

Distributed information processing by insect societies

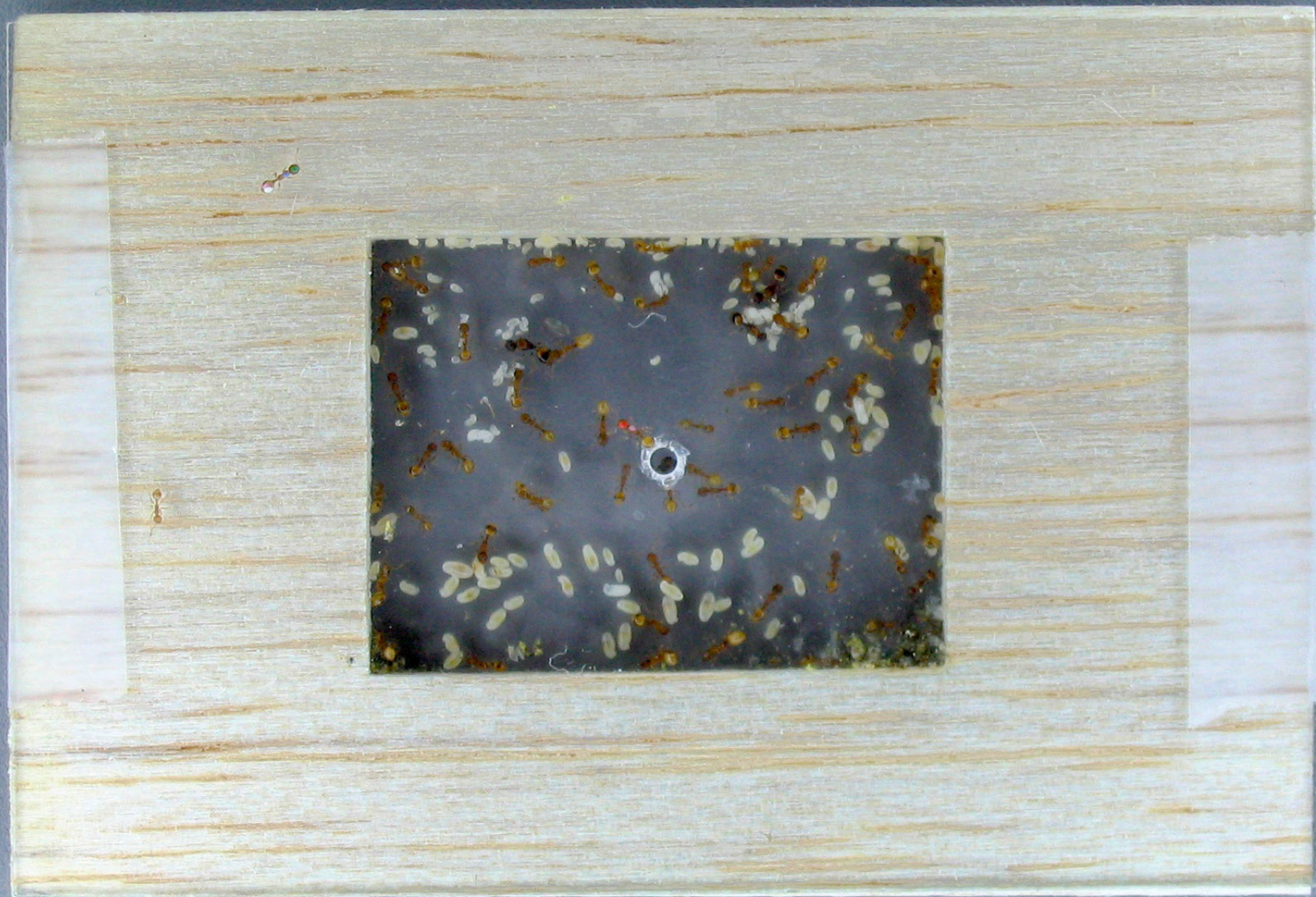
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Nest of
Temnothorax
rugatulus







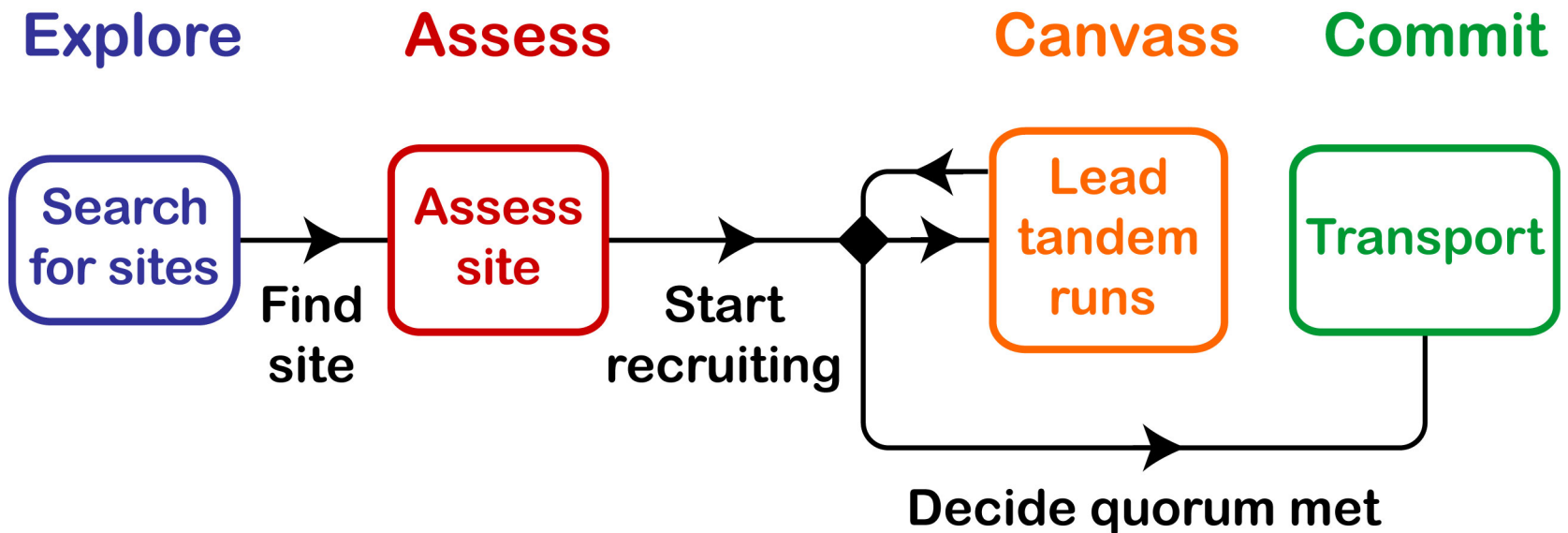
Scouts use tandem runs to recruit other scouts



