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Ascribing Leadership for Solving Coordination Problems with Asymmetric Information

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Abstract

Coordination problems can be solved by designating a leader whose decisions others follow. However, this solution creates a second-order coordination problem: who should lead and who should follow? We investigate the decision to follow in coordination games where one player has supplementary information about which strategy yields which payoff. We varied whether this information was relevant for maximizing benefits and whether players' interests were fully aligned. Participants chose to adopt the follower role when their partner had relevant information and their interests were aligned. Asymmetric information further served as a focal point for coordinating on who should lead even when the supplementary knowledge was irrelevant to payoff maximization, with knowledgeable individuals emerging as leaders. Surprisingly, participants chose to follow even when their informed partner could potentially use their private information to the follower's detriment.

Keywords: leader-follower; decision-making; coordination; information; asymmetry; Schelling salience

Introduction

Higher social status is often associated with increased fitness, access to valuable resources, and mating opportunities (Cowlshaw & Dunbar, 1991). Hence, the reasons why individuals voluntarily (i.e., without coercion) accept lower social hierarchical positions have been of interest to researchers from distinct fields (Bastardoz & Van Vugt, 2019; Henrich & Gil-White, 2001; Maner, 2017; McClanahan et al., 2022). In this study, we investigate voluntary deference as a strategy within social interactions, in which an individual's desired outcome is contingent on the interdependence between their partners' and their own actions (King et al., 2009; Price & Van Vugt, 2014; Smith et al., 2016), or a coordination problem.

A fundamental feature of coordination problems is the existence of multiple strategies that can yield successful coordination, making it difficult for individuals to determine which strategy to adopt (i.e., the Nash equilibrium selection problem). Nevertheless, solutions to coordination problems typically arise when a single strategy is salient to all agents involved in the interaction (Schelling, 1960). Leadership ascription, however, offers an alternative solution that bypasses the need to solve this selection problem directly (King et al., 2009; Price & Van Vugt, 2014).

A leader-follower dynamic entails a sequential disclosure of decisions or actions between individuals in which one individual's action reveals information to another, who subsequently acts accordingly (Cooper et al., 1990; Muller et al., 2003; Rapoport, 1997). When individuals coordinate on who should lead, the leader's choice determines the best

response for followers, thereby resolving the original coordination problem (King et al., 2009; Price & Van Vugt, 2014). Hence, once disclosed, the leader's decision provides followers with the information needed to identify their optimal strategy (Cooper et al., 1990; Muller et al., 2003; Rapoport, 1997). However, leader-follower solutions to coordination create a second-order coordination problem. Namely, the issue of deciding who should lead and who should follow.

Research on leader-follower dynamics has identified several factors that influence the emergence of leadership, including personality traits and leadership styles (Hemshorn de Sanchez et al., 2022; Kim et al., 2020). However, less empirical work has examined the decision to follow as a strategic choice made in anticipation of others' decisions and their consequences for oneself (Oc et al., 2023). We hypothesize that asymmetric information plays a crucial role in driving leadership ascription. More precisely, when one individual possesses information relevant to coordination that the other lacks, this asymmetry may serve as a focal point for resolving the second-order coordination problem (i.e., leadership ascription).

We conducted a dyadic card-matching experiment to address four questions: (1) Do individuals use leader-follower dynamics to achieve coordination when information is asymmetrically distributed? (2) Do individuals correctly identify situations where following is advantageous versus disadvantageous? (3) Are there other motivations that influence decisions to lead or follow? (4) Does information asymmetry serve to identify a focal point for coordinating on leadership ascription?

Our dependent variable is the decision to follow, that is, to ascribe leadership to the other player. Moreover, we manipulate several independent variables: (a) whether information is asymmetrically distributed or shared by both players, and whether asymmetric information is relevant or irrelevant for identifying the payoff-maximizing strategy; (b) whether players' interests are fully aligned (both prefer the same equilibrium) or partially aligned (each prefers a different equilibrium but both prefer coordination over miscoordination); and (c) whether players must coordinate on leadership ascription or whether one player can unilaterally assign leadership roles.

