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Navigating Danger: Behavioral Spreading and Misinformation Suppression in Coral Reef Fish

Keywords: Collective behavior, social networks, social contagion, escape behavior, animal behavior

Extended Abstract

Wild animals must navigate complex environments, and accurate responses are crucial, as a wrong response can result in being killed and eaten [1]. For social animals, living in groups can provide both protection through safety in numbers and additional information about potential threats. However, since this information cannot always be checked, it is also a potential source of misinformation that can lead to inaccurate decision-making. False alarms occur regularly in groups, and escape responses are costly, both in the energy spent on the response and the time not spent foraging. This means animals face a trade-off when dealing with information from their neighbors [2]. Therefore, social animals need a strategy that enables them to suppress the spread of misinformation while remaining sensitive to social information in the case of real threats. This research aims to understand the behavioral strategies that social animals use to avoid responding in non-threatening situations while remaining vigilant to predators, making use of detailed behavioral data, models of social contagion, and tools from network science [3].

Using stereo video recordings of wild reef fish exposed to visual looming stimuli, we tracked individual positions, response times, and speeds to study how responses spread through groups. While not all stimulus presentations led to an escape, 74 trials showed at least one fish responding. The number of secondary responders ranged from none to the entire group (Figure 1A). Larger groups were more tightly packed, yet responses remained local rather than spreading through the entire group (Figure 1B). To explain this pattern, we built and fitted models of social information transfer. Models that included response speed, where individuals delayed their response compared to their neighbors who reacted before them, matched the observed data and prevented cascades throughout the entire group.

Analysis of the social networks revealed that the position of the first responder determined whether the response spread through the group. While the networks were fully connected, the distance between individuals strongly shaped the flow of information. In particular, the distance of the first responder to the center of the group predicted the extent of social spreading: responses initiated closer to the edge of the group spread further, while those initiated near the center tended to remain local. In contrast, the overall number of weighted ties of the first responder was not associated with the spread. This suggests that geometry matters more than connectivity in determining how information travels through groups.

Overall, this work demonstrates that escape dynamics in reef fish are shaped not only by how individuals time their responses but also by their position within the group. By combining behavioral data, modeling, and network analysis, we reveal strategies that allow groups to remain sensitive to real threats while minimizing the costs of misinformation. These insights highlight the importance of spatial structure in collective behavior and provide a framework for understanding how social animals navigate the trade-offs of group living in complex environments.

Ethical considerations This study was carried out with free-living coral reef fish using non-invasive stereo video recordings and brief visual stimuli that mimic natural predator movements. The presentations were harmless, and no fish were handled or injured at any point. All fieldwork was conducted under the appropriate permits and followed local and institutional ethical guidelines.

References

[1] William E. Cooper and Daniel T. Blumstein. *Escaping From Predators*. Cambridge University Press, 2015.

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[3] Sara B. Rosenthal et al. "Revealing the hidden networks of interaction in mobile animal groups allows prediction of complex behavioral contagion". In: *Proceedings of the National Academy of Sciences* 112.15 (2015), pp. 4690–4695.

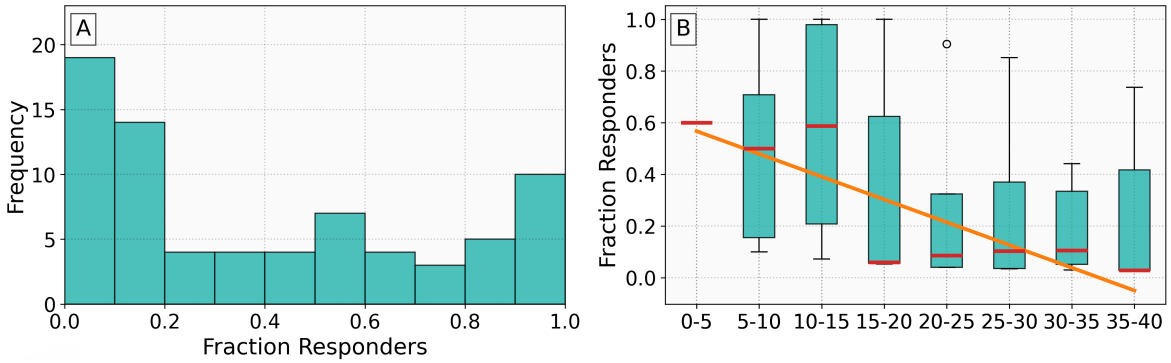

Figure 1: **Group-level patterns in the dataset.** (A) The fraction of fish showing an escape response in the groups is varied, (B) This fraction decreases with group size.