How are social preferences realized? Considering the importance of space: *A comment on De Moor et al. (2025)*

Kaija Gahm[1], Orr Spiegel[2], and Noa Pinter-Wollman[1]

[1] Department of Ecology and Evolutionary Biology, University of California, Los Angeles, CA, U.S.A.

[2] School of Zoology, Faculty of Life Sciences, Tel Aviv University, Tel Aviv, Israel

Handling editor: Dr. Kees van Oers

Animal social interactions that behavioral ecologists observe and study are a subset of 'realized' social interactions, which are themselves a representation of animals' 'social preferences'. As De Moor et al. (2025) carefully and thoroughly dissect in their paper, the distinction between three conceptual layers: observed, realized, and preferred social interactions, is critical for our ability to interpret animal social behavior and compare social interactions across systems. De Moor et al. (2025) identify key challenges in bridging the gap between two of these layers: observed and realized social interactions. However, they provide little information about how one might link realized interactions to social preferences. This link is important to examine because it provides information about the factors that facilitate and prevent animals from interacting according to their preferences alone, potentially revealing tradeoffs in social behavior. Here we expand the discussion of latent layers of social networks by identifying key challenges and some potential solutions to inferring social preference.

In Figure 1, we outline some factors to consider when examining the relationship between social preference and realized interactions. For example, demographic events, such as births deaths, affect which preferred social interactions can be realized (Figure 1, arrow 1), as reviewed by Shizuka and Johnson (2020). An important key mediator between social preference and realized interactions is space and its effect on animal movements (Webber et al. 2023). De Moor et al. (2025) briefly mention that spatial constraints (such as geographical barriers) may prevent animals from realizing their social preferences, resulting in fewer realized interactions than an animal might prefer. However, spatial features (such as food resources) may facilitate social interactions, resulting in more realized social interactions than an animal might prefer, i.e. 'incidental' social interactions. The impact of space on social interactions can differ across systems (e.g., when comparing terrestrial and aquatic animals). Thus, it is critical to consider the role of space in linking preferred to realized interactions (oval in Figure 1).

While De Moor et al. (2025) highlighted the transition from social preferences to realized social interactions, this relationship is bidirectional and spatial features can mediate how realized interactions might affect social preferences. First, spatial features can affect how individuals prefer to interact. For example, when resources become scarce, or when population densities increase, individuals might change their social preferences to avoid conspecifics (Albery et al 2025). The state of spatial features can thus affect social preference both in direction and in magnitude in different ways across species and ecological systems (Figure 1, arrow 2). Second, realized social interactions can impact movement decisions (e.g., through collective movements (Strandburg-Peshkin et al. 2015) and resource depletion), which then affect the space that animals are exposed to. Therefore, animal movements can mediate feedback from realized interactions to social preferences through their impact on the spatial features that animals encounter (Figure 1, arrow 3). Finally, realized social interactions create social structures, such as dominance hierarchies, which can affect how individuals experience interactions with particular partners. Thus, realized social interactions may feed back and affect social preferences directly (Figure 1, arrow 4). We emphasize that these latent networks affect each other not only in one direction (preference to realized to observed), but also via more complex feedbacks, and that space is an important mediator of those feedbacks (Figure 1, arrows 2, 3, 4).

One way to uncover the impact of space on the relationship between realized and preferred networks is to use spatially explicit datastream permutations. We outline such a method in Spiegel et al. (2016) and refine it in Gahm et al. (2024). In brief, the method creates a reference (or 'null') network (Hobson et al. 2021) by shifting each individual movement trajectory forward or backward in time. This shifting temporally decouples the synchrony between movements of individuals that may be preferentially moving together (i.e., linked in the preference network), while retaining each individual's explicit use of space (i.e., in relation to various geographical features). We illustrate that this randomization method can reveal that space is more important for some social interactions than for others (Gahm et al. *in review*).

To conclude, we would like to reiterate our enthusiasm for the latent layers framework, as introduced by De Moor et al. (2025). Disentangling these latent layers is needed not only for comparing social structures across systems, but also for thoroughly understanding the mechanisms that underlie animals' social behavior. Explicit consideration of the role of space and other processes that link realized and preferred social interactions will uncover new insights about animal sociality.

Funding statement

NPW and OS are funded by the U.S. National Science Foundation and the Binational Science Foundation (NSF-BSF grant: NSF IOS division 2015662/BSF 2019822_. KG is funded by an NSF Graduate Research Fellowship: DGE2034835.

References

Albery GF, Becker, DJ, Firth, JA. et al. 2025. Density-dependent network structuring within and across wild animal systems. *Nat Ecol Evol.* 9, 2002–2013. https://doi.org/10.1038/s41559-025-02843-z

De Moor D et al. 2025. Latent layers in social networks and their implications for comparative analyses. Behav Ecol. 36(6). https://doi.org/10.1093/beheco/araf113

Gahm K et al. 2024. A wrap-around movement path randomization method to distinguish social and spatial drivers of animal interactions. Philos Trans R Soc B Biol Sci. 379(1912):20220531. https://doi.org/10.1098/rstb.2022.0531

Gahm K et al. *In review*. Relationship between spatial and social phenotypes in an avian scavenger. Preprint: https://www.authorea.com/users/920464/articles/1292712-relationship-between-spatial-and-social-phenotypes-in-an-avian-scavenger

Hobson E, Silk MJ, Fefferman NH, Larremore DB, Rombach P, Shai S, Pinter-Wollman N. 2021 A guide to choosing and implementing reference models for social network analysis. Biol Rev. 96(6):2716-2734. doi: 10.1111/brv.12775

Shizuka D, Johnson AE. 2020. How demographic processes shape animal social networks Simmons L, editor. Behav Ecol. 31(1):1–11. https://doi.org/10.1093/beheco/arz083

Spiegel O, Leu ST, Sih A, Bull CM. 2016. Socially interacting or indifferent neighbours? Randomization of movement paths to tease apart social preference and spatial constraints. Methods Ecol Evol. 7(8):971–979. https://doi.org/10.1111/2041-210X.12553

Strandburg-Peshkin A, Farine DR, Couzin ID, Crofoot MC. 2015. GROUP DECISIONS. Shared decision-making drives collective movement in wild baboons. Science. 348(6241):1358–1361. https://doi.org/10.1126/science.aaa5099

Webber QMR et al. 2023. Behavioural ecology at the spatial–social interface. Biol Rev. 98(3):868–886. https://doi.org/10.1111/brv.12934

Figure legend

Figure 1: Important factors to consider when examining the relationship between preferred and realized social interactions. (Oval) Space may both constrain and facilitate social interactions, resulting in fewer or more realized social interactions than would be preferred (blue arrows). (2) The state of spatial features can affect social preferences (dark green arrow). (3) As animals move through their environments, they encounter different spatial features; thus, realized interactions may influence how space is used (light green arrow). Beyond spatial features, other elements, such as demographic effects (1, magenta arrow) and social structures (4, orange arrow) may impact the relationship between preferred and realized social networks.