The relative spread of disease and information in group-living societies

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BACKGROUND

Living in groups carries many benefits including the ready availability of social information from group-mates. However, there are costs of living in close proximity to others including increased infectious disease risk. Theoretical models have suggested that the types of social network generated by living in groups (Fig. 1) and/or forming sub-groups can change how information and disease spread through populations and may alter the balance between information and infection. However, the role of group size in impacting this is poorly known.

OBJECTIVE

Determine how group size and the social division between groups (network modularity) impacts the relative rate of spread of infection and information

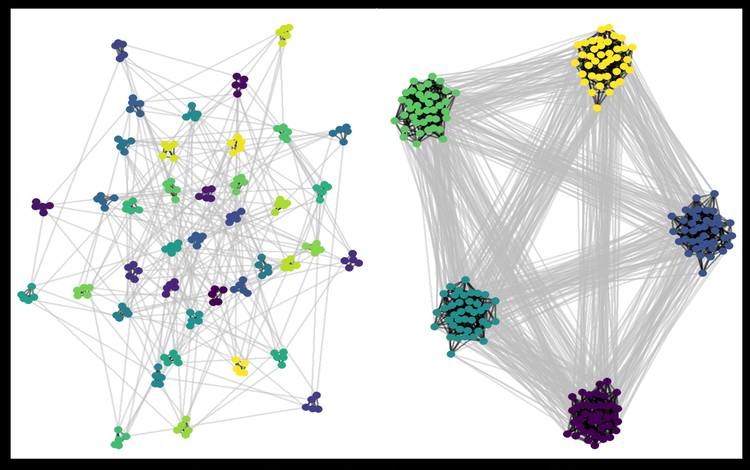


Fig. 1. Networks with similar frequencies of between-group contacts (modularity) can have very different size groups which may alter transmission dynamics.

MODEL OVERVIEW

We modelled the spread of infectious disease as a simple contagion and the spread of information as a complex contagion with a conformist social learning rule (Fig. 2).

First, for a range of disease transmissibilities we matched the rate of spread of disease and information in a randomly connected network (with varying densities of connections).

We then compared the rate of spread in modular social networks that varied in their modularity and group size.

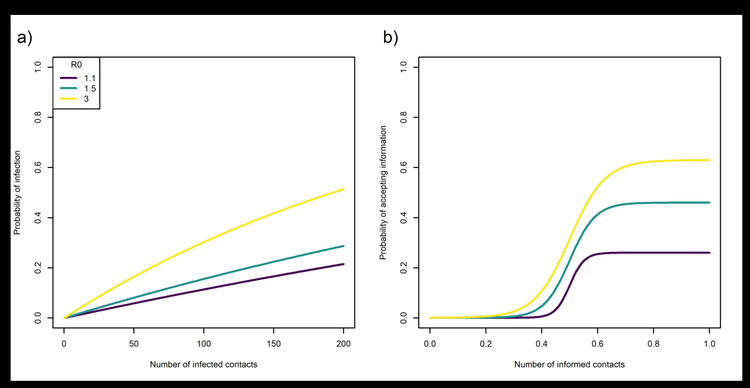


Fig. 2. Functional forms for the probability of a) an individual being infected and b) an individual becoming informed.

KEY RESULTS

- ***Infection and information both spread more slowly in more modular networks but only when group sizes are smaller (Fig. 3).***

