

Q&A

# Questions for Kay Tye: How loneliness drives social behavior

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19 APRIL 2016

Most people are wired to seek pleasure in the company of others, but individuals with autism appear to **lack this drive**. The chemical messenger **dopamine** may rouse the brain's reward center **differently** in autism, dulling the pleasure from social interaction.

A new study suggests that social contact is more than just a reward — it may also serve to block bad feelings<sup>1</sup>.

The findings raise the intriguing possibility that people with autism don't recognize loneliness as a bad feeling. As a result, they are less driven to seek out social interaction as a remedy.

The study, published in February in *Cell*, shows that brief periods of isolation alter connections between neurons that communicate with the chemical messenger dopamine. These neurons are typically associated with pleasure and reward. But the new work suggests that changing the strength of their connections, a process known as synaptic plasticity, can drive an intense aversion to loneliness.

We asked lead researcher **Kay Tye**, assistant professor of neuroscience at the Massachusetts Institute of Technology in Cambridge, how this alternative to the social reward theory can help to inform autism research.

**Spectrum:** How did this discovery unfold?

**Kay Tye:** It was completely serendipitous. Gillian Matthews, a student working with **Mark Ungless**, research fellow at Imperial College London in the U.K., was looking at how cocaine can induce synaptic plasticity — specifically, the strengthening of connections — between neurons that communicate with dopamine. For this experiment, you inject the animals with either cocaine or saline and then put them alone in a cage overnight so they don't freak the other animals out. But

she found that the mice showed a lot of synaptic plasticity after being isolated overnight, regardless of whether they'd received cocaine or saline.

We thought social isolation might be causing the changes, but we really weren't sure. So we did a series of experiments and found that the mice become more social if you use light to stimulate a set of dopamine-releasing neurons in the brainstem when the mice are in a group. But when the mice are alone, they avoid the light stimulation. This suggests that the activating these neurons creates an [unpleasant] experience for the mice.

**S:** How can an unpleasant feeling drive social behavior?

**KT:** You'll eat your favorite food as a reward, even if you're not particularly hungry. But other times you'll eat because you're hungry. Hunger is an unpleasant state; people don't enjoy being hungry. In fact, it is a state that people try to escape by eating.

You can imagine social behavior in a similar way. Animals might engage in social interaction because they find those interactions rewarding, or they could engage in social interaction to escape the negative state of loneliness.

There are a number of well-understood mechanisms in your body and brain that can detect dehydration or hunger, and try to restore that homeostatic balance. But it's not really clear how we recognize whether our social needs are being met.

**S:** Were you surprised that such a brief period of isolation can alter the brain?

**KT:** I thought it was pretty striking. I wouldn't expect such dramatic changes in brain circuitry after only 24 hours. There are a lot of advantages to living in groups, so this neural circuit could have evolved to help animals survive. When mammals are isolated, they become motivated to seek out social interaction.

**S:** Does being alone necessarily mean being lonely?

**KT:** Not everyone who's alone feels lonely. And similarly, you don't have to be alone to feel lonely. You could be in a crowded room and still feel lonely. So obviously there's a lot of complexity in those situations.

Interestingly, we only see these effects in socially dominant mice, which tend to bully other mice. We don't see it in socially subordinate ones. So if you're a subordinate mouse, maybe you feel relieved when you're isolated.

**S:** Could your study hold clues about conditions such as autism?

**KT:** We think that the experience of loneliness is likely to be different in individuals with autism, and it could very well be due to a perturbation in this neural circuit. When we feel lonely, it increases our motivation to seek social contact and satisfy an unmet need for social interaction. But what happens if this circuit is broken or perturbed? What would we be like if we were unable to feel lonely?

People with autism don't seek out social contact. But that might not mean that they are unable to feel motivated. It could mean, rather, that it's difficult for them to recognize that they need social contact or detect the discrepancy between how much they need and how much they're actually getting. It's a neat question.

**REFERENCES:**

1. Matthews G.A. *et al.* *Cell* **164**, 617-631 (2016) [PubMed](#)