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RESEARCH

The effect of social network structure on group anchoring bias

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Abstract
Decisions—whether made by individuals or groups—often involve estimating quantities, a process that is subject to anchoring bias (Tversky and Kahneman in Science 185: 1124–1131, 1974). Differences in susceptibility to anchoring bias between individuals and groups have been recently explored with the result that groups appear less biased than individuals (Meub and Proeger in Theor Decis 85:117–150, 2018). However, existing studies treat groups monolithically without taking into account their network structure—the pattern of relationships among members. The present paper investigates the effects of group social network structure on anchoring bias. Using a structured survey instrument, we gathered data on competence-based trust relationships among 264 students enrolled in a university degree program. An anchoring experiment was conducted in which some of the students made estimates as individuals, while others did so in groups of different structures. The findings provide initial evidence of differences in bias levels across variously structured groups as well as relative to individuals. Groups with highly centralized trust networks (where a single person owned everyone's trust) showed more anchoring bias than dense groups (where everyone trusted everyone else) and sparse groups (where no one trusted any other member of the group) showed more bias than dense groups. In addition, despite previous research demonstrating groups are less susceptible than individuals to anchoring bias, this study shows a higher presence of bias in both our centralized groups and sparse groups when compared to individuals, suggesting that group structure might moderate the mitigating effect of groups on anchoring bias. The research has implications for organizational behavior and social network literature. Specifically, this study contributes to the debate on anchoring bias for group decisions by highlighting the significant role of social network structure. At the same time, it contributes to the literature on network structure and performance by providing initial evidence of how network structure affects anchoring bias susceptibility. Moreover, our study contributes to management practice by alerting managers to the dangers of centralized networks, suggesting that competence-based trust plays a vital role in the resistance to anchoring bias.

Keywords Anchoring effect · Task · Team performance · Competence-based trust · Cognitive bias · Anchor

Introduction

Tversky and Kahneman (1974) showed that, when asked to estimate a quantity, people make use of an anchoring-and-adjustment heuristic in which they take a starting value and then adjust upwards or downwards as needed. Research shows that the initial value (the anchor) tends to exert a great deal of influence, and subsequent adjustments are rarely sufficient, even when the anchor is quite arbitrary. This gives rise to anchoring bias. These systematic errors not only concern individual decisions, but also involve collective ones (Whyte and Sebenius 1997; Minson and Mueller 2012; Paulus et al. 2022).

Anchoring has a strong influence on many different kinds of decisions including, but not limited to, negotiation (Galinsky and Mussweiler 2001), property pricing decisions (Northcraft and Neale 1987), bidding behavior (Wolk and Spann 2008), consumer judgment and decision-making (Wegener et al. 2010), purchase quantity decisions (Wansink et al. 1998), the perceived risk of a gamble (Slovic 1967) and self-efficacy judgments and behavior (Cervone and Peake 1986; Thorsteinson et al. 2008).

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Recently, researchers have reported that the interaction of multiple individuals in making estimation decisions mitigates bias such that groups tend to suffer less anchoring than individuals (Meub and Proeger 2018; de Wilde et al. 2018). One proposed mechanism for this is that the personal preferences of group members assume the role of additional (contradictory) anchors that become more influential in the final decision than the external one (Sniezek 1992; Whyte and Sebenius 1997). However, this mechanism may not function in the same way for all groups since they may have different internal structures and, consequently, members' preferences could have different influences; for example, a group with a dominant central person might behave more like a single individual.

Responding to the call to examine the effects of social influence on group-level anchoring (Furnham and Boo (2011) and to explore the social construction of anchoring biases in groups (de Wilde et al. 2018), in this study we consider the effect of the competence-based trust network on anchoring bias.

In fact, a network of competence-based trust (also called cognitive trust) has been shown to play a vital role in decision effectiveness (Olson et al. 2018), and, usually, members in the decision-making process who have competence-based trust in one another engage in agreement-seeking behavior (McAllister 1995; Cummings and Cross 2004; Chou et al. 2013; Parayitam and Papenhausen 2018).

Anchoring in group decision-making can be described as the aggregate of individual biases but also as the reflection of the different influences of the individuals within the group (Whyte and Sebenius 1997); hence it is reasonable to hypothesize that different structures of competence-based trust relationships would confer different power to these "social influences" and, therefore, would be subjected to the anchoring bias in different ways.

Consequently, we aim to fulfill the following objective:

- To investigate the effect of social network structure on group anchoring bias

To accomplish this objective, we designed and conducted a laboratory experiment involving differently structured groups belonging to the same organization. Being the organization based on informal relations, we considered decision-makers groups having different informal structures, specifically having a different structure of competence-based trust relations.