Scouts transport the inactive majority of the colony



Decision algorithm used by active ants





A

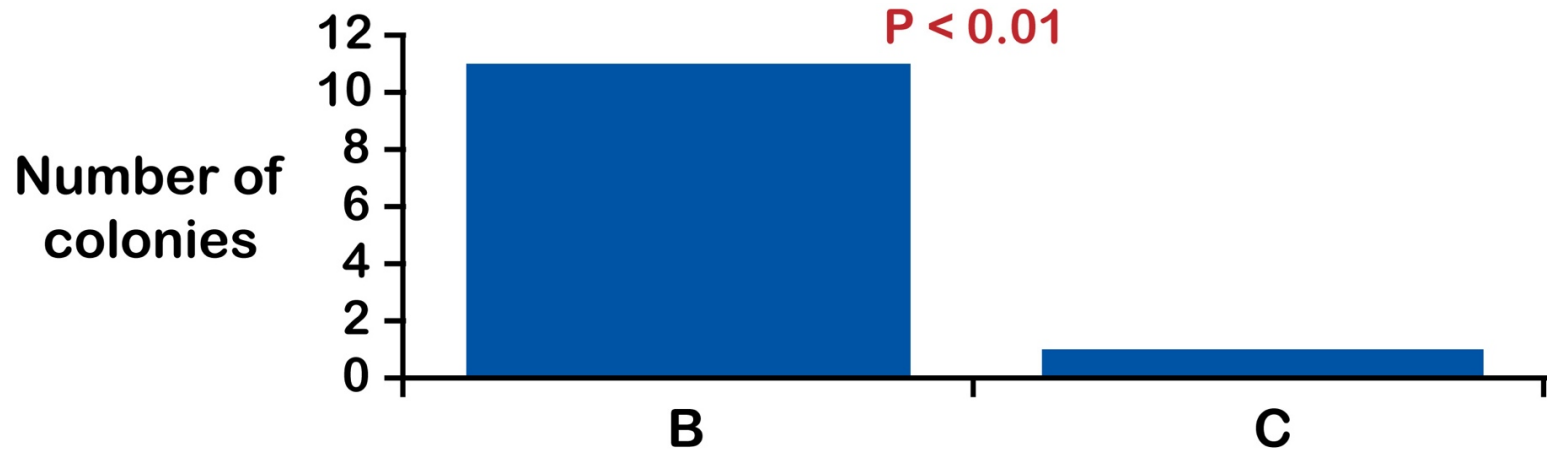


B

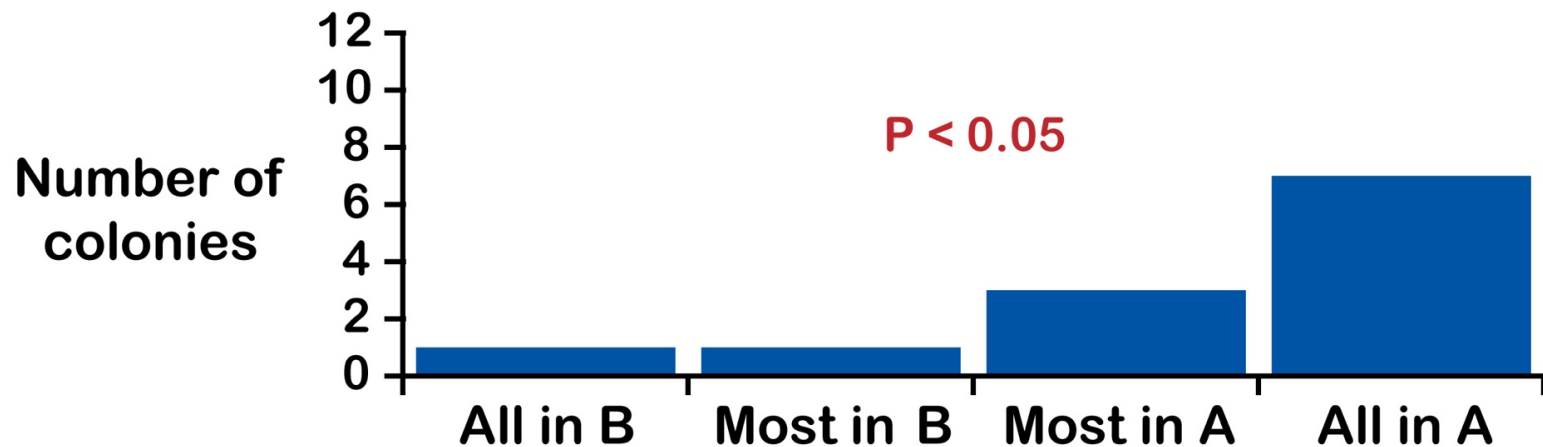
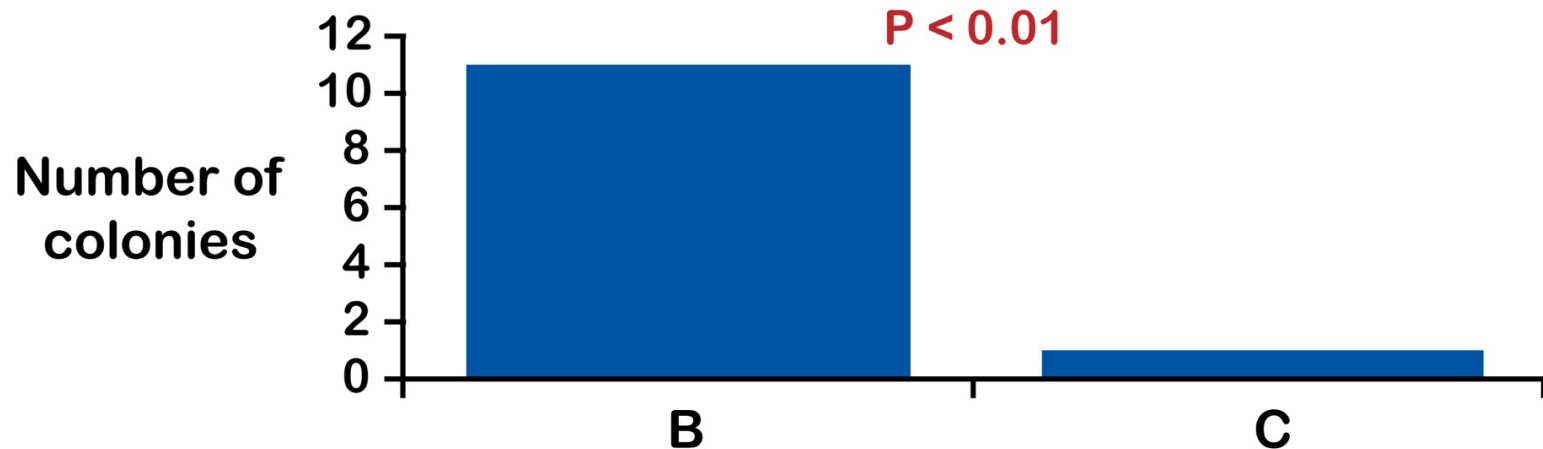


