Rethinking brain evolution in social insects: harnessing perspectives into a new predictive framework

Author(s): Rebekah Keating Godfrey, Rebekah Keating Godfrey , Wulfila Gronenberg

Institution(s): Department of Neuroscience, University of Arizona, Tucson, AZ ; Department of Neuroscience, University of Arizona, Tucson, AZ ; University of Arizona

Attempts to link sociality and brain evolution in Hymenoptera have developed largely in response to existing theory from primate literature. Specifically, the social brain hypothesis proposes that individual cognitive demands expand with social networks size, lead to observed expansion of higher association cortices in social primates. Conversely, existing eusocial insect theory assumes a reduction of or release from individual cognitive demands in eusocial lineages because of division of labor and predicts concurrent reductions in individual brain investment, particularly in higher association centers. The social brain hypothesis for eusocial insects suffers two primary flaws due to its origin within the framework of the theory developed for primates. First, not being derived within what is known about the evolution of insect sociality, it does not provide adequate alternate hypotheses for differences in brain region investment across lineages. Second, it neglects core questions about the nature of social neuroethology, namely “What cognitive processes are required to coordinate social behaviors?” “Does social structure provide a release from cognitive demands at the individual level?” and “In what ways do brains change in response to or as a result of these kinds of behavioral change?” Here we attempt to re-orient the conversation about sociality and brain evolution in Hymenoptera by taking a critical look at assumptions underlying current theory, discussing the cognitive and neural traits that may be unique to or uniquely modified in social Hymenopteran lineages, and outline existing alternate hypotheses for differences in brain structure across lineages varying in sociality.