In this study, we combine field-based data on ongoing trust relations among members of a single organization with a laboratory experiment that examines how different patterns of trust relations among experimenter-designed groups affect anchoring bias, and how these groups compare with individual decision-makers.

This article is structured as follows. First, relevant literature is reviewed to identify gaps in research and to formulate hypotheses. Next, the methodology is described in detail with a focus on the sample, experiment, and measures. Afterwards, there is a section describing the results. The last section contains the discussion and conclusions of the research.

Group trust and performance

Research on trust at the group level provides evidence for many effects on behaviors and performance including that team members' cognitive trust in the team leader and in other team members facilitates the development of collective efficacy and enhances team performance (Chou et al. 2013); the interpersonal trust and affect-based trust have been shown to facilitate effective coordinated action in organizations (McAllister 1995) and members' trust in their leaders is critical for effective team performance because cognition-based trust directly influence team potency and indirectly (through affect-based trust) influenced team psychological safety (Schaubroeck et al. 2011).

It is widely recognized that trust network ties play a significant role in group functioning. For example, trust ties affect reciprocal services, frequency of exposure, motivation in helping each other, influence (Granovetter 1973), similarity in decisions about jobs (Kilduff 1990) and in attitudes about new technology (Rice and Aydin 1991). Avolio et al. (2004) propose that "authentic leadership" (a trust-based construct) influences followers' attitudes and behaviors through the key psychological processes of identification, hope, positive emotions, optimism, and trust. Chou et al. (2013) characterized team cognitive trust using two referents: cognitive trust in the leader and cognitive trust among team members. Empirical findings confirmed that team cognitive trust in the context of a transformational leadership process was related to proximal outcomes (collective efficacy) and distal outcomes (team performance). Competence-based trust is grounded in performance-relevant cognitions such as competence, responsibility, reliability, and dependability (McAllister 1995; Schaubroeck et al. 2011) and is positively correlated with task advice relations, i.e., channels through which it is possible to obtain resources such as information, assistance, and guidance related to the completion of their work (Chua et al. 2008).

The network structure of groups

The pattern of social ties among members of a group forms a network with a certain structure. For example, if we look at competence-based trust ties among members of a given

group, we might find the network is very dense—nearly everyone has a trust tie with nearly everyone else or it might be very sparse—potentially, there could be no ties within the group. This would have consequences for group functioning. For example, in a decision-making context, a sparse network would mean that few people would trust in the opinions of others, and more likely to retain their own counsel. In contrast, a dense network would be associated with members giving due consideration to many others' opinions. Group networks also vary in terms of centralization (Borgatti et al. 2018). A highly centralized trust network would be one in which one person was trusted by many, and no other person possessed many trust ties. In such a network, the views of the central person would tend to be given more weight than the views of others.

Social network literature shows that different structures perform differently on many occasions and that competence-based trust plays a significant role in influencing decision-making (Chua et al. 2008). We propose the following hypotheses.

Anchoring bias of dense and sparse competence-based trusted groups

When the anchor is presented at the group level, multiple different preferences (acting as anchors) can enter the discussion space: the other members' preferences tend to have a more influential effect than the external anchor (Sniezek 1992; Whyte and Sebenius 1997) mitigating the anchoring effect (de Wilde et al 2018).

The processes that explain groups' suboptimal decisions are information-driven and preference-driven processes (Stasser and Birchmeier 2003; Schulz et al. 2006). Information-driven decisions occur when individuals integrate and transfer information in a biased way. Preference-driven decisions occur when individuals within the group weigh and aggregate their preferences to make a decision.

We expect that when the density of competence-based trust ties within a group is high, group members will have more confidence in their estimates and will also have more influential preferences (acting as internally generated anchors) to consider. Both of these factors are recognized as mitigating factors of the anchoring effect at the group level (de Wilde et al. 2018).

Given the above arguments, we propose the following hypothesis.

Hypothesis 1. *Groups with a dense structure of competence-based trust relationships are less biased by anchoring than groups with a sparse network structure of competence-based trust relationships.*

Anchoring bias of individuals and groups without competence-based trust relationships

A group with few trust ties is unlikely to have confidence and reveal private, divergent views. As a result, additional anchors are neither aired nor trusted, giving the external anchor greater weight and removing the mitigating factor given by the additional anchors/preferences (Sniezek 1992; Whyte and Sebenius 1997). In addition, we would argue that the group setting relieves a certain amount of responsibility from each member, compared to a solitary individual who is asked to make an estimation decision. Hence, we expect that individuals will be more resistant to anchoring bias than null trust groups.