Method

To determine the minimum required sample size, an a priori power analysis was conducted using G*Power version

3.1.9.6 (Faul et al., 2007). We were unable to identify a satisfactory prior work with a comparable paradigm from which an effect size could have been estimated. Therefore, a medium effect size was used for the sample size calculation as a moderate estimation. The result indicated that a chi-square goodness-of-fit test required a sample size of $N = 52$ to achieve 95% power for detecting a medium effect ($w = .5$) at a significance level of $\alpha = .05$.

Using an online participant database (Sona Systems, www.sona-systems.com), we recruited 104 participants ($F = 69$), with an average age of 25.15 years. Participants were previously informed that compensation would be based on their performance during the experiment. Participants were compensated for their participation based on the number of coins collected during the experiment (€0.25 per coin), with a minimum compensation of 5 euros. Players were matched into dyads from the same recruitment pool and were not known to each other prior to the study (self-reported).

Study Design

Each participant received two cards of distinct colors (e.g., red and green) and attempted to match their partner's chosen color without communicating with their partner. Successful coordination (matching colors) earned both players a specified number of plastic coins. Paired participants played 10 rounds involving three types of coordination problems (Table 1). In the Pure Coordination game (PC), players are indifferent about which equilibrium to coordinate upon (Figure 1, left). In the High-Low game (HL), one equilibrium is payoff-dominant for both players (Figure 2, left). In the Bach-Stravinsky game (BS), each player prefers coordination at a different equilibrium (Figure 3, left).

Table 1. Sequence of rounds played by participants. Game type (PC = Pure Coordination, HL = High-Low, BS = Bach-Stravinsky), knowledge condition (FK = Full Knowledge, AK = Asymmetric Knowledge), decision structure (S = Simultaneous, LF = Leader-Follower coordination, LFD = Leader-Follower Dictator), and which player has private information are specified for each round.

Sequence of Rounds				
Round	Information	Game	Pre-game	Knowledgeable
1	FK	PC	S	x
2	FK	HL	S	x
3	AK	PC	S	p1
4	FK	HL	LF	x
5	FK	PC	LF	x
6	AK	PC	LF	p1
7	AK	HL	LFD	p1
8	AK	HL	LFD	p2
9	AK	BS	LFD	p1
10	AK	BS	LFD	p2

Furthermore, rounds varied in knowledge conditions. In Full Knowledge (FK), both players knew which color yielded which distribution of rewards. In Asymmetric Knowledge (AK), only one player knew which color corresponded to which equilibrium.

Rounds also varied in decision structure. In Simultaneous rounds (S), players chose their color cards simultaneously. In certain rounds, players were able to designate a leader by selecting one player to choose the color card first, with the second player seeing the first player's choice before deciding. Leadership assignment occurred either unilaterally by Player 2 (LFD, Leader-Follower Dictator) or through coordination (LF). In the LF condition, both players simultaneously indicated who should lead; if they agreed on the leadership ascription, the assigned leader chose the colored card first; if they disagreed, they reverted to simultaneous choice.

Payoff Structure

Sequential decision-making with information disclosure in the LF and LFD rounds creates a new game structure. Under the assumption that players are rational payoff maximizers with common knowledge of rationality, the leader-follower game can be characterized with payoff matrices that depend on the initial game played. For instance, if the initial game is a PC game, players should be indifferent between leading and following (under rational-choice assumptions). However, they benefit from coordinating on complementary roles (Figure 1, right), which ensures that either color chosen by the leader will be subsequently matched by the follower.

		Player 1				Player 1	
		Green	Red			Lead	Follow
Player 2	Green	1	0	Lead		0.5	1
	Red	0	1			0.5	1
?	Green	1	0	Follow		1	0.5
	Red	0	1			1	0.5

Figure 1. Left: Pure Coordination payoff matrix. Right: Corresponding leader-follower payoff matrix (P2 uninformed).

When the initial game is an HL game under information asymmetry, the uninformed player should prefer to follow the informed player. In contrast, the informed player should prefer to lead (Figure 2, right). In case of miscoordination, an uninformed player will have a 50% probability of choosing the payoff-dominant color, and their expected payoff can be represented as half of the value of the highest payoff.

		Player 1				Player 1	
		Green	Red			Lead	Follow
Player 2	Green	5	0	Lead	2.5	3	
	Red	0	1		Follow	5	2.5
?		0	1				

Figure 2. Left: High-Low payoff matrix. Right: Corresponding leader-follower payoff matrix (P2 uninformed).