C

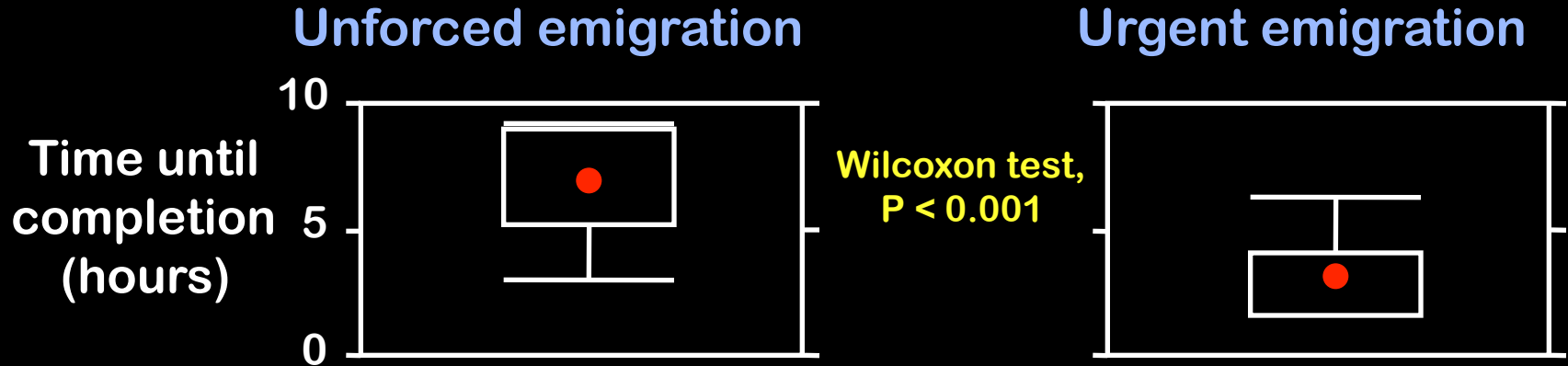
Colonies can choose the better site



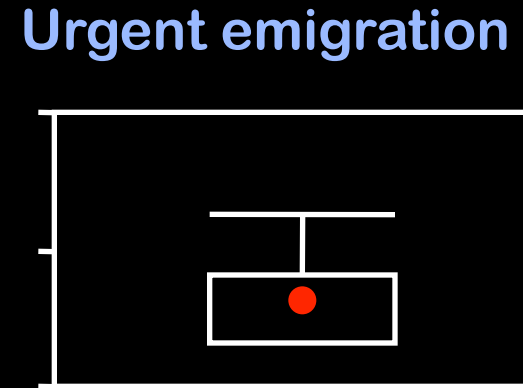
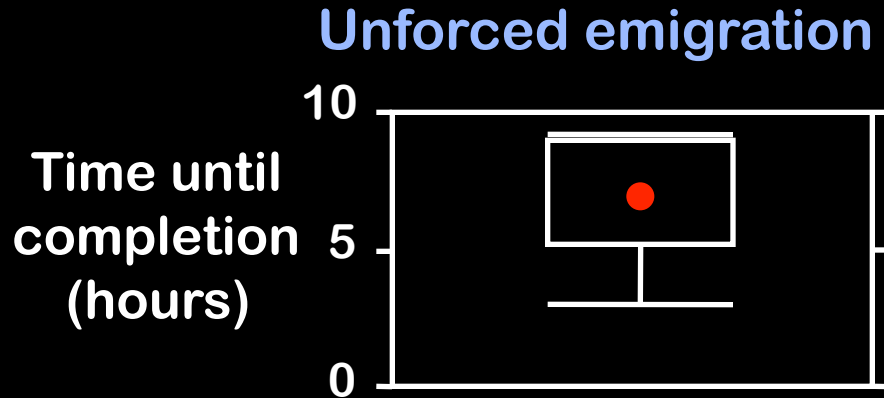
Colonies compare available options



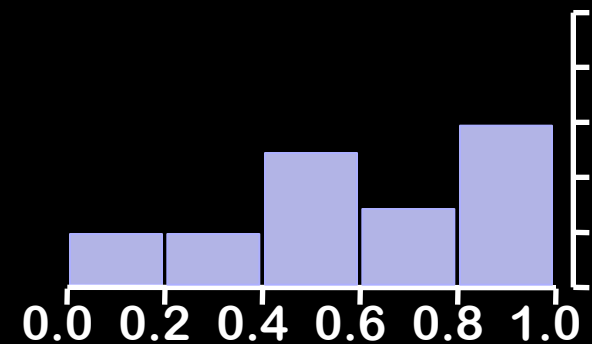
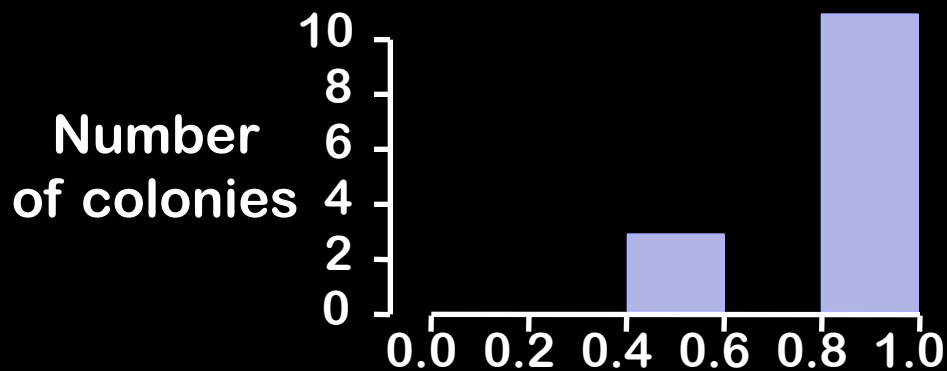
In urgent emigrations, decisions are faster...



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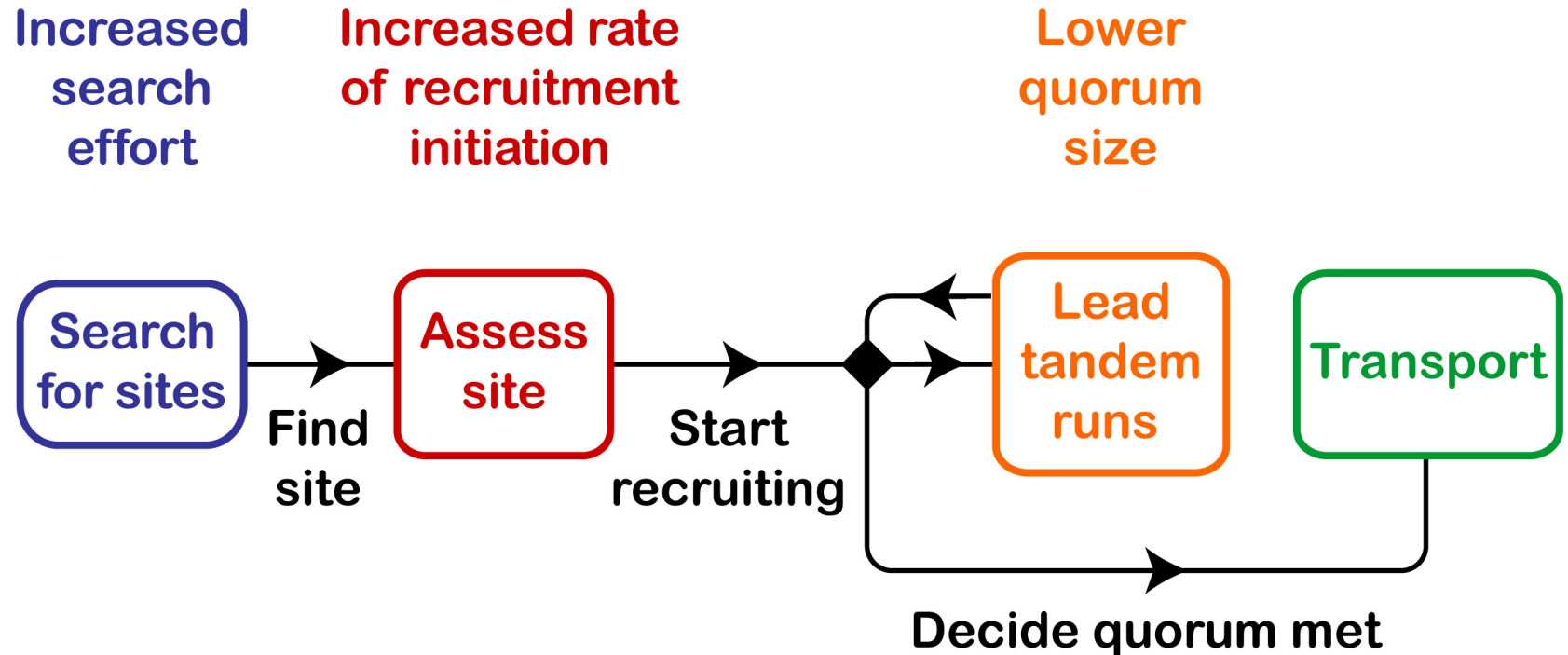