Hypothesis 2. *Individuals are less biased by anchoring than groups with an absence of competence-based trust relationships.*

Anchoring bias of centralized and dense competence-based trusted groups

To compare centralized and dense groups we can take as references the highest centralized group and the highest dense one. The first one would have one person with the maximum degree of centrality that we can call a "cognitive leader" and the other members of the group would be only connected with the central person, we can call these members "cognitive followers" (the cognitive followers would not have connections between each other). The highest dense group would be characterized by a perfectly connected graph of competence-based trust relationships.

In centralized groups, the dominance of the central person, whose ideas would tend to spread to the other members has a significant role in decisions (Granovetter 1973; Schaubroeck et al. 2011). In fact, central actors are more likely to be opinion leaders, as measured by in-degree centrality (Valente and Davis 1999). This leads us to conjecture that a highly centralized group would behave differently in estimation tasks than a dense one.

In the centralized structure, just one opinion, i.e., the one of the cognitive leader, may dominate (acting as an additional anchor during the information-driven process). In contrast, in the dense one, it is hard to know whom to believe, favoring the discussion and the consideration of more "equivalent additional anchors", respectively, in the information-driven and preference-driven decision processes (see de Wilde et al. 2018). The reciprocal competence-based trust between members of the dense group would enhance the influence of these multiple additional anchors making it more resistant to the anchoring bias than the centralized one (strongly influenced by the cognitive

leader's preference functioning as the strongest anchor). In fact, on the one hand, the multiple preferences in the clique create discussion and resistance to the anchor, on the other, the dominant preference of the cognitive leader and the absence of trust between the other members in the centralized group, would produce a missing discussion and a tendency to accept the leader preference. It is plausible that the acceptance of the leader preference is amplified and driven by the absence of trust between the other members, they not only would avoid discussion but also would encourage the "leader" preference. It follows that:

Hypothesis 3. *Groups with a dense structure of competence-based trust relationships have less anchoring bias than groups with a centralized structure.*

Anchoring bias of individuals and groups with centralized competence-based trust networks

Although it has been recently demonstrated that groups are less biased than individuals in the case of anchoring (Meub and Proeger 2018), this result could be conditional on the group's network. Considering the highest centralized group as reference (see hypothesis 3), the combination of the absence of competence-based trust between the cognitive followers and the relationships they have with the cognitive leader would make people find unanimity anchoring to the leader's preference (which would be individually biased by the external anchor and more confident in expressing her/his preference because of the followers trust). This additional anchor induced by the leader's preference would be so influential that the centralized group would be more biased not only than dense groups (hypothesis 3) but also than individuals. In fact, we hypothesized that the leader's preference would more easily become a decision in the centralized group than in the individual decision process, in which the individual spends more effort in deciding. The followers' trust (in the leader) would make the cognitive leader express her/his influential preference diminishing the effort spent in deciding towards a less anchored solution; consequently, this will make the centralized group more anchored than the individual one. It follows that:

Hypothesis 4. *Individuals are less biased by anchoring than groups that have a centralized structure of competence-based trust relationships.*

Method

A laboratory experiment was conducted in which 264 people were asked to perform a quantity-estimation task in the presence of anchors: 140 performed the task individually, while the remaining 124 were asked to perform the task in 4-person groups constructed based on existing competence-based trust ties among individuals (previously identified by the researcher through questionnaires). One type of group defined by the researcher was the maximally centralized sociometric star, in which all trust ties were directed to the same person, the center of the star. A second type of group was the sociometric clique, in which everyone trusted everyone. A third type of group was the null graph, in which no trust ties existed within the group at all.

Experiment

We asked groups and individuals to estimate some values giving them anchors previously identified through calibration. Finally, we tested and compared their susceptibility to being biased.

The experiment comprises two treatments: calibration and anchor (Jacowitz and Kahneman 1995). It involved four experimental subjects: individuals, centralized groups (stars), dense groups (cliques), and groups with the absence of structure (nulls).

For the calibration treatment, in order to identify the anchor value, we asked another sample (composed of 50 students) to estimate 6 quantities (obtaining a 100% response rate). As shown in Table 1, the quantities to be estimated were included in questions about general knowledge such as the selling price of "The Scream" painting by Edward Munch and Amazon profits in 2015.

Table 1 Calibration questionnaire

Questions
1. How much do you think "The Scream" painting by Edvard Munch was sold for? (mil $)
2. What is Facebook's net worth? (mil $)
3. How much is the average purchase price per square foot of a house in China? ($)
4. How much do you think Apple's revenue in 2015 was? (mil $)
5. How much has been spent on gambling in Australia in 2015? (mil $)
6. How much do you think Amazon's profit in 2015 was? (mil $)

We chose the 15th and the 85th percentiles of the distribution of estimates in the calibration group as anchors for the experimental subjects following the procedure shown by Meub and Proeger (2018). We calculated the mean, median, and 15th and 85th percentile of the calibration estimates. These values are reported in Table 2.

