Who Follows the Crowd – Groups or Individuals? *

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Abstract
In games of social learning individuals tend to give too much weight to their own private information relative to the information that is conveyed by the choices of others. In this paper we investigate differences between individuals and small groups as decision makers in information cascade situations. In line with results from social psychology on intellective tasks we find that groups behave more rationally than individuals. Groups, in particular, are able to abandon their own private signals more often than individuals if it is rational to do so. Our findings have important implications for the design of decision making processes in organisations, finance and other economic settings.

JEL Classification: C91, C92, D70, D8

Keywords: Information Cascades, Herding, Group behaviour

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1. Introduction

The inclination of humans to follow the crowd is a well documented phenomenon (see for example Surowiecki, 2005). Economists have rationalised such behavioural patterns by considering social learning games, in which it can indeed be optimal to follow the behaviour of previous decision makers, “the herd”, irrespective of private information (Bikhchandani et al., 1992). Experimental studies on social learning games, however, provide convincing evidence that individuals tend to herd less than would actually be rational since they seem to give excessive weight to their own private information relative to the information that is conveyed by the choices of others (Nöth and Weber, 2003, Goeree et al., 2006, Weizsäcker, 2006). The aim of the present paper is to investigate into the behavioural differences between individuals and small groups as decision makers in social learning games. In particular we are interested in potential differences regarding the degree of rational behaviour and the overemphasis of private information. Such a comparison is important since small groups as decision-making entities are at least as widespread as individuals in business and economic environments.

Situations resembled by social learning games occur in many economic contexts which involve a sequential flow of information revealed through actions by others. Most of the literature contributes to herding behaviour in banking and finance (recent studies include Drehmann et al., 2005, Alevy et al., 2007). Hirshleifer and Teoh (2003) provide a comprehensive review of herd behaviour in capital markets. In the labour market context, hiring decisions and the duration dependence of unemployment can be explained by rational herding (see Kübler and Weizsäcker, 2003 and Oberholzer-Gee, forthcoming). Other examples of rational herding are strategic business decisions like product choice decisions and location choices for bank branches (Bikhchandani et al., 1998). In situations characterised by social learning games, decision makers are frequently constituted by small groups rather than by individuals. Investment decisions, for example, are often taken by financial expert groups and not by an individual alone. In the consumer context we observe joint decisions by households each consisting of several members rather than by individuals.

While small group research constitutes a viable research area in social psychology (see Levine and Moreland, 1998, and Kerr and Tindale, 2004, for reviews), only recently the economic literature has started to investigate differences in decision making of groups and individuals, pioneering examples being Cason and Mui (1997), Bornstein and Yaniv (1998), Cox (2002), Kocher and Sutter (2005), and Rockenbach et al. (forthcoming). Most of the economic
literature on group decisions investigates strategic interaction games and provide mixed evidence on the question whether groups or individuals are the more rational decision makers. Kocher and Sutter (2005) compare decisions by individuals and groups in a beauty contest game. They are able to provide the important result that groups are not better decision makers per se but they seem to learn faster in games in which the mutual level of reasoning is decisive. Cox and Hayne (2006) investigate bidding behaviour of groups in common value auctions. Decisions of groups are found to be less rational compared to individuals when each member of a group has distinct information. The significant difference with respect to rational behaviour disappears when group members have common information. Bone et al. (1999), and Rockenbach et al. (forthcoming) investigate group decisions under risk. Both papers cannot support the hypothesis that group decisions are more consistent with expected utility theory than individual decisions. To our best knowledge the question of differences between decisions taken by a small group compared to an individual in social learning games has not been investigated so far. In particular, it is an open question whether groups or individuals are more inclined to “follow the crowd”.

The present paper approaches this issue by comparing decisions of groups consisting of three individuals with that of individuals as decision-making entities in a standard experimental social learning game. In particular, in each of our sessions one randomly determined individual decision maker is “shadowed” by a group player which allows for a clean ceteris paribus comparison of the decisions by groups and by individuals. Our results have important implications for the design of decision making processes in organisations, finance and other economic settings.

