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Neural circuits for social communication and navigation in naked mole-rats

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Summary

Many animals including humans are highly social. Yet very little is known about the behavioral and genetic mechanisms that contribute to the onset and maintenance of sociality. We will investigate the social and navigational behaviors in a highly social mammal: the African naked mole-rat, *Heterocephalus glaber*. The naked mole-rat is native to the harsh subterranean environments of sub-Saharan East Africa. It is one of the most remarkable social mammals. It lives in large colonies of up to 300 individuals, dominated by one female, called the queen. Given their poor vision and hearing, naked mole-rats may rely primarily on olfaction and mechanosensation to create social bonds, find food, and recognize heterospecifics and threats. However, how olfactory and mechanosensory cues contribute to their social and navigational behaviors is unknown. Understanding the basic biology underlying the unique sociality of the naked mole-rat will broaden our perspective on the various possibilities of communication and the unique coping mechanisms in harsh environments.

Registration details	
Status of the study	Accessible
Date of registration	2023-10-12
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Planned start of the study	2023-10-15
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License	

1. General Information

Keywords

Not provided

Funding sources

Not provided

International code of classification

Not provided

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2. Study design

Introduction

little is known how chemical communication evolved. We aim to study the evolution of olfactory communication in mammals. One difficulty in studying social behavior in the lab is in finding species with high levels of cooperative interaction and social communication. The naked mole-rat as a eusocial mammal displays a higher level of social organization than any other known rodent. They burrow complex tunnel systems that can be up to 4 kilometers long in search of food (underground roots, bulbs, and tubers)(Williams and Shattuck, 2015). We hypothesize that changes in the brain of the naked mole-rat allow for this increased sociality and that a full classification of the molecular and electrophysiological mechanisms underlying this enhanced sociality will provide insights into conserved mechanisms for social cooperation and communication across mammalian species. The naked mole-rat provides a unique opportunity to study how olfactory chemical cues are used to modulate behavior and to investigate brain regions that are involved in these processes (Clarke and Faulkes, 1998; Kutsukake et al., 2012).

In addition to olfaction, touch has been confirmed to be crucial for social interactions in both mice (Huzard et al., 2022) and humans (Cascio et al., 2019). Therefore, touch may also be an effective way for naked mole-rats to socialize with other individuals. Given the poor vision of naked mole-rats, touch is also important for navigation behaviors (Kimchi and Terkel, 2004). Naked mole-rats owns a very unique touch system, reminiscent of the fish lateral line, they have sparse and large hairs arranged in stereotyped rows along their bodies (Crish et al., 2003), however, for now, there are no studies on the function of these hairs. Preliminary data from our lab showed that these mechanoreceptors are tuned to certain deflection angles, providing directional in-formation, suggesting that they are not only able to perceive environmental fine textures but also may sense skin wrinkle of other animals.

The purpose of this study is to identify the chemical signals and the underlying neurobiological substrates the underlie the social behaviors of naked mole-rat. Moreover, we aim to characterize the type of mechanosensory information that naked mole-rats use during navigation and the underlying brain regions.

Type of research

Exploratory

Hypothesis of your study

We hypothesize that naked mole-rats depend on odors, particularly queen-specific odors, to regulate and coordinate colony tasks and communication. Additionally, we propose that the mechanoreceptors in their body hairs may offer tactile information, allowing mole-rats to perceive the detailed texture of their external environment.

Study design

Aim 1: Assessment of social dominance hierarchies

Aim 2: Collecting the odors of the different members and colonies

Aim 3: Behavioral characterization of the newly identified odors of naked mole-rat.

Aim 4: Identifying the brain regions involved in olfactory communication and reproductive suppression.

Aim 5: Recording and observing how naked mole rats move and navigate.

Aim 6: Investigating what kind of information naked mole-rat can acquire by touch during navigation.

Aim 7: Exploring whether naked mole rats can use path integration strategies.

Aim 8: Experiment for investigating brain activity during hair stimulation by no harm and non-invasive method.

Aim 9: Map anatomical connectivity of hair mechanoreceptors using genetic tracing.

Method of blinding

Experimental Design, Double-Blind, and Data Collection and Assessments

Method of randomization

Experimental Design: Blinding begins with the design of the experiment. Researchers plan in advance how they will ensure that the assessment of outcomes or data collection is performed without knowledge of the treatment groups. Double-Blind: Both the researchers and the animal handlers are unaware of the treatment groups. Typically, a third party, such as a data analyst or another researcher, is responsible for assigning animals to groups and providing the necessary information to the experimenters. Data Collection and Assessments: During the experiment, the blinded personnel perform data collection and assessments without knowledge of which treatment group each animal belongs to. This can include measurements of physiological parameters, behavioral observations, or any other relevant data. Data Recording: When recording data, researchers often use coding or labeling systems that do not reveal the treatment groups. The data are stored in a way that maintains confidentiality until analysis. Unblinding: After all data have been collected, and the analysis is ready to begin, the blinding can be removed. Researchers then match the treatment groups with the data using the coding system established earlier.

3. Methods

3. 1. Neural circuits for social communication and navigation in naked mole-rats

Description of the method

Aim 1: Assessment of social dominance hierarchies

Aim 2: Collecting the odors of the different members and colonies

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Aim 9: Map anatomical connectivity of hair mechanoreceptors using genetic tracing.

Narcotic/analgesic treatment

Not provided

Drugs/substances

Not provided

Antibodies

Not provided

Cell lines, viruses, DNA or RNA constructs and bacteria

Not provided

4. Statistics

4. 1. T-test, One-way-Anova

Assigned method(s)

Neural circuits for social communication and navigation in naked mole-rats

Main endpoints

Please contact mohammed.khallaf@mdc-berlin.de for more information.

Secondary endpoints

Not provided

Sample size calculation

Please contact mohammed.khallaf@mdc-berlin.de for more information.

Primary statistical analysis

Please contact mohammed.khallaf@mdc-berlin.de for more information.

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Exclusion criteria

Not provided

5. Animals

5. 1. Naked mole-rats

Animal strain/breed

Naked mole-rats

Genetically modified

No

Sex

Female
Male

Further characteristics of the animals (e.g. age, body weight, size)

Naked mole-rats

Housing conditions

Please contact mohammed.khallaf@mdc-berlin.de for more information.

Refinement

Not provided