The second part of the experiment consisted of asking our experimental subjects (both individuals and groups) six questions after priming them with the anchors identified through the calibration. Following Meub and Proeger (2018), we prepared two versions of the questionnaire. The estimation questions were the same as on the calibration questionnaire but with the addition of an anchor. In questionnaire A, question 1 was primed with the high anchor, question 2 with the low one, question 3 with the high one, question 4 with the low one, question 5 with the high anchor, and finally question 6 with the low anchor. In questionnaire B, the anchors' matching was inverted relative to questionnaire A. Each question was framed in a way that required the participant(s) to indicate whether they believed that the answer was lower or higher than the anchor. Each experimental subject (whether a person or a group) had 9 min time to answer the questions in the order they were listed. The questionnaire used for the estimation task is shown in Table 3.

The experiment was conducted at the university. In the case of groups, participants were asked to sit together around a table for the estimation task, simulating an organizational meeting and discussing values. In the case of individuals, participants performed their tasks in their classrooms.

Sample and setting

Prior research suggests that in small groups (groups made up of 3–20 individuals) cognitive trust emerges after the team has worked together for at least 8 weeks (Webber 2008). We selected a sample with pre-existing competence-based trust relationships, which would allow us to test the groups we needed for our hypotheses. The sample consisted of 264 students at a major European university. They were undergraduate students attending a course called "Business Management" and master's students attending a course

Table 2 Calibration output

Questions	Calibration subject ($n=70$)			
	Mean	Median	15th pct	85th pct
1. How much do you think "The Scream" painting by Edvard Munch was sold for? (mil $)	136,93	80	10	300
2. What is Facebook's net worth? (mil $)	9958,24	50	8,95	370
3. How much is the average purchase price per square foot of a house in China? ($)	3702,33	800	21,5	2000
4. How much do you think Apple's revenue in 2015 was? (mil $)	371,23	30	3,25	550
5. How much has been spent on gambling in Australia in 2015? (mil $)	179,49	10	2	117,5
6. How much do you think Amazon's profit in 2015 was? (mil $)	183,46	20	3	167,5

Table 3 Estimation task questionnaires

1. How much do you think "The Scream" painting by Edward munch was sold for? (mil $)
More or less than [300] (10) million dollars? __
Estimate the value __

2. What is Facebook's net worth? (mil $)
More or less than [8.95] (370) million dollars? __
Estimate the value __

3. How much is the average purchase price per square foot of a house in China ($)
More or less than [2000] (21,5) dollars? __
Estimate the value __

4. How much do you think Apple's revenue in 2015 was? (mil $)
More or less than [3,25] (550) million dollars? __
Estimate the value __

5. How much has been spent on gambling in Australia in 2015? (mil $)
More or less than [117,5] (2) million dollars? __
Estimate the value __

6. Estimate Amazon's Profits in 2015 (mil $)
More or less than [3] (167,5) million dollars? __
Estimate the value __

[] anchor in questionnaire A

() anchor in questionnaire B

called "Project Management". Subjects in the calibration group ($n=70$) were recruited from a group of undergraduate students taking another management course at the same university.

In order to create the groups, we mapped existing competence-based trust relations among the 264 individuals. Since about 80% of the courses are mandatory in these programs, and both are held during the last year of the program, these students had the opportunity to know each other very well during the two years that preceded this study.

We asked each student to fill out a network survey in which they were asked to name a maximum of ten people in their program (and a minimum of four) that they trusted with respect to competence, additionally indicating two that they trusted more and two that they trusted less. We created valued networks by assigning a weight of 3 for a high trust level, a weight of 1 for a low trust level and a weight of 2 otherwise. Table 4 shows the questionnaire used to build the cognitive trust networks.

Based on these questionnaires with 100% response rate of the two classes, we built and analyzed two valued social networks based on cognitive trust (the one of the business management class and the one of the project management one). The social network analysis was conducted using UCINET 6 (Borgatti et al. 2002). The people mentioned in the questionnaire had to belong to the same program, but not necessarily to the same class. For this reason, some of the people mentioned in the questionnaires generated new nodes.

The three kinds of groups we built are shown in Fig. 1. They are described in detail in the Measures section.

Of the 264 individuals in our experiment, 140 individuals performed the task individually and the remaining 124 performed the task in 4-person groups (people performing the group task were not asked to do it individually). The moderate size of the network allowed us to make the assignment manually, without the need for a computer algorithm. For larger networks, it would probably be necessary to write a program to make the assignments. To make the assignments into groups, we first assigned individuals to cliques, then to stars, and finally to null groups. For nodes in the same position, the assignment was random. The rest of the sample was asked to perform the task individually. There were 31 groups: 10 cliques, 10 stars, and 11 nulls; each of them constitutes an observation.

