

# Using Experience to Promote the Emergence of Leaders and Followers

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## 1 Introduction

- Performance improves when individuals in large groups differentiate into roles [2]
- How individuals differentiate is an area of intense study
- Personality is understood to play a role
- For example, in collective movements:
  - **Bold** individuals generally **lead**
  - **Shy** individuals generally **follow**



- Experience also influences behavior [3]
- What if experience is the only way?
- Artificial systems (e.g., robot teams) are initially identical
- Can distinct leaders and followers emerge using experience alone?

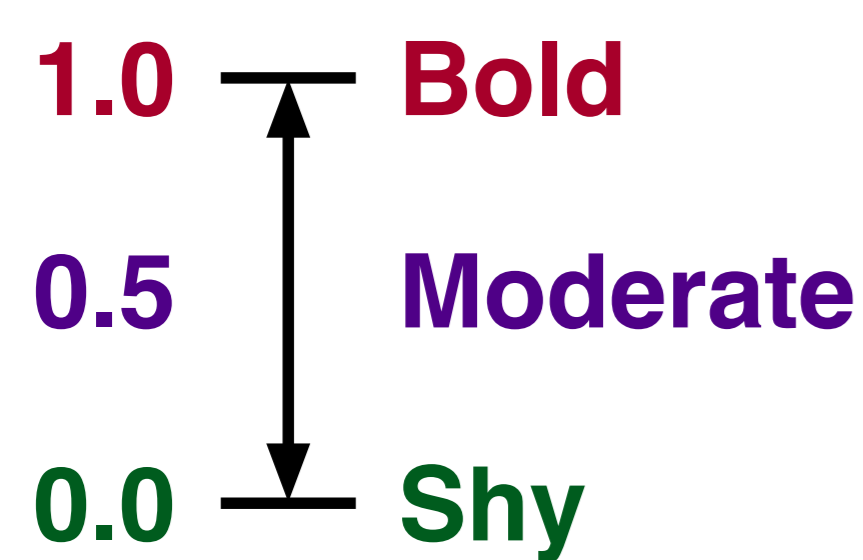
## 2 Materials and Methods

- Modified collective movement model to include personality [4, 1]
  - **Bold**: ↑ Initiate, ↓ Follow, ↓ Cancel
  - **Shy**: ↓ Initiate, ↑ Follow, ↑ Cancel
- **Moderate** personality (0.5) results in no change to model
- Leader's personality was updated after an attempted movement

$$p_{t+1} = p_t(1 - \lambda) + \lambda r \quad (1)$$

$r = 1$  for success and  $r = 0$  for failure

- Initial personality values:



