Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

- The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement
- A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
- The statistical test(s) used AND whether they are one- or two-sided
  - Only common tests should be described solely by name; describe more complex techniques in the Methods section.
- A description of all covariates tested
- A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
- A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
- For null hypothesis testing, the test statistic (e.g. F, t, r) with confidence intervals, effect sizes, degrees of freedom and P value noted
  - Give P values as exact values whenever suitable.
- For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
- For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
- Estimates of effect sizes (e.g. Cohen's d, Pearson's r), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection

All data were collected using the protocols and software described in:
- Mersch, D. P., et al. Tracking individuals shows spatial fidelity is a key regulator of ant social organization. Science 340, 1090 (2013).
- Stroeymeyt et al., Social network plasticity decreases disease transmission in a eusocial insect. Science 362(6417):941-945 (2018).
- Worker trajectories and physical contacts were extracted using freely available software; https://github.com/laurentkeller/antrackingUNIL

Data analysis

The automated tracking datasets generated for the current study, and code for constructing the bipartite spatial networks, and for the simulations, are available in the Dryad repository; https://doi.org/10.5061/dryad.9w0v4bb.
Implementation of the fixed-rows, fixed-columns null model was performed using the `r2dtable` function from the 'stats' package (version 3.4.2) for R. Trajectory segmentation was carried out using the 'changepoint' package (version 2.2.2) for R.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. Github). See the Nature Portfolio guidelines for submitting code & software for further information.
Data

Policy information about availability of data
All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:
- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy.

The automated tracking datasets are available in the Dryad repository, https://doi.org/10.5061/dryad.9w0vt4bjb

Human research participants

Policy information about studies involving human research participants and Sex and Gender in Research.

| Reporting on sex and gender | N/A |
|-----------------------------|-----|
| Population characteristics  | N/A |
| Recruitment                 | N/A |
| Ethics oversight            | N/A |

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

- [ ] Life sciences
- [ ] Behavioural & social sciences
- [x] Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

| Study description               | Comparison of the spatial & social organization within nests of four species of social insects. |
|---------------------------------|-------------------------------------------------------------------------------------------------|
| Research sample                 | The experiments were non-manipulative tracking experiments, conducted on 50 colonies of social insects. As a purely descriptive study, there were no treatment factors, and the design was not factorial nested or hierarchical. The 50 colonies were drawn from four species (Apis mellifera, 10 colonies; Lasius niger, 20 colonies; Leptoethorax acervorum, 10 colonies; Temnothorax albipennis, 10 colonies). For full details on the number of tracked individuals in each colony, see Table 1 in the main text. |
| Sampling strategy               | There were two levels of replication within our study: the level of the colony and the level of the individual. We chose to use 10 colonies per species (20 in the case of L. niger) as this represents a good practical compromise between sufficient replication at the colony level, and the time required to tag individuals that make up each colony. In total, our resulting sample size was therefore of 50 colonies and 12494 individuals, totalling 340 000 ant/bee hours of observations. |
| Data collection                 | A. mellifera, 10x72hr tracking sessions by TOR; L. niger; 20x72hr sessions by NS; L. acervorum & T. nylanderi; 20x72hr sessions by TOR & NS. |
| Timing and spatial scale        | ervorum & T. nylanderi; 20x72hr sessions by TOR & NS. Timing: Tracking sessions were conducted between November 2013 - December 2016. Spatial scale - ants: Trajectories of individuals moving within ~60x40mm rectangular nests Spatial scale - honeybees: Trajectories of individuals moving within ~60x60cm double-sided observation hives. |
| Data exclusions                 | No data were excluded. |
| Reproducibility                 | The experiments included internal replication (10 colonies per species). All reported findings were shown to be statistically significant using all replicates. |
| Randomization                   | Colonies were allocated to categories according to species. |
Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

| Materials & experimental systems | Methods |
|--------------------------------|---------|
| n/a                            | n/a     |
| ☒ Antibodies                   | ☒ ChiP-seq |
| ☒ Eukaryotic cell lines        | ☒ Flow cytometry |
| ☒ Palaeontology and archaeology| ☒ MRI-based neuroimaging |
| ☐ Animals and other organisms  |         |
| ☒ Clinical data                |         |
| ☒ Dual use research of concern |         |

Animals and other research organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research, and Sex and Gender in Research.

| Laboratory animals | The study involved colonies Apis mellifera, Lasius niger, Leptothorax acervorum, Temnothorax nylanderi. |
| Wild animals       | None                                                   |
| Reporting on sex   | N/A                                                   |
| Field-collected samples | None                                           |
| Ethics oversight   | The use of insects in research is not subject to any regulations or ethical restrictions. |

Note that full information on the approval of the study protocol must also be provided in the manuscript.