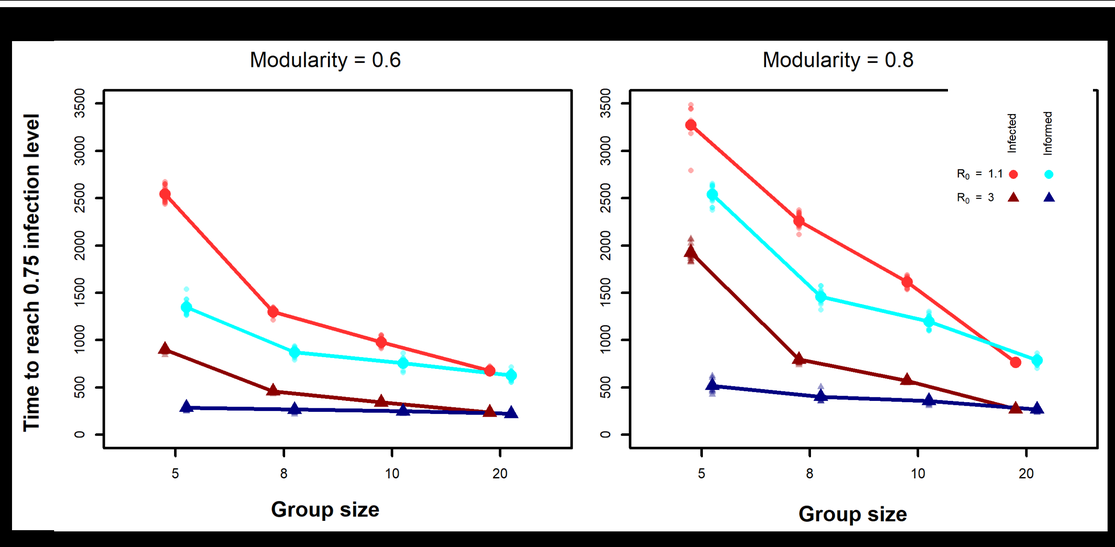
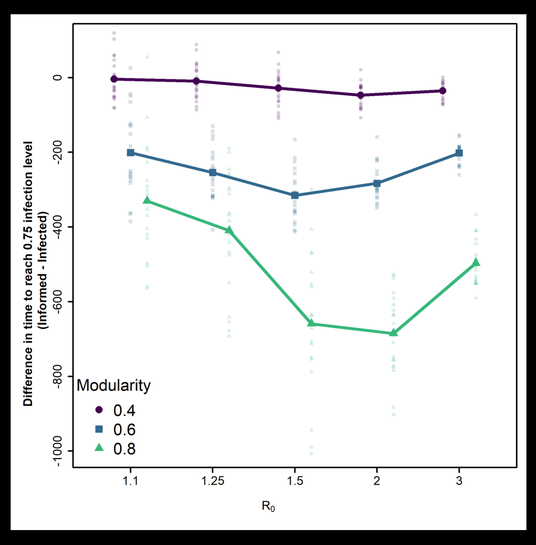
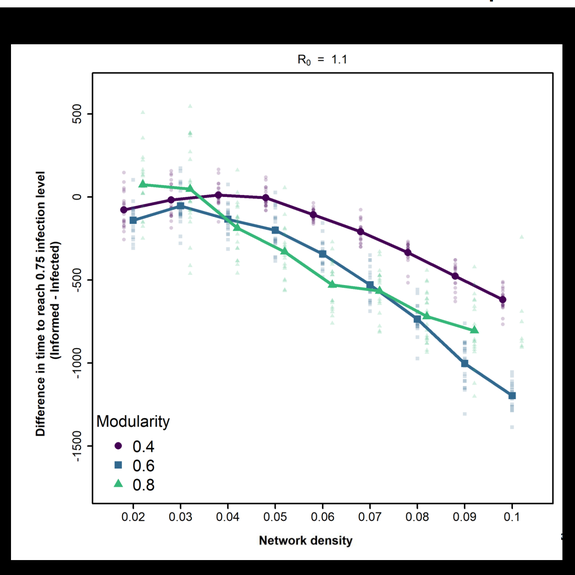


Fig. 3. The time taken for 75% of the population to be infected (red points/lines) or informed (blue points/lines) in modular networks of differing group sizes (x axis). Large points represent the overall mean and small, semi-transparent points results from individual simulation runs



- ***The spread of information slows down less than the spread of disease (Fig. 4). The greatest difference is for intermediate rates of transmission.***

Fig. 4. The difference in time taken for 75% of the population to be informed versus infected for differing rates of transmission (x axis). Results are shown for small groups with three different modularities.



- ***Information takes even less time to spread c.f. disease when the density of connections in the network is greater (Fig. 5).***

Fig. 5. The difference in time taken for 75% of the population to be informed versus infected for networks with small social groups differing in their modularity (colours or lines/points) and density of social connections when transmission rate is low.

Modular social networks with small groups can mitigate the trade-off between information and infectious disease spread in animal societies.

Read more: https://doi.org/10.1101/2021.05.01.442253