In the next section, we describe the theoretical background and the experimental set-up. Section 3 introduces our hypotheses on groups’ behaviour in social learning games by particularly drawing on the findings from social psychology. Our results are presented in section 4 and section 5 concludes.

2. Theory, Experimental Design and Procedure

A Benchmark Model of Decision Making in a Social Learning Game

We consider a simple game of social learning as described, for instance, in Anderson and Holt (1997), Dominitz and Hung (2004) and Alevy et al. (2007). There are two possible states of nature $\Omega = \{A, B\}$, with the true state denoted by $\omega \in \Omega$. Both states are equally likely to
occur with probabilities $\Pr(A) = \Pr(B) = \frac{1}{2}$. A total of 6 players sequentially make a binary decision, $a$ or $b$, each after receiving a binary private signal $s \in \{s^A, s^B\}$, that are independently drawn from a distribution depending on $\omega$. If $\omega = A$ the distribution is $\Pr(s^A|A) = \frac{2}{3}$ and $\Pr(s^B|A) = \frac{1}{3}$. Analogously, if $\omega = B$ the distribution is $\Pr(s^A|B) = \frac{1}{3}$ and $\Pr(s^B|B) = \frac{2}{3}$. Along with her private signal $s$, each player at the decision node $j$ observes the history of all previous decisions $H_{j-1} = \{h_1, \ldots, h_{j-1}\}$. The payoff of a decision $a$ or $b$ that matches the true state of nature is given by $\pi(a|A) = \pi(b|B) = 1$ and otherwise $\pi(a|B) = \pi(b|A) = 0$. Let us assume that it is common knowledge that all players update their beliefs about the probabilities of $\omega \in \Omega$ according to Bayes’ rule. Supposing that $s_1 = s^A$, Bayes’ rule implies

$$\Pr(\omega = A | s_1 = s^A) = \frac{\Pr(s^A|A) \Pr(A)}{\Pr(s^A|A) \Pr(A) + \Pr(s^A|B) \Pr(B)} = \frac{2}{3}. \quad (1)$$

Analogously, one obtains $\Pr(B|s^B) = \frac{2}{3}$ and $\Pr(A|s^B) = \Pr(B|s^A) = \frac{1}{3}$. Given that $s_1 = s^A$ the expected payoff of the decision $a$, $\pi(a)$, exceeds that of a decision $b$, $\pi(b)$, and to maximise expected payoff the first player will decide $a$. If the second player observes the decision of the first player and also receives a signal $s_2 = s^A$, updating according to Bayes’ rule yields

$$\Pr(\omega = A | H_1 = a, s_2 = s^A) = \frac{\Pr(s^A|A)^2 \Pr(A)}{\Pr(s^A|A)^2 \Pr(A) + \Pr(s^A|B)^2 \Pr(B)} = \frac{4}{5}. \quad (2)$$

This already shows that two consecutive identical decisions yield a posterior probability of 0.8. Even if the third player receives a private signal $s^B$, the posterior probability for state $A$ would be given by $\Pr(\omega = A | H_2 = a, a, s_3 = s^B) = \frac{2}{5}$. Thus, the third decision maker should follow the herd and choose $a$ regardless of her signal. In the example above we call the decisions of the first two players informative for subsequent players. The decision of the third player is not informative since he has to choose $a$ irrespective of his signal. In this situation rational behaviour can be represented by a choice heuristic based on a counting rule. Define the net number of informative $a$ decisions by $\Delta = (\# \text{ of informative } a \text{ decisions}) - (\# \text{ of informative } b \text{ decisions})$. An $A$-cascade, in which the decision $a$ is rational regardless of one’s own signal, occurs if $\Delta = 2$. Analogously a $B$-cascade occurs if $\Delta = -2$. 

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**Experimental Design and Procedure**

Our experimental design closely followed the seminal experiment by Anderson and Holt (1997). In particular, the two states of nature were represented by two urns containing two black and one red marble (urn A) and one black and two red marbles (urn B). In the beginning of a round one urn was randomly selected but remained hidden to the subjects. 6 players chose sequentially with the decision order being determined at random in each round. Before making his choice a player saw all decisions of the preceding players and additionally received a private signal in the form of a marble, which was randomly drawn from the three marbles in the selected (but hidden) urn.