If the initial game is the BS game, rational choice analysis predicts that an uninformed player who can unilaterally assign roles should prefer to lead. By leading and making an uninformed, random choice of color, they have a 50% chance of selecting the color that yields the best payoff for themselves, thereby coordinating on their preferred equilibrium. If they follow, the informed player will predictably choose their own preferred equilibrium, leaving the follower with the inferior payoff (Figure 3, right). In case of miscoordination in this scenario, under a rational choice assumption, the informed player will select the best payoff for themselves, and the uninformed player will, with a 50% chance, select the color that matches the informed player's selection.

		Player 1				Player 1	
		Green	Red			Lead	Follow
Player 2	Green	1	0	Lead	2.5	3	
	Red	0	5		0.5	3	
?		0	1	Follow	5	2.5	
		0	1		1	0.5	

Figure 3. Left: Bach-Stravinsky payoff matrix. Right: Corresponding leader-follower payoff matrix (P2 uninformed).

Across all sessions, we used the same sequence of 10 rounds to gradually introduce participants to more complex game rules and increasing structural complexity within the game.

Procedure

Participants waited in separate rooms until they were simultaneously invited to enter the experimental room and choose seats at a table. The participant who chose the right-side chair was assigned the role of Player 2 throughout the session (this information was not disclosed to the participants). Each player received two colored cards and was informed they would play an unspecified number of rounds with the goal of collecting coins.

Both players were informed that, in each round, they could collect a number of coins from the left or right side of the table upon successful coordination (i.e., four possible rewards were placed on the table, two for each player: golden coins in Fig. 4A). The participants were instructed

that, to coordinate successfully, they would have to select the same color card without communication. Whenever players' chosen color cards differed, no reward would be granted to either player. However, in the case of successful coordination, the reward granted in the round would depend on the color card placed in front (hereafter, Reward Cards) of each participant's possible rewards (i.e., coins).

In the first round, participants played a PC game with Full knowledge and Simultaneous decisions on the color cards (PC-FK-S). Both players were asked to choose a color card and place it face down on the table (Fig. 4B). After making their decision, the experimenter revealed the color selected by each player and distributed the rewards (Fig. 4C). In the second round, participants played the HL game with the same FK and S conditions.



Figure 4. Round 1 - (A) Beginning of the round. (B) Players simultaneously choose the two color cards in their hands. (C) Decisions of players are revealed.

In the third round, players were introduced to the Asymmetric Knowledge Condition (AK). In this round, the experimenter placed the Reward Cards in a cardholder to make the card color visible only to P1 (Fig. 5A). Both players were informed that the game's rules remained unchanged, with the color of the Reward Cards determining the number of coins rewarded on its corresponding side in the event of successful coordination. In the third round, participants played a PC game and, once more, were asked to choose one of the two color cards in their hands and place it on the table with the color facing down (Fig. 5B). The experimenter then revealed the players' decisions and Reward Cards to both players (Fig. 5C).

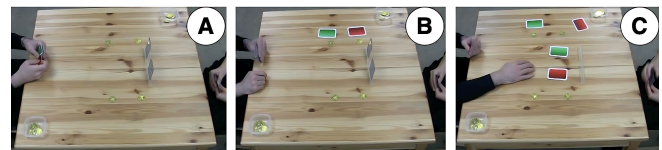


Figure 5. Round 3 - (A) Beginning of the round. The cardholder on the right allows only P1 to see the color of the Reward Cards. (B) Players simultaneously choose the two color cards in their hands. (C) Players' decisions and reward cards are revealed.

Round 4 introduced Arrow Cards for leader-follower ascription. Players were told that one of them could choose and display their color card first. Using arrow cards placed face-down, each player independently indicated who should lead (i.e., who could choose first: Figure 6A). If both arrows

pointed to the same player, that player chose and displayed their color card first (Figure 6B); if arrows pointed to different players, both chose and displayed their color card simultaneously (Figure 6C-D).

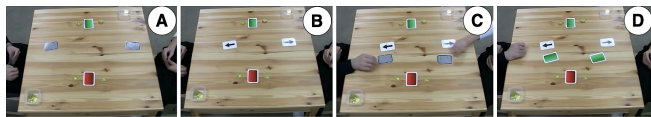


Figure 6: Round 4 - (A) Players place the arrow card on the table. (B) The arrow cards are revealed. (C) Players place their color cards on the table. (D) The color cards are revealed.