...but less accurate



Proportion of colony in good nest

Urgency alters behavior at multiple phases of decision-making



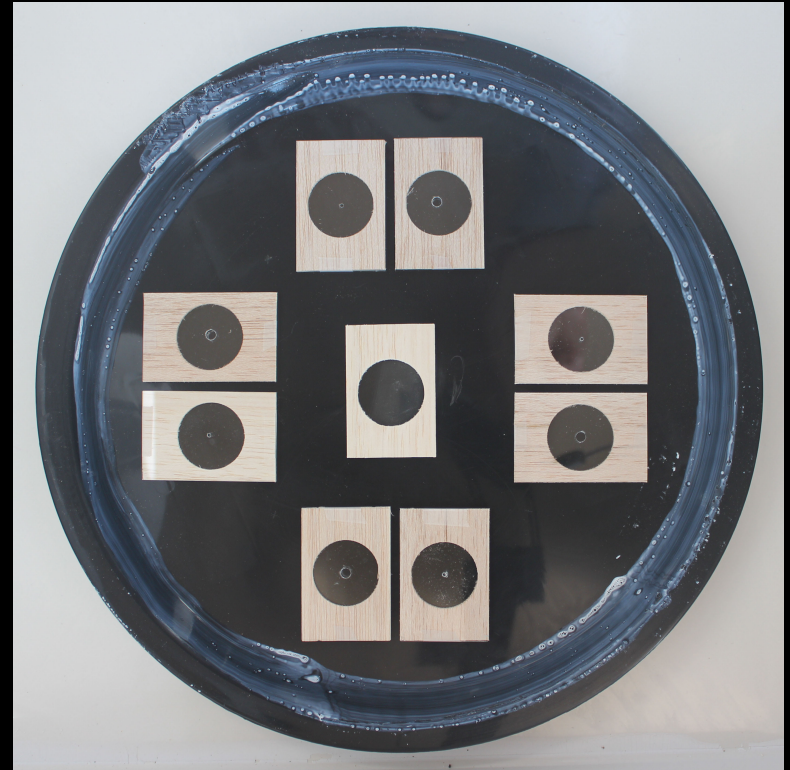
Individual choice vs. collective choice



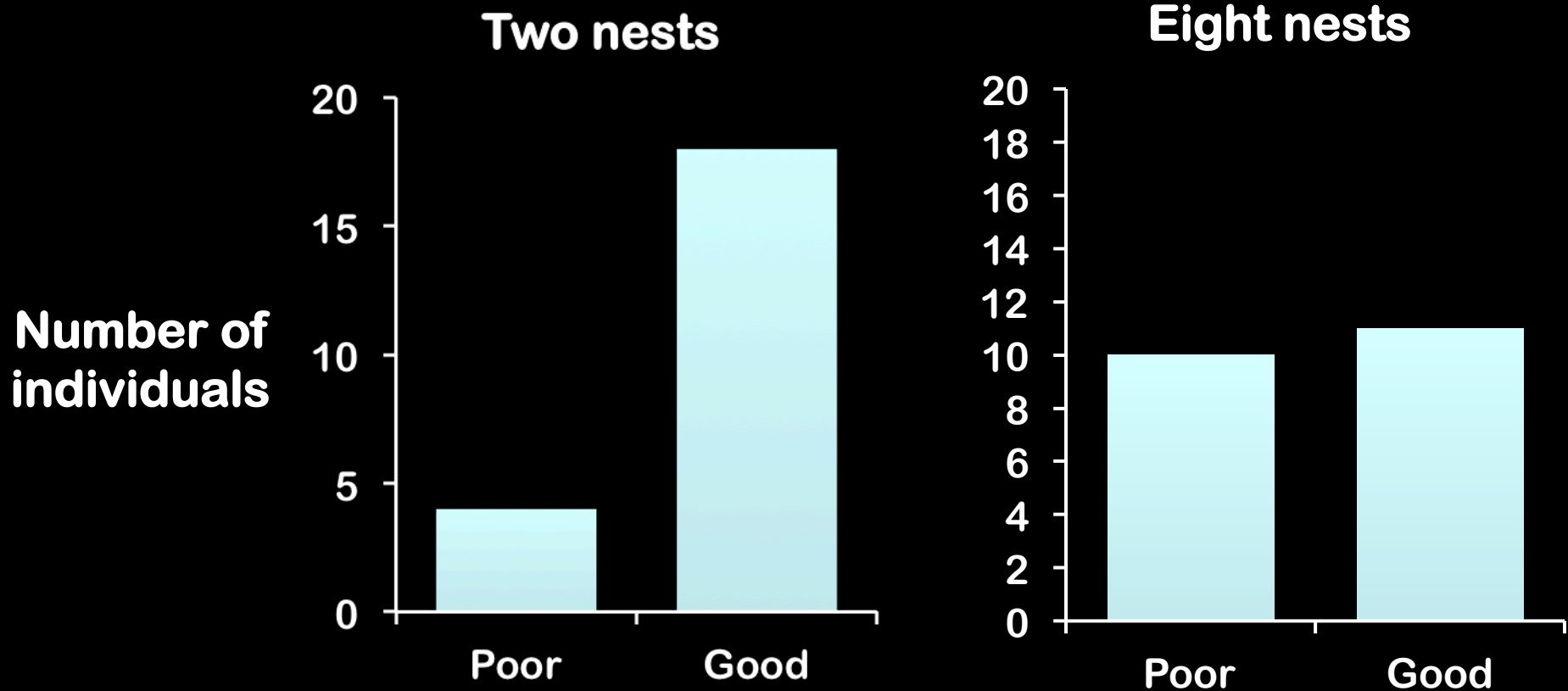
Does a colony have a greater cognitive capacity than a single ant?