In addition to the sequential decisions of the 6 individual players in each round we observed one decision by a group player. The group player consisted of three subjects and was matched to one particular individual player throughout the whole session. We will refer to the two decisions by the individual player and by the matched group player as the **focal decision pair** in this round. The respective individual player is called the **focal individual player**. The group “shadowed” the focal individual player in the sense that the group player faced exactly the same strategic situation including the same information as the matched individual player. To be precise, all members of the shadow group observed the same history of preceding choices and received the same signal about the urn (draw of a marble) as the matched individual player. After a group discussion the group members had to come up with an unanimous decision which, however, was not included into the decision history visible to subsequent players.

The experiment was conducted at the *Cologne Laboratory for Economic Research* at the University of Cologne in July and October 2006. 108 subjects participated in the 12 sessions each comprising 15 rounds. Subjects were recruited by the online recruiting system ORSEE (Greiner 2004) and were allowed to participate in one session only. About half of the students were studying economics and business administration (56 subjects). All 9 subjects in one session received the same introductory talk. In the instructions we referred to the decisions as guesses and to the shadow group as an “additional player.” Whether a participant acted as an individual player or a group member was randomly determined after the introduction. The roles were individually communicated to all participants who were then individually seated in cubicles. Members of the group were informed that they were seated in three adjacent cubicles. The experimental software was programmed in Java, a programming language

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1 The introduction was given in German. A translation is provided in the appendix.
developed by Sun Microsystems, Inc. In particular the random selection of the urn and the random draw of a marble from the selected urn were animated at the computer screen. The current position in the decision sequence and the history of decisions of preceding players in the current round were also visible. Decisions on urn A or urn B were entered into the computer mask. A screenshot is displayed in Figure A.1 in the appendix. Participants representing the group player were requested (by a screen box) to come together in the central cubicle to discuss their choice after they saw the animation of the marble draw on their individual screens. When returning to their cubicles they individually had to enter the decision agreed upon. If the entered decisions of the individual group members were not the same a dialog box requested them to discuss their decision again. Importantly, we had to make sure that the other subjects could not listen to the group discussion and learn about the group’s signal or their decision. We took the following measures to prevent the individual players from listening to the group’s discussion: 1) Group members were asked to speak in a low voice. 2) A complete row of cubicles separated the cubicles of the shadow group members from the individual players (see Figure A.2 in the appendix for concrete arrangements). 3) All participants had to wear ear muffs during the whole session – of course, the members of the shadow group were allowed to take them off during group discussions (see Figure A.2 for a photo of the ear muffs used). 4) During the waiting time subjects were allowed to individually play simple computer games to distract them from their surroundings.

At the end of a round when all subjects had taken their decisions participants got to know the actually selected urn for that round and they were informed about their payoffs. Subjects earned 1 Thaler for a correct guess in a round which at the end of the experiment was converted to 1.20 Euro. Each member of the shadow group earned 1 Thaler for a correct guess of the group. In addition subjects were paid a show-up fee of 2.50 Euro at the end of the experiment. On average a participant earned in total 13.25 Euro. The experiment was run under anonymous conditions. Participants did neither learn the identity of each other nor could they infer whose turn it was to decide at a certain decision node. Only the members of the group interacted in face-to-face communication. A session lasted for about 90 minutes.
3. Hypotheses on groups’ behaviour