Measures

To test the hypotheses, the dependent variable we used was the Anchor Effectiveness Index (AEI), while the main effect variable is the subject type (Star, Clique, Null, and Individual). The Anchoring Index has been described by Jacowitz and Kahneman (1995) as the difference between the median estimate in the high and the low anchor condition divided by the distance between the high and low anchor. For the purposes of statistical analysis, Jacowitz and Kahneman recommend transforming all the estimates in the corresponding percentiles in the calibration group (assigning 0 or 100 to anchor estimates out of the calibration range). Based on this, Meub and Proeger (2018) define the Anchor Effectiveness Index (AEI) which measures with a single index the average deviation from calibration's median depending on the anchor condition. Specifically, in the high anchor condition, we subtract 50 from each percentile score, whereas in the low anchor condition, we subtract the percentile scores from 50.

Following Jacowitz and Kahneman (1995) and Meub and Proeger (2018), we used the Mann–Whitney test (also known as the Wilcoxon rank sum test) to compare the observed AEI scores.

Table 4 Questionnaire to build the competence-based trust networks

1. Please list a maximum of ten people that usually collaborate with you and that you trust, and whom you go to most for advice and information about exams, class exercises, workgroups, etc. (you must list at least 4 individuals)
2. Thinking of the people mentioned above, please list: • The two individuals that you trust more • The two individuals that you trust less

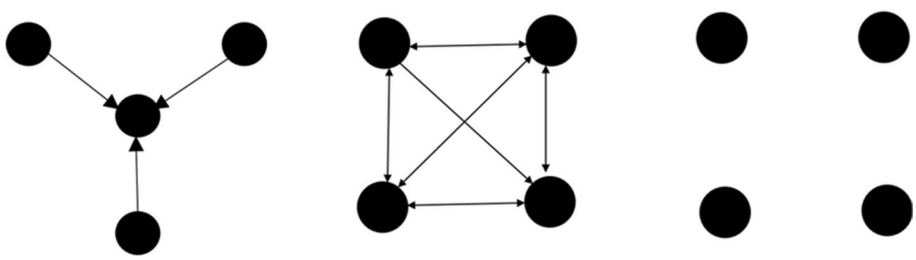


Fig. 1 Experiment groups' structures

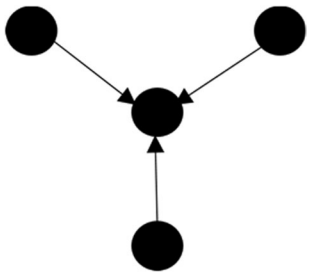


Fig. 2 Star group

Fig. 3 Clique group

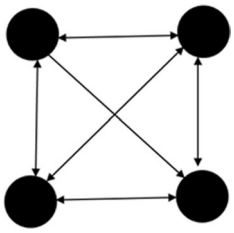
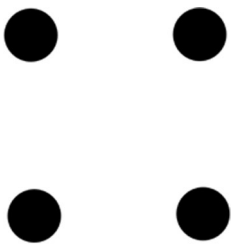


Fig. 4 Null group



Types of groups

In the group structure, we refer to as "Stars" there is a central person who has an incoming trust tie from every other person, and no other person receives any trust ties. This yields a structure with the maximum possible centralization value (see Borgatti et al. 2018; Borgatti 2005). We used only ties with a weight greater than or equal to 2—i.e., strong ties.

This means that in this group, four people significantly trust the central person but lack trust ties to each other (Fig. 2).

The second type of group was a sociometric clique: everyone trusted everyone else with intensity (weight) greater than or equal to 2. In this kind of group, each participant has the same centrality, and the group has the maximum density value (Borgatti et al. 2018) (Fig. 3).

The third type of group is the null network. In this type of group, there are no cognitive trust ties—the network is perfectly sparse (Fig. 4).

Results

Table 5 reports the estimations for the six questions (E1, E2, E3, E4, E5, and E6) of individuals and the calculated partial and total AEI (Table 5). The median estimates indicate that the individuals are susceptible to the anchoring bias. In fact, for almost all the questions, the estimates' median is higher (lower) than 50 in the high (low) anchor case.