Two treatments: Subjects choose between either two nests or eight nests



Individual ants experience cognitive overload



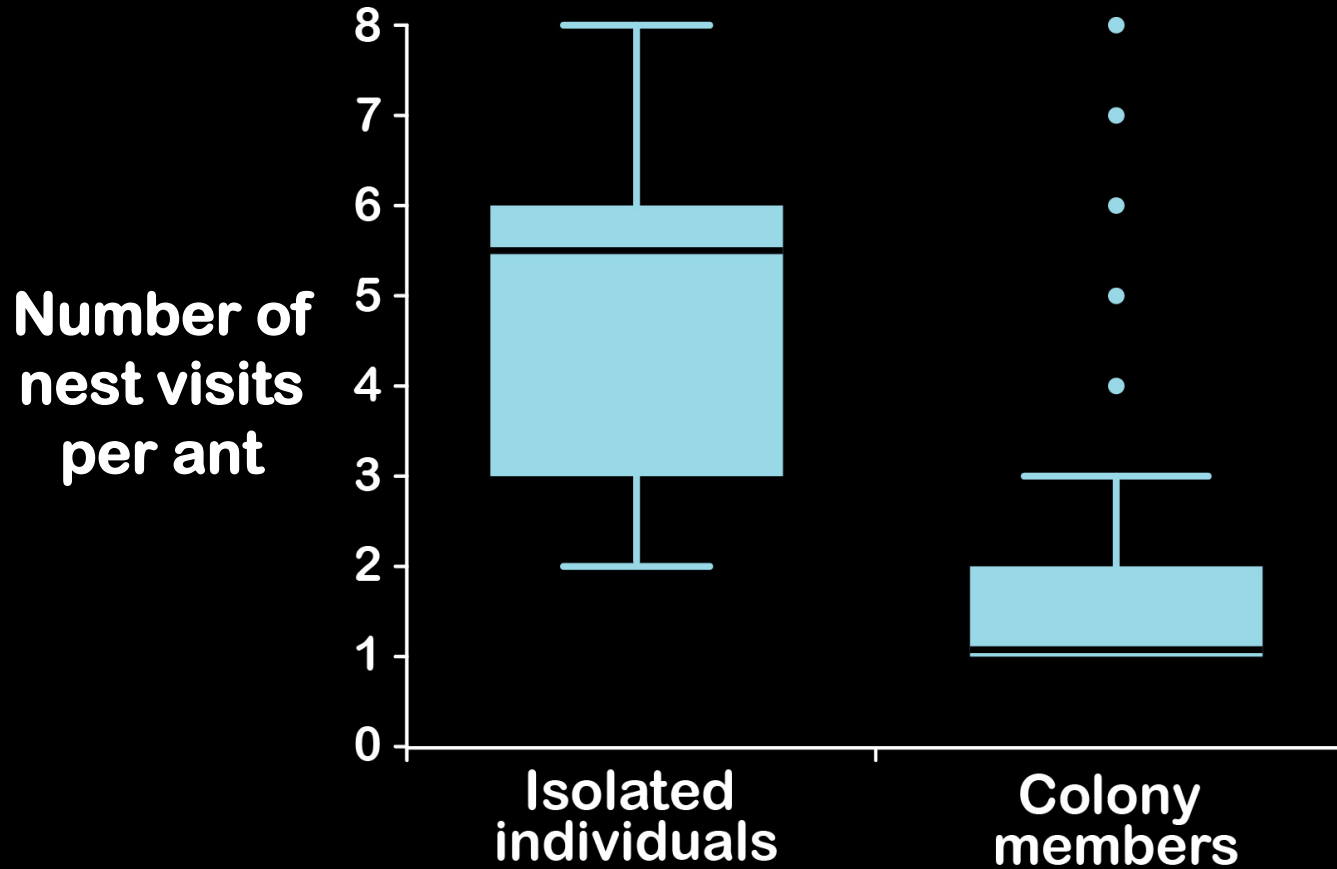
$$\chi^2 = 4.2, N = 43, df = 1, p = 0.04$$

Colonies do not experience cognitive overload



$$\chi^2 = 0.36, N = 40, df = 1, p = 0.55$$

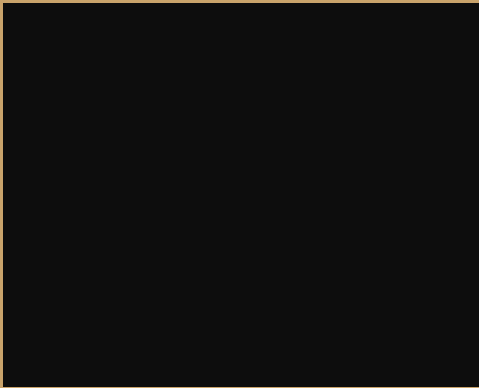
Lone ants visit more nests



Do colonies make more precise discriminations than individuals?



Which square is darker?

