Neurocomputational modeling of leadership in delegation decisions

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Abstract

Despite growing interest in understanding human decision-making dynamics in social contexts, its relationship with leadership traits and their underlying neural computations remains poorly characterized. Systematic parameterization of social actions is essential for categorizing leadership styles and explaining individual variability. Here we investigated how individuals respond to decision dilemmas in authoritarian leadership contexts where they could prioritize personal gain (own-reward), team productivity (productivity), or team member wellbeing (welfare). Using a computational model, our results revealed that participants in the productivity group mainly processed each team member's competence, whereas those in the welfare group concentrated on team members' unhappiness, with these distinct processes reflected in the frontoparietal value-processing network. These findings demonstrate that individual leadership styles correspond to distinct neurocomputational processes during social decision-making.

Keywords: Leadership; Subjective valuation; Individual difference; Computational modeling

Introduction

Effective leadership critically influences group prosperity through the strategic balancing of competing priorities. Understanding the subjective valuation of such tradeoffs among different leaders is critical to illuminate individual differences in leadership styles. Traditionally, the two critical factors involving "concern for production" and "concern for people" were embodied in various leadership constructs to characterize different leadership styles (Blake & Mouton, 1964; Northouse, 2023). In this study, to account for individual differences in relative preference towards each of the three unique and compatible goals to pursue in a typical leadership decision context: maximizing team reward, protecting member welfare and securing their own reward, we designed a novel delegation task ("play-boss"), developed a computational model and examined the neural underpinnings of leadership decisions. Through this approach, we aimed to unveil 1) how different leaders attend to distinct sources of information (i.e., competence and unhappiness of the team members) and track them to guide their delegation decisions and 2) how they respond to the task outcome and complaints from other members, providing insights into the evolving expectations regarding this information. We expected that the distinct types of feedback including the team reward and others' unhappiness would be differentially processed in the frontoparietal areas depending on one's preference (Dixon & Christoff, 2012; Chong et al., 2017) but additionally recruit different regions involved in social cognition (Sescousse et al., 2013).

Methods

Task design In our task, participants (N = 62) acted as a boss and either chose to complete their job (a two-armed bandit task) themselves or to delegate it to one of three team members on each trial (delegation phase in Fig. 1). The session was divided into five blocks of trials, with one of the four team members designated as a competent member for each block. This competent member was more likely to succeed, thereby increasing the chance of receiving a team reward. Regardless of their delegation decisions, the leaders received three types of feedback: 1) whether the individual reward was earned, 2) whether the team reward was earned and 3) information on how many members were currently unhappy with the task delegation (feedback phase in Fig. 1). Delegating the work guaranteed the individual reward for the leader regardless of the task outcome, but the team reward was only secured if the task outcome was successful. Lastly, participants were asked to predict the most competent and the unhappiest member in the team for one third of the trials (query phase in Fig. 1). All other members were computerized agents believed to be humans.

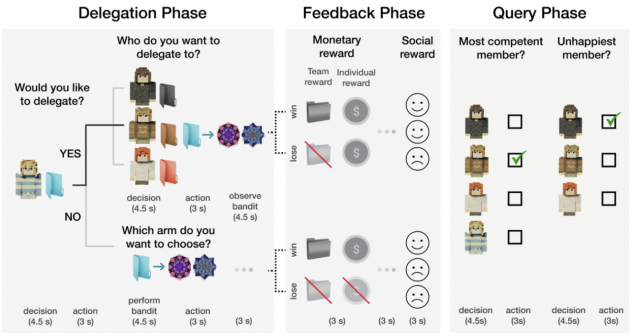

Figure 1: A schematic illustration of the "playboss" task

Computational model Our computational model was designed to capture the relative emphasis on each of the objectives for each participant, including the expected value of competence and unhappiness of each member as well as the expected reward probability. Individual preferences for each goal were quantified using two separate parameters: θ capturing the relative importance of the team production over welfare and ω indicating the degree of emphasis on the expected own reward when making the delegation decisions. The production and welfare components weighted by θ determined the team management utility value of our model. This utility value was, in turn, combined with the own reward component weighted by ω in order to compute the expected value of delegation. The parameters optimized to predict the actual delegation decisions were then used to categorize each participant's leadership trait.

fMRI data analysis We conducted an inter-trial representational similarity analysis (RSA) for each parcel and subject, computing correlations between the multivoxel patterns in each parcel and each of the two information (competence and unhappiness) and feedback (team reward and social) models in our task.

Figure 2: Computational modeling of behavioral data. The left panel shows the three distinct groups with different emphasis on each of the three objectives. The right panel visualizes the actual delegation responses of the representative participants from the productivity and welfare groups, showing completely different patterns of delegation decisions.

Results

We categorized the leadership style of each participant based on our computational model parameters (Fig. 2). The optimal solution of the k-means clustering proposed three clusters, each of which represents a distinct leadership style preferring each unique strategy: the productivity-focused (high θ and low ω), welfare-focused (low θ and low ω) and own reward-focused groups (low θ and high ω).

The RSA correlation map obtained for each participant and model was statistically tested for interaction effects: if the productivity-focused group specifically monitors the competence and reward information in contrast to the welfare-focused group only attending to the unhappiness and social feedback. We found significant interaction effects in both query and feedback phases in IPL (F=3.97, p=.049; F=7.48, p=.008) and dACC (F=5.63, p=.02; F=3.63, p=.06). IPFC also exhibited similar trends but they did not reach significance (Fig. 3B). These results illuminate the role of frontoparietal value-processing regions in flexibly representing distinct information depending on one's leadership style. Moreover, we found significant model effects in STS (F=7.74, p=.006) responding more consistently to social feedback in the welfare-focused group, potentially reflecting an empathetic response to unhappy members in the team.

Conclusion

Taken together, we identified the computational processes behind the delegation decisions which characterized the distinct patterns of behavioral responses and neural activity across different leaders. Our results suggest the frontoparietal network as a central hub of subjective value-processing, flexibly forming expectations regarding the delegation utility depending on information an individual is attending to (see Figure 3A). The productivity and welfare focused leadership styles characterized in our parameter space and their distinct neural processes shed light on the traditional leadership constructs. Our study provides a stepping stone towards understanding the neural mechanism of leadership decisions based on how different leaders approach potential dilemmas and their underlying reasoning behind subjective valuations.

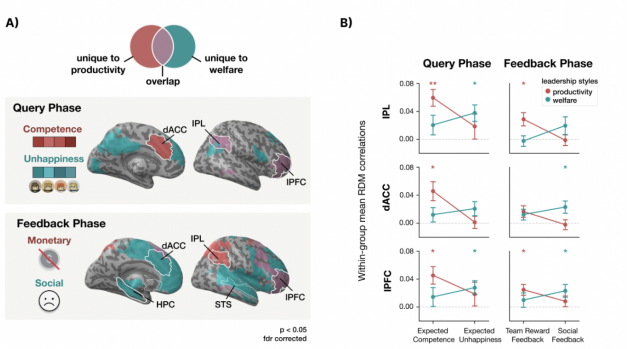

Figure 3: A) Neural representations of leadership-specific decision variables, showing differential processing across leadership styles. B) Interaction effects between leadership styles (productivity vs. welfare) and information type (competence vs. unhappiness and team reward vs. social feedback) in frontoparietal regions.

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