In the fifth round, participants played an LF pre-game with a PC payoff structure, in which both Reward Cards were visible to both players (FK condition). Participants received the exact instructions as in round four. In the sixth round, the previous configuration was repeated; however, the Reward Cards were now visible only to P1.

In the seventh round (and subsequent rounds), only P2 was allowed to use the arrow card to decide the first mover, thus being able to use a leader-follower strategy to solve the color coordination problem unilaterally (Leader-Follower Dictator). Thus, P2 could decide alone who should choose the color card first by either placing the arrow towards themselves or toward the other player (Fig. 7A). Participants played an HL game in the seventh round, where P1 had visual access to the Reward Cards. In the eighth round, participants played an HL game in which only P2 had private knowledge of the Reward Cards. In the ninth round, participants played a BS game in which only P1 had visual access to the Reward Cards. The same condition was repeated in Round 10, with P2 as the knowledge player.

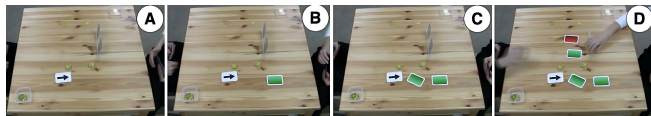


Figure 7: Round 7 - (A) Player 2 places their Arrow Card on the table, facing up. (B) Player 1 places their color card face up on the table. (C) Player 2 places their color card on the table. (D) Reward Cards are revealed.

Results

The study sample comprised 52 dyads (104 participants), of whom 66.3% were female, and 31.7% were male. The average age of participants was 25.15 years (*SD* = 5.08). Average monetary compensation was €6.81 (*SD* = 0.86) for Player 1 and €6.77 (*SD* = 0.78) for Player 2 (Figure 8), with no meaningful difference by gender (females: *M* = €6.79, *SD* = 0.83; males: *M* = €6.80, *SD* = 0.82). Full descriptive statistics (e.g., dyad composition, age distributions) are available in the open data report (Silva & Heintz, 2023;

<https://osf.io/nyqrk/files/osfstorage/69faf5b70613e6e18adf8211>). Hypotheses were pre-registered on OSF, addressing Strategic Followership, Schelling Salience, and Other-regarding Preferences (Silva & Heintz, 2023, <https://osf.io/9576d>).

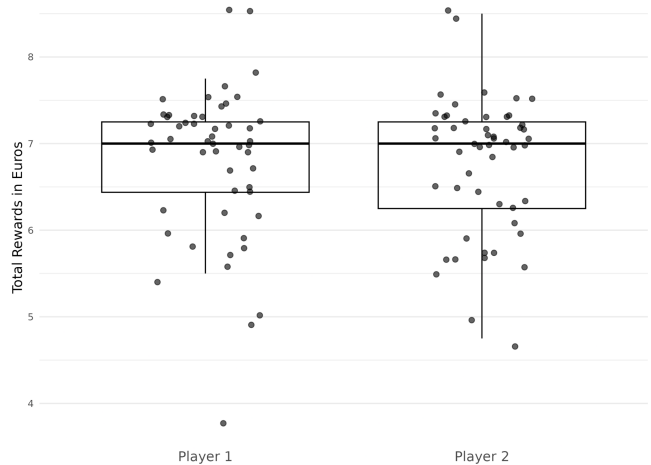


Figure 8. Box plot x-axis: player 1 and player 2. Y-axis: total compensation of players.

As shown in Figure 9, coordination success was markedly higher in rounds with a pre-game leader–follower structure (LF and LFD) relative to the rounds played without a leader-follower pre-game, consistent with the prediction that providing an unambiguous leadership signal reduces the strategic uncertainty that drives miscoordination, especially on Pure Coordination games (e.g., Round 1 success rate is 44%, compared with 81% in Round 5).