## 3 Results

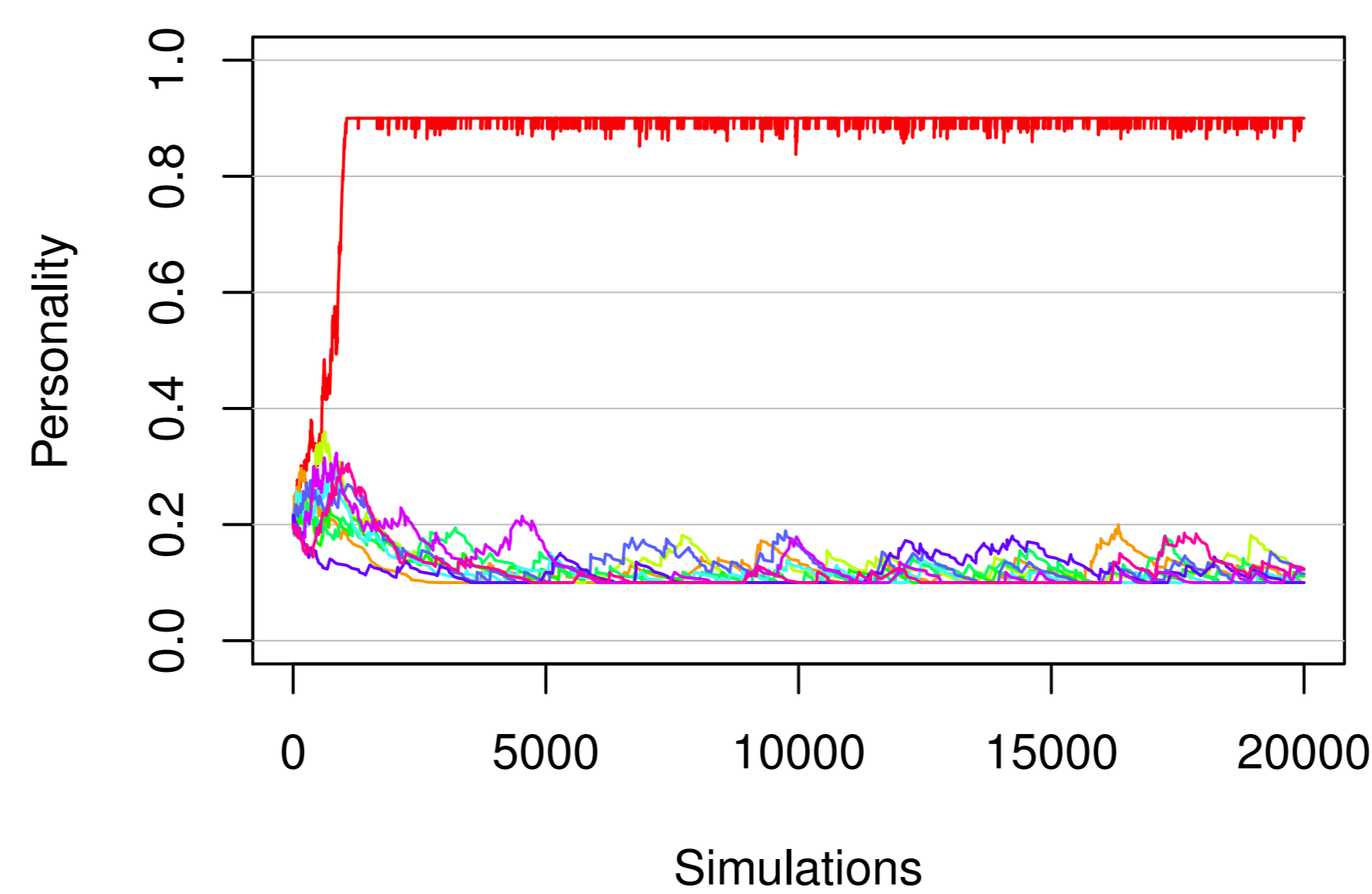


Figure 1: Fast emergence example

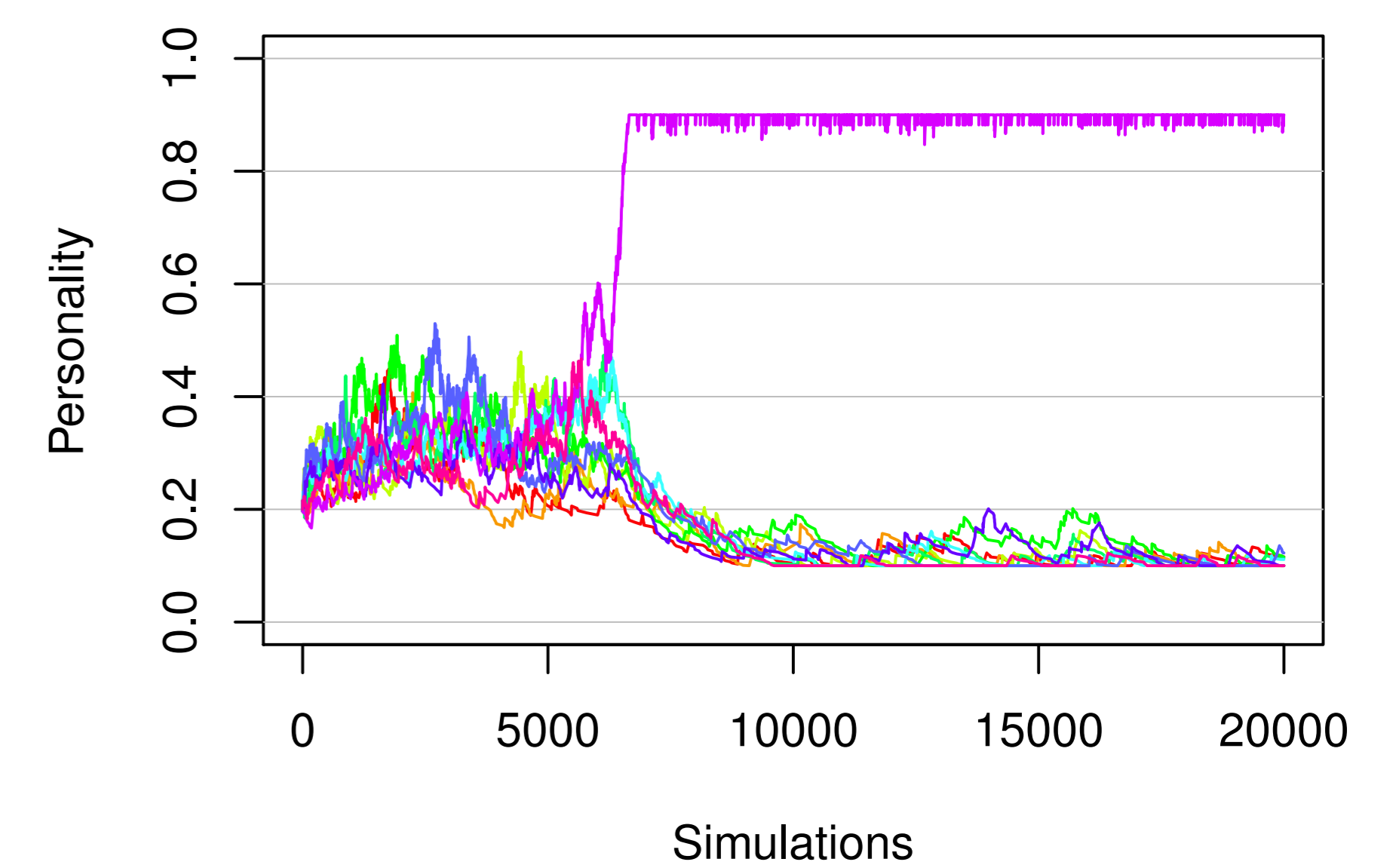


Figure 2: Slow emergence example

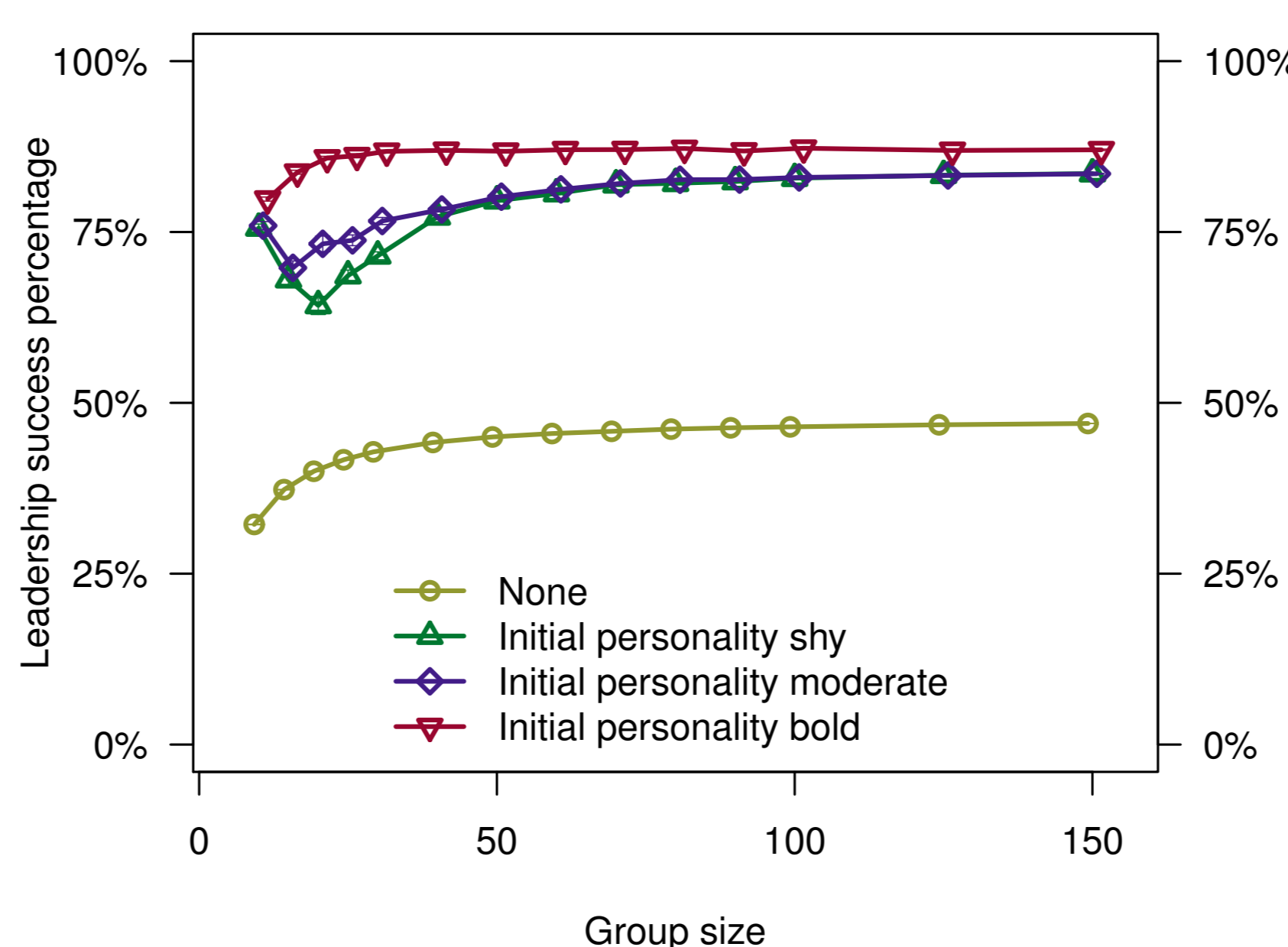


Figure 3: Mean leadership success

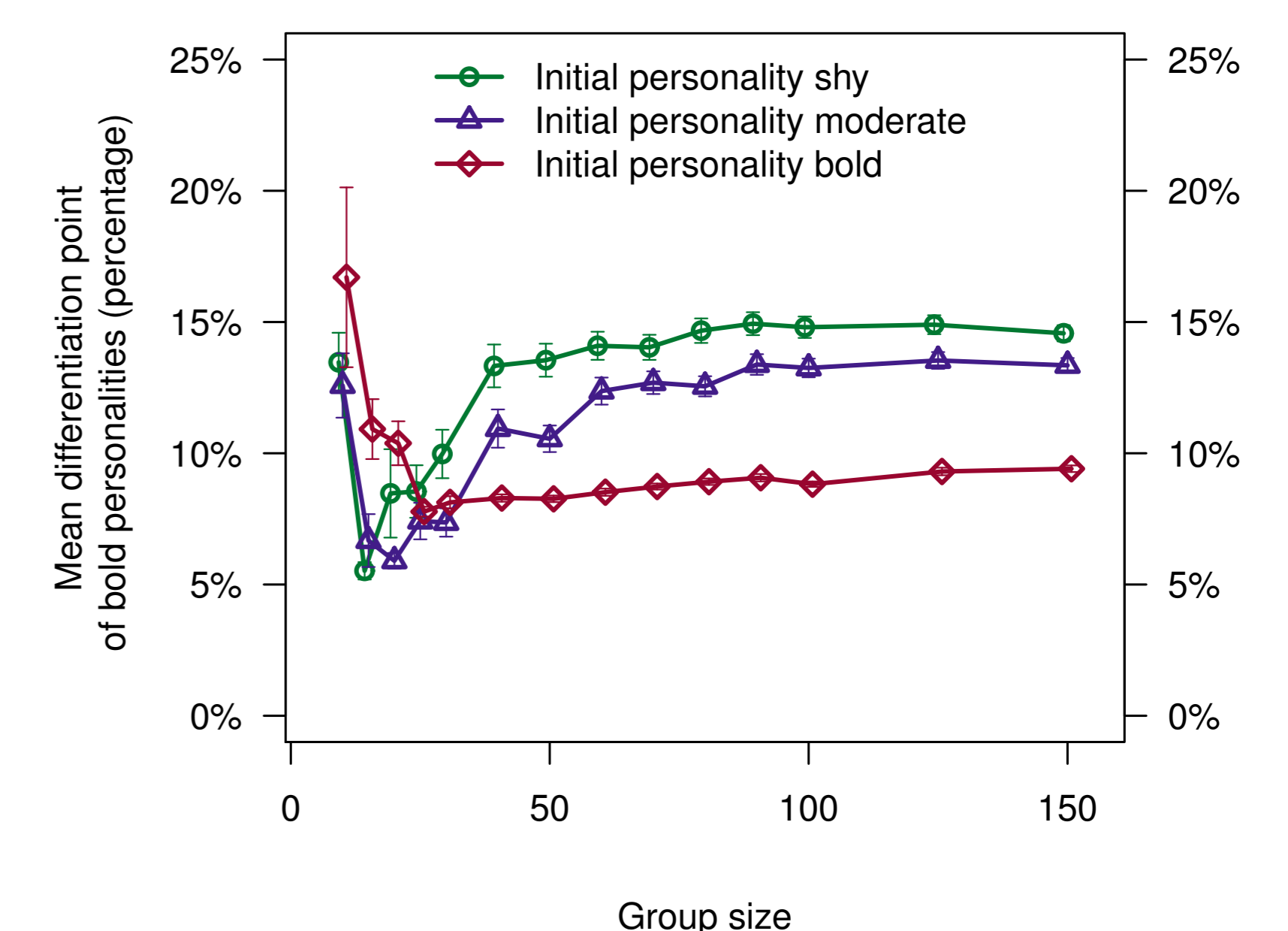


Figure 4: Mean emergence time

## 4 Discussion

- Experience alone promoted emergence of distinct personalities
- Small percentage of bold leaders with remaining individuals being shy
- Personality simulations had greater success (KS test,  $p \ll 0.0001$ )
- Initial **bold** personality simulations outperformed **moderate** and **shy**
- Simulations with fixed personalities (e.g., all **bold**) did not change success
- Emergence of distinct personalities is key!

- Distinct personalities were stable after emergence
- Number of simulations required for emergence is group size-dependent
- But, overall percentage of total simulations is consistent for groups larger than 50
- Faster distinct personality type emergence leads to higher overall success
- $\lambda$  can be used to tune, but
- Appears that initial personality has an effect on emergence time

## References

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