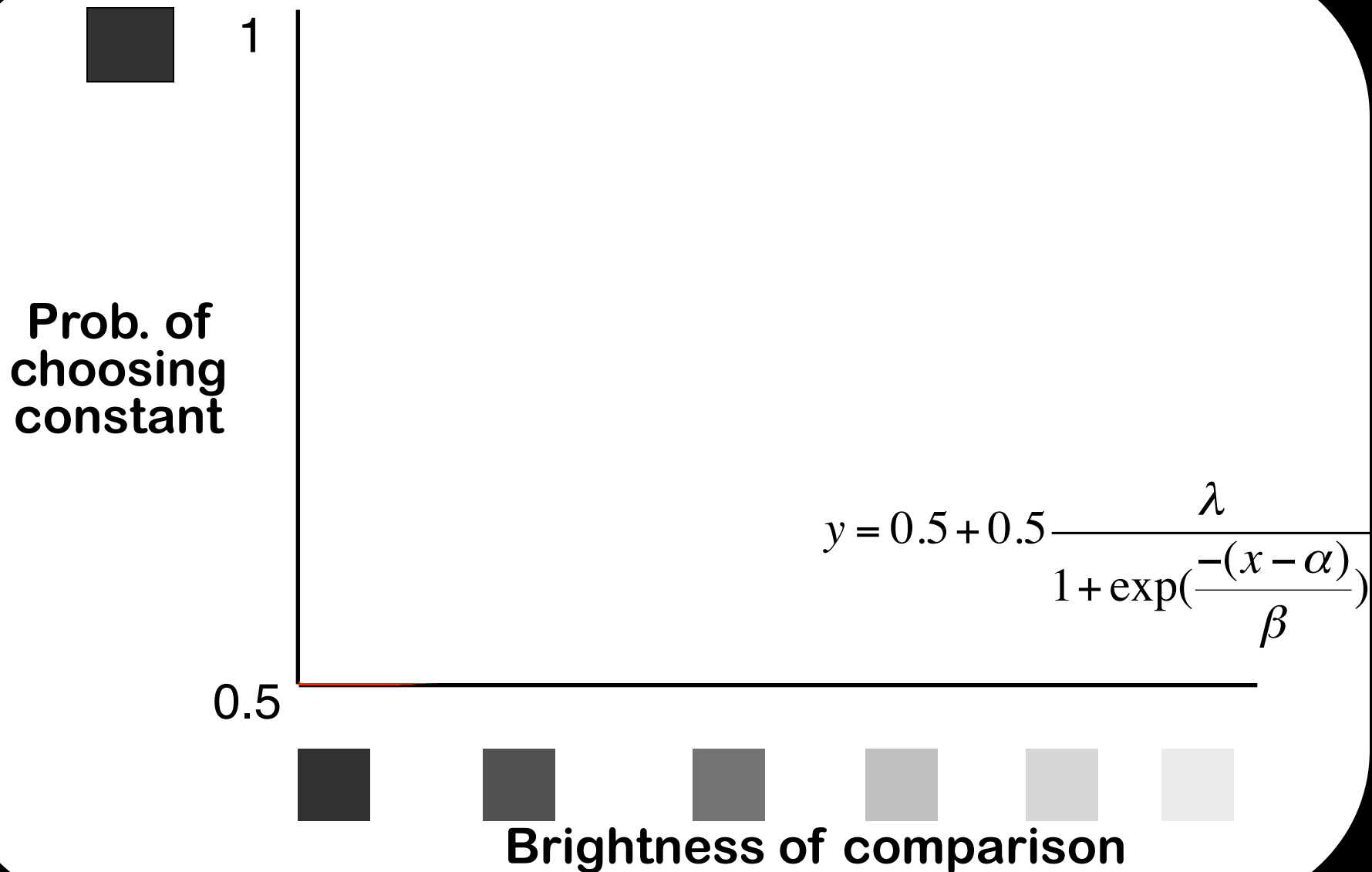


Constant

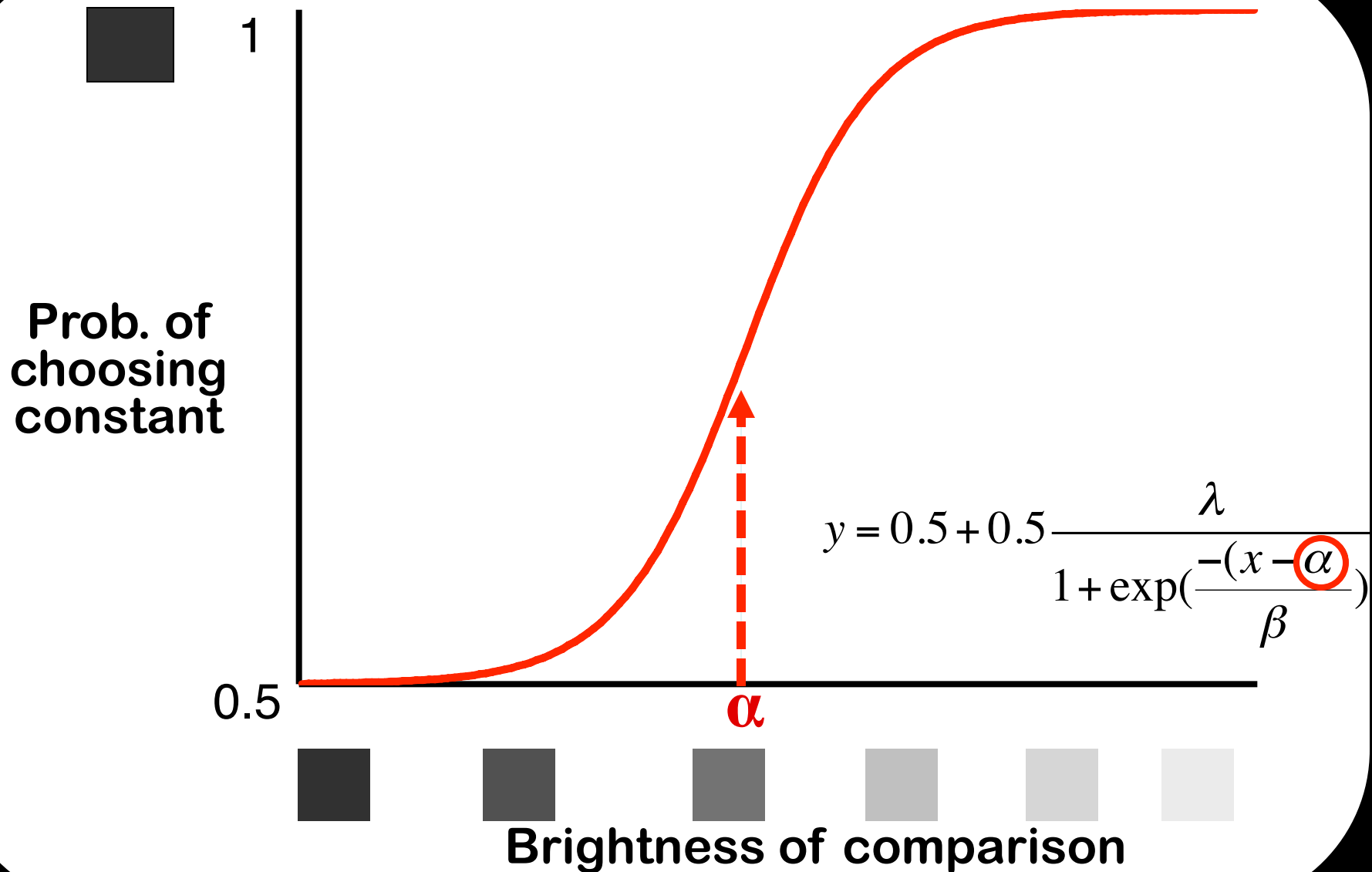


Comparison

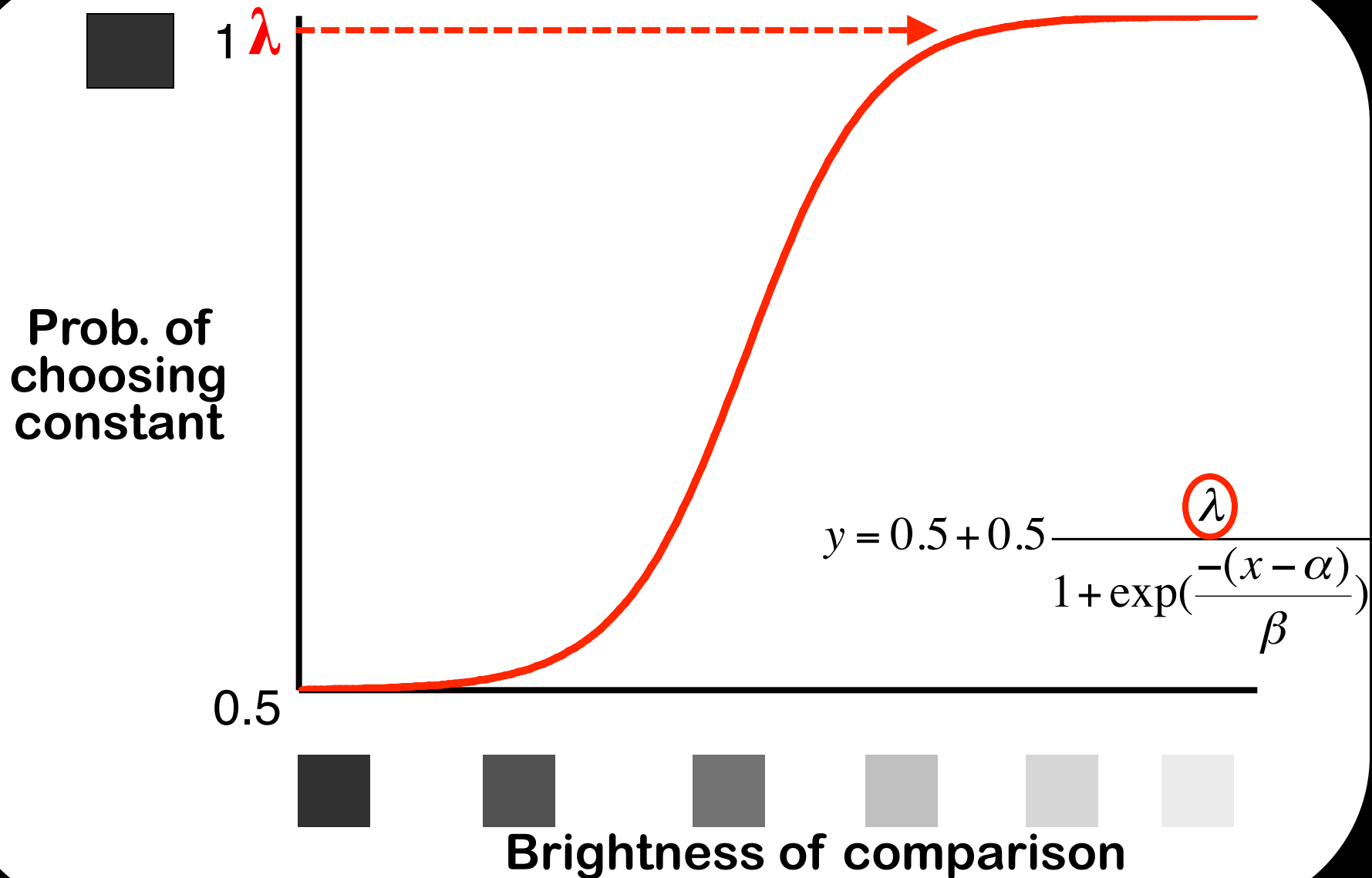
Plotting a psychophysical function



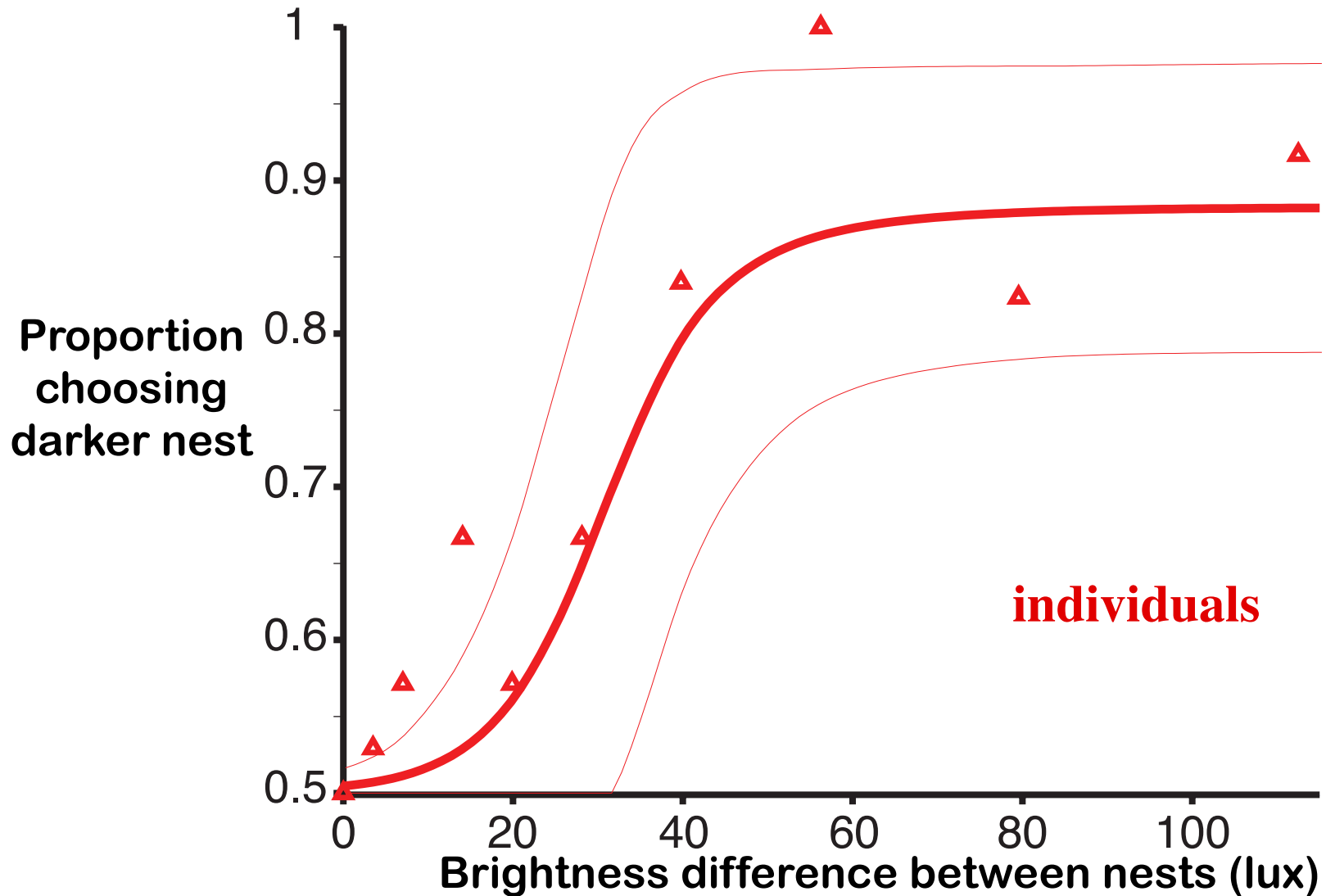
α = Detection point



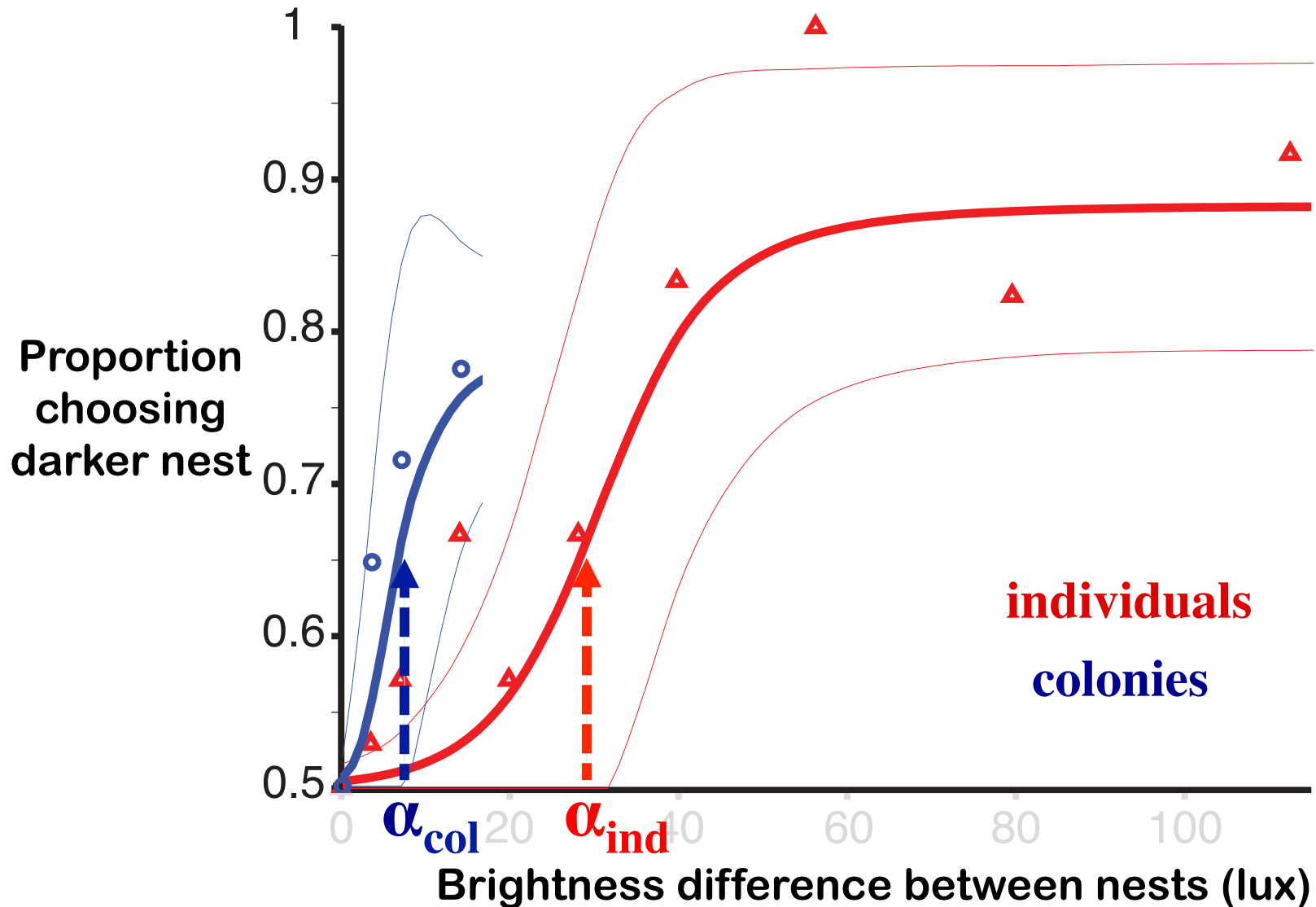
λ = Maximum accuracy



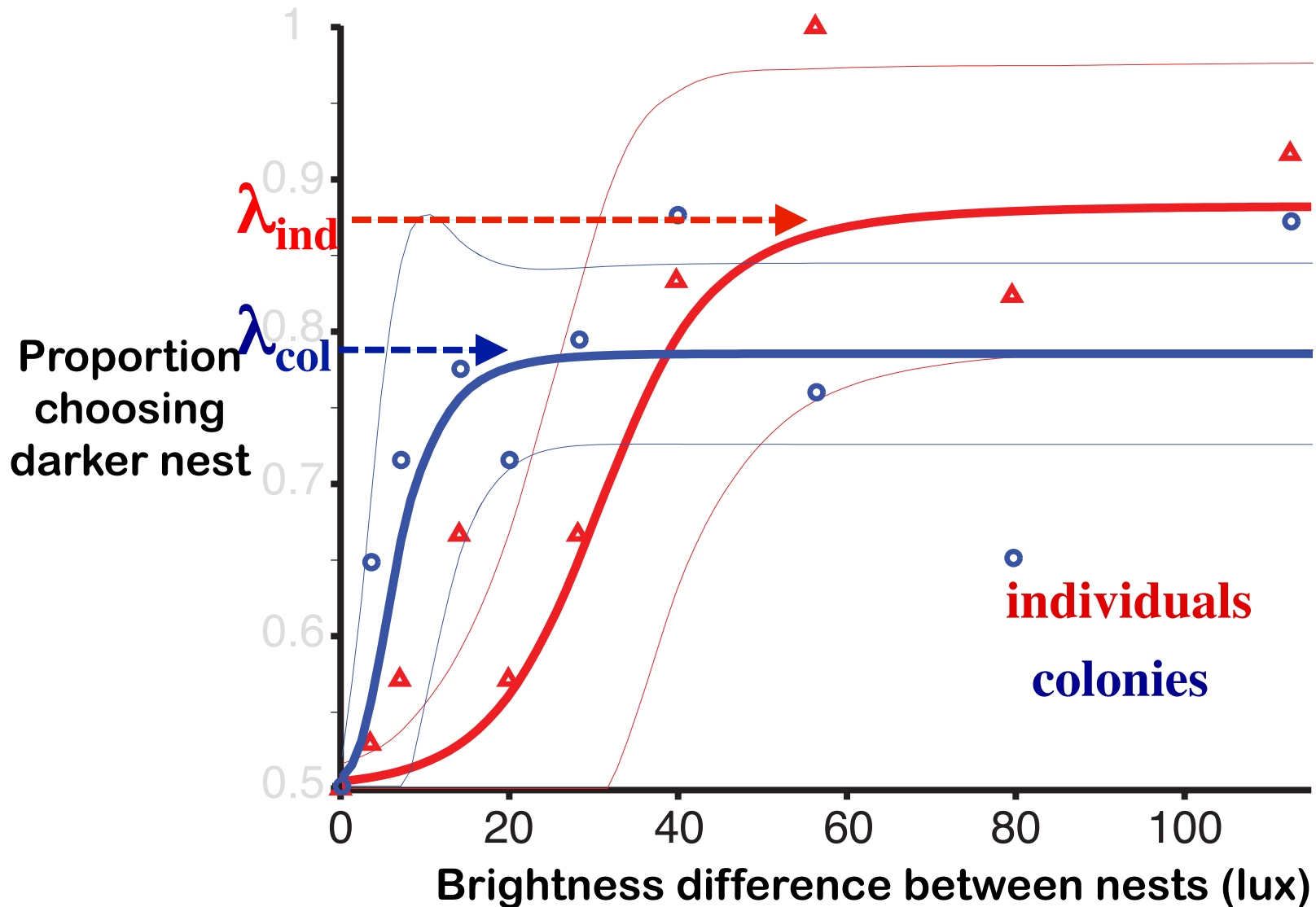
