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Study: Changing bee behavior changes bee brains

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A forager bee covered in pollen. (Photo: pdphoto.org)

Aging animals, including honeybees, often show signs of cognitive decline such as poor memory and problems with learning new information. We know that aging impacts behavior, but can behavior also change how the brain ages? A recent study by Nicholas Baker, Florian Wolschin, and Gro Amdam published in *Experimental Gerontology* explores an interesting connection between age-related learning deficits and behavioral roles in honeybees.

Honeybees (*Apis mellifera*) were used in this study because of their unique social structure. Nurse bees take care of the nest by cleaning, building combs, feeding baby bees, and tending to the all mighty queen bee. These bees don't show obvious signs of aging and can live for 100 days or more. Forager bees, by comparison, have hard lives spent flying around searching for nectar and pollen. These bees typically die within 7-10 days of beginning their foraging and show learning deficits that become more severe the longer the bees spend foraging. The researchers involved in this study wanted to know whether just the act of foraging caused the bees to have a harder time learning.

In order to determine whether foraging was making the bees senile, the researchers had to make sure that the forager bees weren't simply older than the nurse bees. This is an important consideration because in a typical colony foragers start off as nurse bees and then become foragers after two to three weeks. To deal with this potential confound, the researchers placed dots of paint on the backs of individual bees so they could track the age of the bees and if and when they started foraging. Next they used a scent task to compare the learning ability of the different bee groups and found young and old nurse bees had identical learning abilities, but that the older foragers had significant learning deficits compared to the young foragers. This result suggests that something about the foraging behavior specifically leads to decreased learning ability over time.

If foraging behavior causes a decline in learning ability, could this effect be reversed if the foragers returned to being nurse bees? To study this the researchers took advantage of an interesting natural colony phenomenon: removing existing nurse bees from a colony forces some foragers to revert back to nurses in order to maintain the social homeostasis of the colony. By comparing these forager-nurse converts with bees of the same age who continued to forage, the researchers found that the reverted nurse bees performed significantly better than the long-term forager bees. Simply by changing their role in the colony, the bees regained their learning ability within two weeks.

To further explore this role-dependent change in learning ability the researchers ground up bee brains and compared the levels of various proteins between the good and bad learners. They found associations between learning ability and levels of proteins involved in stress response, cellular maintenance, and neuronal function. This prompts an interesting follow up question: what are the cellular mechanisms that connect the change of a bee's colony role with changes in the these proteins?

The findings from this study are intriguing, especially in the context of other research showing that social interactions benefit fly lifespan and that social interactions may help prevent cognitive decline in humans. The study also highlights how their complex social structure makes honeybees particularly useful for studying the ways specific behaviors can influence the aging brain.