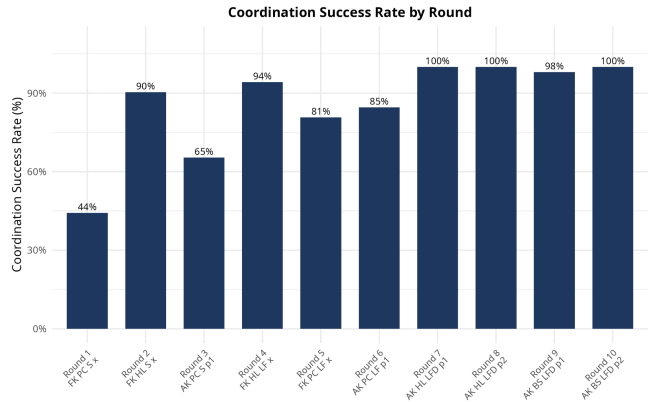


Figure 9. Bar plot with the percentage of trials per round in which coordination was successful.

Strategic Followership

We hypothesized that people recognize it is in their interest to follow those who know the best option when interests are aligned. We therefore predicted that when interests were

aligned, Player 2 would follow significantly more often when uninformed than when informed. A chi-square goodness-of-fit test confirmed significant differences between conditions, $\chi^2(1, N = 52) = 59.92, p < .001$ (Figure 10). However, Fisher's exact test found no significant difference in followership rates between the Aligned Interest condition (Round 7) and the Conflict of Interest condition (Round 9) when P1 was informed.

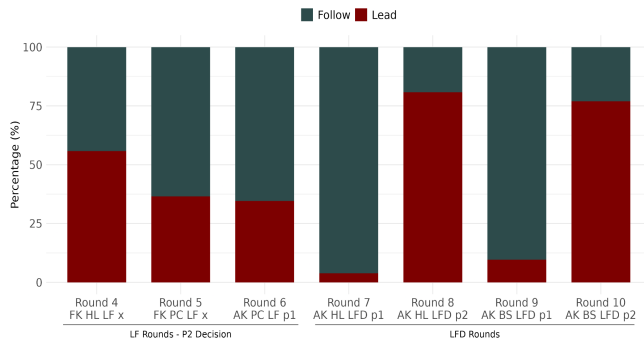


Figure 10. Player 2 Lead/Follow decision percentages across rounds 4-10. Dark teal indicates Follow, dark red indicates Lead. Rounds 4-6 (LF Rounds) show only P2 decisions.

Schelling Salience

We hypothesized that asymmetric information would be used to identify a focal point, with informed players emerging as leaders, even when the information was irrelevant for a certain payoff distribution. We predicted that when coordination on leadership roles was required, Player 2 would follow the informed partner using their private information state as a focal point. First, we tested whether Player 2's followership differed between asymmetric and full knowledge in the PC game (where private information is payoff-irrelevant). The chi-square test found no difference in the frequency of followership between Rounds 5 and 6, $\chi^2(1, N = 52) = 0, p = 1$.

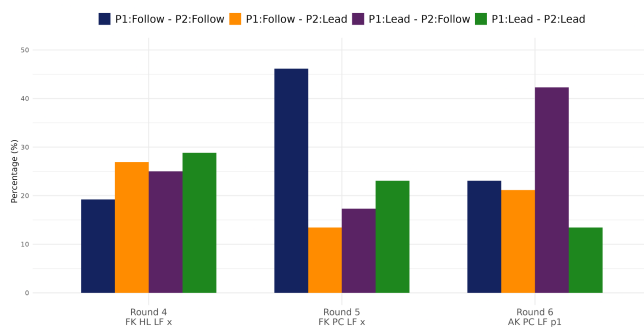


Figure 11. Percentage of Lead/Follow decision pair combinations in rounds 4-6 (LF Rounds). Each bar represents the proportion of pairs of Player 1 and Player 2's decision to follow or lead.

However, examining paired decisions (all four combinations of lead-follow choices), we found significant differences between Round 5 (FK) and Round 6 (AK), $\chi^2(3, N = 52) = 11.66, p < .01$ (Figure 11). Post-hoc analysis based on standardized residuals with Bonferroni correction showed that the P1 Lead / P2 Follow pairing deviated from expected values (Residual = $-2.79, p_{adj} = .021$). Other pairings did not differ significantly.

Other-regarding preferences

We expected people to choose to follow in the Conflict of Interest condition because of other-regarding preferences. Therefore, we conducted a binomial test on the frequency of Player 2 followership on Round 9. The binomial test indicates that in the Round 9 decisions to follow were significantly more frequent than 0% ($p < .001$).

