some untapped social behavior at a group level was something that interested me. But the other reason was that when you walk around with vials of flies and bottles of flies, you look at them a lot. And as I would watch them I just saw them doing very interesting things, and it appeared to me that they were involved with one another. And so the idea that there might be some genetic contribution to this was an exciting idea, and that’s how I got into it initially.

PNAS: What did you find in your recent PNAS study?

Levine: We were able to track the flies and understand the patterns of interaction by looking at how they behave. The study really took on the question, are there emergent features that occur spontaneously when flies are allowed to interact with each other in an empty dish. The answer was yes. And more than yes, the answer that we got suggested that there might be a genetic contribution to the way the groups are structured because we saw differences between different wild type strains.

PNAS: The researchers analyzed the social networks formed by the flies

Levine: We asked whether there was a structure in the group, and we found that the patterns of interaction were not random, they were not accidental, and that when you look at different wild type strains, it’s as if the strains place a different emphasis on how they interact with each other at the group level. What we find is that the cohesion of the group, the way that different parts of the group are able to interact with each other, is organized in a different way in different strains. We think there’s a genetic component to it.

PNAS: Levine also studied how the flies form these networks

Levine: The other part of the study involved the demonstration that the flies rely on chemical communication to achieve this. When we took vision out of the picture, the
groups did not form as quickly, but they formed in the expected way. When we removed a lot of the fly’s ability to hear, we saw that the groups formed in a more or less normal way. But when we removed taste using a mutation the groups really formed in a random way, and when we reduced the ability of the flies to smell a lot, often the networks wouldn’t form and when they did form they formed in an abnormal way that involved a lot of very tight clustering among the flies as if they were having difficulty interacting in a normal manner.

**PNAS:** What do you plan to study next?

**Levine:** Future directions include a variety of approaches to understand what genes may underlie the patterns of interaction that we’re seeing. We assume that these patterns are determined by the nervous system and so we want to know what neurons are involved in regulating and modulating these interactions. We want to understand how the networks we’re looking at may map onto other networks that form in the context of other behaviors, and we want to know how they reduce to networks of genes and cells that support them. And so there’s a variety of approaches to take to those questions and we’re going for it.

**PNAS:** Levine says his research has implications for the study of sociality in other species.

**Levine:** When we learn things about flies, they often generalize to other species, and there are well known examples including biological clocks and learning where the genetic pathways involved translate not only to other insects but to other species including humans. It’s exciting to think that we may be entering an area of biological investigation that allows us to identify how biology informs group behavior. This is exciting because of the potential it holds for addressing concerns that have to do with diseases like schizophrenia and autism, and that it may also hold promise for understanding in a better way how we interact with our world as a group, and not just as an individual.

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