Table 5 Descriptive statistics for individuals

	Average points (std.dev.)		Extreme values in % (outliers)		AEI
	Low anchor	High anchor	Low anchor	High anchor	
Individuals					
E1	32,36 (25,33)	74,65 (23,55)	26,03 (6,85)	50,00 (6,94)	54,17
E2	26,94 (28,37))	75,82 (19,68)	34,72 (2,78)	46,57 (2,74)	51,80
E3	25,83 (25,82)	68,90 (21,96)	0 (0)	31,51 (0)	47,17
E4	29,04 (31,49)	76,87 (17,89)	0 (0)	40,28 (0)	53,14
E5	22,5 (3,14)	74,25 (16,41)	1,39 (1,39)	36,99 (1,37)	48,21
E6	31,91 (70,64)	71,11 (30,19)	0 (1,37)	63,89 (1,39)	51,72
Total	28,25 (4,00)	73,60 (3,01)	10.36 (9.90)	44,87 (2,07)	51,03

Table 6 Descriptive statistics for nulls

	Average points (std.dev.)		Extreme values in % (outliers)		AEI
	Low anchor	High anchor	Low anchor	High anchor	
Nulls					
E1	36,83 (32,44)	90 (7,07)	0 (0)	80 (0)	65,54
E2	46 (23,02)	77,5 (6,12)	0 (0)	16,17 (0)	58,64
E3	58 (19,23)	61,67 (29,27)	0 (0)	16,17 (0)	55,45
E4	36,67 (19,66)	62 (17,89)	0 (0)	20 (0)	52,73
E5	28 (4,47)	60 (26,83)	0 (0)	0 (0)	40,09
E6	35 (20,74)	64 (25,10)	33,33 (0)	0 (0)	52,73
Total	40,08 (10,49)	69,19 (4.88)	25,55 (0)	14,67 (0)	54,33

Table 7 Descriptive statistics for stars

	Average points (std.dev.)		Extreme values in % (outliers)		AEI
	Low anchor	High anchor	Low anchor	High anchor	
Stars					
E1	36,83 (32,44)	65 (19,15)	33,33 (0)	25 (0)	58,1
E2	65 (17,61)	81,67 (4,08)	0 (0)	16,17 (0)	73,33
E3	27,5 (9,57)	70 (22,80)	40 (0)	16,17 (0)	43
E4	43,33 (10,33)	85 (10)	0 (0)	75 (0)	70
E5	27,5 (17,08)	78,33 (4,08)	25 (0)	0 (0)	58
E6	36,67 (21,60)	75 (5,77)	0 (0)	20 (0)	62
Total	40,08 (10,49)	75,83 (7,43)	16,38 (0)	25,56 (0)	59,07

Table 8 Descriptive statistics for cliques

	Average points (std.dev.)		Extreme values in % (outliers)		AEI
	Low anchor	High anchor	Low anchor	High anchor	
Cliques					
E1	22 (2,37)	82 (8,37)	60 (0)	0 (0)	52
E2	42 (39,62)	85 (3,53)	60 (0)	20 (0)	63,5
E3	30 (33,91)	78 (10,95)	20 (0)	20 (0)	54
E4	24 (5,48)	80 (18,71)	20 (0)	0 (0)	52
E5	18 (13,04)	78 (4,47)	20 (0)	20 (0)	48
E6	24 (8,94)	57 (42,95)	40 (0)	60 (0)	40,5
Total	26,67 (8,45)	76,67 (9,99)	16,67 (0)	43,33 (0)	51,67

Table 6 reports the estimations and AEI for the Null groups. Also in this case the subject is susceptible to the anchoring bias.

Table 7 shows estimations and AEI for the Star groups confirming also, in this case, their susceptibility to the anchoring bias.

Table 8 shows that Clique groups were also biased by anchoring.

The total Anchor Effectiveness Index for each category of subject is reported in the last row of the following table (Table 9).

Anchoring effectiveness

When individuals were shown a high (low) anchor value, they estimated higher (lower) values relative to players in the calibration treatments, leading to estimates greater (lower) than 50. We found that individuals have a systematic anchoring bias, i.e., a deviation from 50 points toward the anchor values (sign test, one-sided, for low anchors $p = 0.0156$; for high anchors $p = 0.0156$). Nulls have the same systematic bias in both conditions (sign test, one-sided, for low anchors $p = 0.0156$; for high anchors $p = 0.0156$). Stars were biased only in the high anchor conditions (sign test, one-sided, for low anchors $p = 0.1094$; for high anchors $p = 0.0156$). Cliques were biased in both conditions (sign test, one-sided, for low anchors $p = 0.0156$; for high anchors $p = 0.0156$).

Estimates for the high and low conditions across all our players were significantly different from each other (Wilcoxon signed-rank test, for individuals $z = 2.201$ $p = 0.0277$; for nulls $z = 2.201$ $p = 0.0277$; for stars $z = 2.201$ $p = 0.0277$; for cliques $z = 2.207$ $p = 0.0273$).

Test of hypotheses

We tested our hypotheses by comparing AEIs in the low anchor condition and the high anchor condition separately and a combination of the two.