Moreover, we tested whether Round 9 decisions or payoffs influenced Round 10 choices. A logistic regression showed that the Round 9 lead/follow decision significantly predicted Round 10 decisions ($\beta = 2.10, SE = 1.00, p = .036$). Round 9 payoff did not predict Round 10 decisions ($\beta = -0.11, SE = 0.19, p = .562$). However, Round 9 payoff significantly predicted Round 10 payoff ($\beta = -0.90, SE = 0.21, p < .001$; Figure 12).

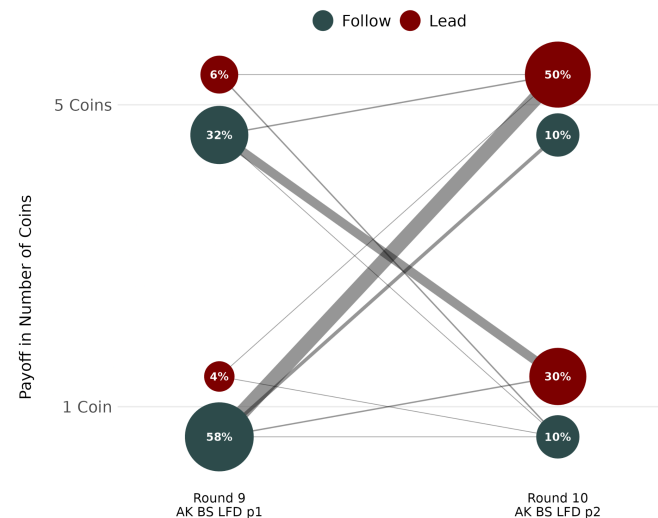


Figure 12. Transition diagram: P2's decisions and payoffs between Round 9 and Round 10. Circle size represents the proportion of participants in each decision-payoff state in each round, and line thickness is proportional to the frequency of that transition.

Discussion

Our study indicates that individuals use leader-follower dynamics to achieve coordination when information is asymmetrically distributed. The employment of leader-follower dynamics as a tool to solve coordination problems is indicated in this study by a higher coordination success in rounds with leader-follower pre-play. Moreover,

most players chose to follow their informed partner in the HL games, indicating a willingness to use sequential decision-making as a coordination device when the leader's and follower's interests are aligned. Therefore, we can infer that individuals correctly identify situations where following is advantageous, as players who lacked relevant knowledge followed their informed partner 96% of the time. However, uninformed players also decided to follow when the initial game made it advantageous for them to be the leader. We interpret such choices as expressions of politeness or expectations of reciprocity. It is possible that participants anticipated continued interactions, even though no information about future rounds was provided. People, indeed, condition current behavior on expectations of future interactions even under uncertainty (Dal Bó, 2005; Lugovsky et al., 2017; Engle-Warnick & Slonim, 2006; Anderson et al., 2024; Brookins et al., 2021). Additionally, our design's observability (by the experimenter, camera, and partner) may have prompted prosocial behavior for reputation-building beyond the game setting (Bradley et al., 2018; Milinski et al., 2002; Nowak & Sigmund, 2005).

Furthermore, our results indicate that information asymmetry may have facilitated coordination of leader-follower roles. However, when comparing Rounds 5 and 6, Player 2's rate of following did not differ, approximately 70% in both Full Knowledge and Asymmetric Knowledge conditions of the Pure Coordination game. Nevertheless, the analysis of paired decisions revealed that successful leader-follower coordination was twice as likely in the Pure Coordination game with asymmetric information than with full knowledge. Under asymmetric information, successful coordination predominantly involved knowledgeable individuals emerging as leaders (42% of dyads). This shift was driven by informed players (Player 1) moving from a preferred follower role under Full Knowledge to a leadership role under Asymmetric Knowledge. This result suggests that participants have relied on a default deference strategy when uncertain about whether to achieve coordination.

Nevertheless, the results of this experiment do not allow us to precisely infer the reasons for P2's decision to follow in the Conflict of Interest condition. Therefore, we will run a new experiment that controls for the possibility of reputation management. In particular, we will run a condition in which participants play with a different person in each round. We predict that if Player 2's behavior on Round 9 of the experiment presented here is driven by reputation management concerns and the expectation of future interactions with the same partners, then the frequency of followership choices will be significantly lower in this planned experimental condition.

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take full responsibility for the accuracy and integrity of all content.

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