Performance of individual ants improves as difference increases



For small differences, performance of colonies exceeds that of individuals



But for large differences individuals outperform colonies



Probability
of choosing
good nest

Personal
information

Social
information
(quorum)

$$h_A(i) = q_A + c \frac{N_A^2}{N_A^2 + T^2}$$

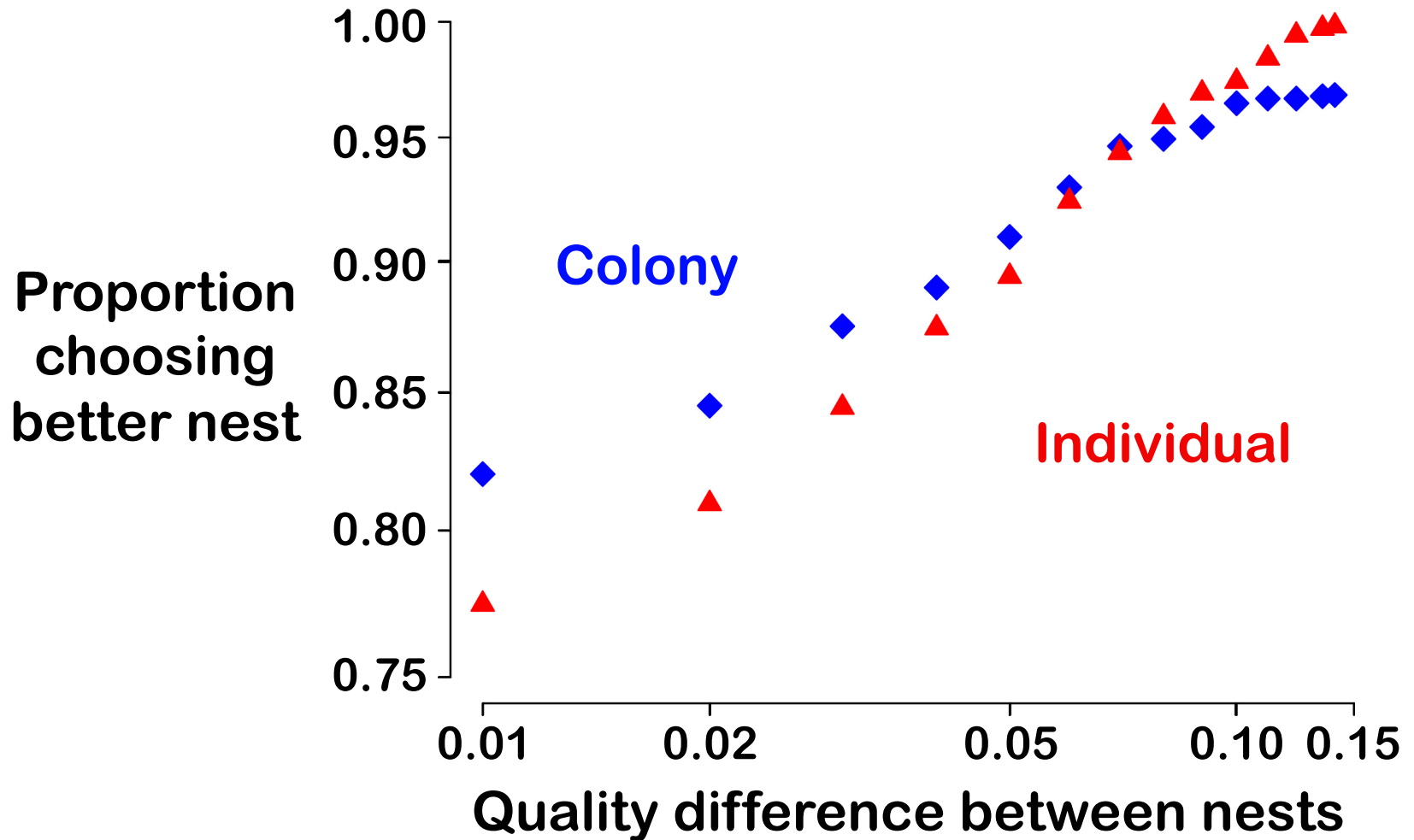
Probability of
choosing
mediocre nest

Personal
information

Social
information
(quorum)

$$h_B(i) = q_B \left(\frac{2q_B}{q_B + q_A} \right)^i + c \frac{N_B^2}{N_B^2 + T^2}$$

Model predicts switch between group and individual advantage



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