Table 9 Anchor Effectiveness Index for individual, clique, star and null players

AEI				
Questions	Individual	Null	Star	Clique
1. How much do you think "The Scream" painting by Edvard Munch was sold for? (mil $)	54,17	65,54	58,01	52
2. What is Facebook's net worth? (mil $)	51,80	58,64	73,33	63,5
3. How much is the average purchase price per square foot of a house in China? ($)	47,17	55,45	43	54
4. How much do you think Apple's revenue in 2015 was? (mil $)	53,14	52,73	70	52
5. How much has been spent on gambling in Australia in 2015? (mil $)	48,21	40,91	58	48
6. How much do you think Amazon's profit in 2015 was? (mil $)	51,72	52,73	62	40,05
Total	51,03	54,33	59,07	51,67

Table 10 Wilcoxon signed-rank test for the AEI of individual, null, star and clique

	Individual	Null	Star	Clique
Individual				
Null	$z=1.363$ $p=0.1730$			
Star	$z=1.782$ $p=0.0747$*	$z=1.363$ $p=0.1730$		
Clique	$z=0.105$ $p=0.9156$	$z=-0.214$ $p=0.7532$	$z=-1.363$ $p=0.1730$	

Table 11 Wilcoxon signed-rank test for the low AEI of individual, null, star and clique

Low anchor	Individual	Null	Star	Clique
Individual				
Null	$z=2.201$ $p=0.0277$*			
Star	$z=2.201$ $p=0.0277$*	$z=0.422$ $p=0.6733$		
Clique	$z=-0.743$ $p=0.4631$	$z=-2.201$ $p=0.0277$*	$z=-1.992$ $p=0.0464$*	

In the general (combined) case, we found a significant difference between stars and individuals (Wilcoxon signed-rank test, $z=1.782$, $p=0.0747$). Table 10 shows these statistical results.

We can conclude that stars were more susceptible to being biased by the anchoring effect than individuals. Therefore, hypothesis 3 was supported.

In the low anchor condition, there was evidence of significant differences between groups. Stars were more biased than individuals (Wilcoxon signed-rank test, $z=2.201$, $p=0.0277$) and cliques (Wilcoxon signed-rank test, $z=1.992$, $p=0.0464$), lending partial support for hypothesis 3. Null groups were more biased than cliques (Wilcoxon signed-rank test, $z=2.201$ $p=0.0277$) in partial support of hypothesis 1. Finally, null groups were more biased than individuals (Wilcoxon signed-rank test, $z=2.201$ $p=0.0277$) in partial support of hypothesis 2. In Table 11, all the statistical results for the low anchor conditions are reported.

In the high anchor condition, there were no significant differences between the observed categories, indicating that the low anchor was more effective.

Table 12 reports the results.

Hypothesis 1: partially supported. Groups with a dense structure of competence-based trust relationships (cliques) are less biased by anchoring than groups not having competence-based trust relationships (nulls).

Our first hypothesis, predicting that cliques would show less bias than null groups, was supported for the low anchor condition, but not the high anchor condition. Hence, we regard it as partially supported.

Dense cognitive trust ties mean that the group "trusts in itself" more than less dense groups. It decreases the propensity for anchoring bias because the group is more likely to explore ideas, communicate, and decipher the best answers compared to a group lacking dense trust ties. In addition, in watching the subjects perform the estimation tasks, it appeared that members' preferences acted as additional anchors in the group decision-making process. The dense competence-based trusted network seems to mitigate the anchoring effect in group decision-making.

Hypothesis 2: partially supported. Individuals are less biased by anchoring than groups not having competence-based trust relationships.

This hypothesis—about which individuals would be less susceptible to bias than null groups—is partially supported in the sense that is supported under the low anchor condition. Specifically, the bias is stronger for individuals rather than in null groups because the formers tend to underestimate the correct answer.

During the experiment, we observed the conversation in the null groups. The preferences expressed by each member (when expressed) were not taken into account by the other group members. The low level of confidence led the group to finish the task avoiding discussion and anchoring to the external anchor.

Table 12 Test of the hypotheses

Hypothesis	Result
Hyp. 1: Groups with a dense structure of competence-based trust relationships (cliques) are less biased by anchoring than groups not having competence-based trust relationships (nulls)	Partially supported
Hyp.2: Individuals are less biased by anchoring than groups not having competence-based trust relationships	Partially supported
Hyp. 3: Groups having a dense structure of competence-based trust relationships are less biased by anchoring than groups having a centralized structure of competence-based trust relationships	Partially supported
Hyp. 4: Individuals are less biased by anchoring than groups having a centralized structure of competence-based trust relationships	Supported

Hypothesis 3: partially supported. Groups having a dense structure of competence-based trust relationships are less biased by anchoring than groups having a centralized structure of competence-based trust relationships.

We found that stars were significantly more biased than cliques in the low anchor condition. In the high anchor condition, the difference was not significant. During the experiment, we observed (qualitatively) that the clique groups seemed more open to discussion.

Hypothesis 4: supported. Individuals are less biased by anchoring than groups having a centralized structure of competence-based trust relationships.

Star groups were significantly more biased than individuals. During the experiment, we observed the leader's preference being so contagious and influential for the other group members as to act as a very influential biased anchor, avoiding the discussion.

Discussion and conclusions

This study sheds light on the role of network structure on a group's susceptibility to anchoring bias. Specifically, our findings suggest that (a) groups with centralized competence-based trust networks (star-shaped groups) would be more biased than individuals; (b) centralized groups might be more biased than dense groups (cliques); (c) groups with dense trust structures might be less biased than groups with sparse trust structures (nulls); and (d) null trust groups might be more biased than individuals.

Thus, in terms of resisting anchoring bias, individuals and trust-based cliques seem to be more successful than both star-shaped structures and null trust structures. The latter case is of particular interest to managerial practice because it might have been supposed that it was sufficient to place a trusted leader in charge of a group that otherwise lacked trust relationships. Instead, such a group is likely to make worse decisions. It would behoove the leader of such a group to start by trying to foster trust relations among the other members.

These initial findings serve as a significant starting point for further exploration of how network structure influences susceptibility to anchoring bias. In fact, this study has some limitations that suggest future research directions. The limitations include (a) the small sample size, (b) the missing tracking of the communication interaction between the group members, and (c) the missing significant differences across network structure under the high anchor condition.

Future studies could be conducted with a larger sample (for example in bigger organizations), they could be controlled for gender and/or expertise, and they could be conducted by tracking the interactions during the decision process (for example by video recording the groups) and, if the difference between low and high anchor conditions still occurred, these studies could investigate the reasons for it.

Moreover, the present study does not consider the domain of expertise of the actors embedded in the organization (and of the cognitive leader of the group). Hence, to better simulate decision-making in an organizational setting, future studies could be designed with questions belonging to this domain of expertise.

Another clear direction for future research is to examine the performance of other group structures. For example, what would happen if we had a "twin star" structure in which there were two central actors whom everyone trusted? Would this be sufficient to bring bias down to levels near that of clique groups? In addition, a group structure commonly observed in network research is the "small world" structure in which there are clusters within the group that have more ties within-cluster than to members of the group as a whole. Do these potentially rivalrous factions reduce bias or increase it? Examining this question empirically would require larger groups, which itself is an underexplored variable.

Another avenue for future research is exploring different kinds of ties among group members. We studied competence-based trust ties, which have prima facie relevance for group estimation tasks—do I trust this person's estimate? However, other kinds of social relations are also relevant including any relation that provides or destroys psychological safety, such as integrity-based trust (on the positive side) and competition (on the negative side). Previous research has compared group decision-making with individual decision-making. The study contributes to that research stream by providing initial evidence on how the internal structure of groups affects resistance to anchoring bias.

The present research is based on a real informal organizational network and had the objective to test differently structured groups and individuals, hence, the limitations on the numerosity of each group sample and random assignment are inherent. However, adequate care is taken to minimize these limitations by randomly assigning nodes with the same positions within the same group type.

This study contributes to the advancement of organizational behavior and social networks literature giving initial evidence on how competence-based trust networks drive cognitive bias susceptibility in groups and individuals. The main results we hypothesized and demonstrated are twofold: (1) the cognitive bias of anchoring exists in different kinds of groups, but we provided some initial evidence that

network structure influences susceptibility to anchoring bias, at least under the low anchor condition; (2) the groups are less biased than individuals only if in the groups there is a certain density of competence-based trust; in groups, without trust or with a centralized network of competence-based trust the individuals resulted to be the least biased.

Moreover, the research offers practical insights for a better allocation and awareness of resources needed to make collective decisions in an organizational context.

The practical insights concern the awareness in assigning people to a decisional task, suggesting to be aware of (1) the good level of resistance to anchoring bias that a group having competence-based trust between members may have (and the scarce level of it in groups in which this trust is missing); (2) the scarce level of resistance to anchoring bias that a group of people composed by a dominant person having the competence-based trust of the other members may have: being trusted by everyone could not be enough since it is preferable that also the other members trust each other; (3) assigning a decisional task to an individual or a group is a choice that might consider the presence of competence-based trust between the available human resources to allocate: if there is a scarce level of trust between the available resources, it is better to assign it to an individual decision-maker.

The findings from the study help in creating a successful social environment in organizations.

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Declarations

Conflict of interest The author(s) declare that they have no conflict of interest.

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