Group performance and group decision making is an extensively studied topic in social psychology. There is no general consensus that groups are better decision makers than individuals. As Kerr and Tindale (2004, p. 634) put it: “Although groups tend to outperform individuals in many domains, groups also can fall prey to the same heuristic-based biases found at the individual level.” One main finding from social psychology is that the performance of groups compared to individuals is to a large extent influenced by task characteristics (Hastie 1986). In intellective tasks, in which the correct solution is demonstrable and can be communicated to other group members, the group performance often approaches or even exceeds the performance of the best group member (Tindale et al. 2003, Levine and Moreland, 1998, Laughlin and Ellis, 1985). Laughlin et al. (2002), for example, show that in a highly intellective task of solving letters-to-numbers problems four-person groups perform better than the best of an equivalent number of independent individuals. Evidence that groups outperform individuals in decisions mimicking monetary policy decisions is also provided in Blinder and Morgan (2005). Experiments on collective induction, i.e., cooperative search for descriptive, predictive, and explanatory generalisations, rules, and principles (cf. Laughlin, 1999), show that groups are fairly effective in correctly retaining information and discarding incorrect hypotheses on general principles or rules (Kerr and Tindale 2004). The decision in a social learning game can be primarily regarded as an intellective task. If one assumes that it is common knowledge that all players behave rational one can deduce the signals received by previous players for most of the histories with Bayes’ rule and iterative reasoning. If one member of the group knows the correct arguments how to do this he or she can easily demonstrate the reasoning to his or her group members.

Of course, the application of Bayes’ rule depends on the beliefs of the decision makers about whether previous players actually behaved rationally. This constitutes a judgemental element in the players’ decisions. In judgemental tasks groups perform often better than the average individual member. However, their judgement typically does not reach the level of its best member (Levine and Moreland 1998, Tindale et al. 2003). Given that in our relatively simple game the assumption of common rationality appears to be the most intuitive at hand we regard the judgemental element in the decisions as less important. Building on these findings from social psychology we derive the following hypotheses:

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2 Judgemental tasks are defined as evaluative, behavioural, or aesthetic judgements often without an ex-post criterion for the correctness of the decision (Tindale et al. 2003).
Hypothesis “Rationality”

Groups tend to behave more rational than individuals.

In particular we are interested in the behaviour in cascades, i.e., in a situation, in which it is actually rational to ignore the own signal and follow the crowd:

Hypothesis “Herding Behaviour”

In information cascade situations groups comply with rational herding to a larger extent than individuals.

4. Results

In the following analysis we generally assume that all players believe that their predecessors decided in accordance with iterated application of Bayes’ rule. If the informative decisions from the history together with the current private signal make both states of nature equally likely we call this an indifference situation. For simplicity we assume that it is common knowledge that all players follow their own signal in an indifference situation.\(^3\) If in a given history a player has unambiguously violated these assumptions (for example, when he should have chosen the same decision as his predecessors irrespective of his signal but he didn’t), we assume that it is common knowledge among all following players that the deviating player followed his private signal (cf. Anderson and Holt 1997, Drehmann et al. 2007, and Dominitz and Hung 2004).\(^4\)

Given these assumptions about what is common knowledge about behaviour, we call a decision Bayesian, if it is in line with Bayesian rationality. A situation, in which following the crowd is consistent with Bayesian rationality but inconsistent with one’s own signal, is

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\(^3\) In fact our data provide evidence in favour of this assumption. In particular we find that in all 12 sessions in indifference situations individual players follow their own signal in the majority of instances with a clear majority of 93 : 27 (Binomial test with an event probability of \(\frac{1}{2}, p=0.000\), two-sided).

\(^4\) Note the consequences of this assumption for the application of the counting rule. Consider a history \(H_5 = a, a, a, a, b\). The decision maker at the fifth decision node obviously violates Bayesian behaviour since he finds himself in a cascade situation and should choose \(a\) irrespective of his private signal. In such a case we assume that all following players take for granted that this decision maker followed his private signal, i.e., that his signal was \(a\). The decisions at the third and fourth decision node are considered to be non-informative since these players have been in a cascade situation. The fifth decision again becomes informative for subsequent players. The counting heuristic after the fifth player’s action would return \(\Delta=1\).
referred to as an information *cascade* situation. If a subject rationally decides against his or her own signal in a cascade situation we call this behaviour *herding*. If a subject follows his or her signal in a cascade situation we denote this behaviour as a *break of a cascade*. Note that a break of a cascade is considered to always be informative for subsequent players because of the assumption that the respective player followed her own signal.

In our statistical analysis we treat each session as one independent observation, which each may comprise several focal decision pairs (instances). We start our analysis by concentrating on all 180 focal decision pairs of individuals and their shadow group players. A comparison of the focal decision pairs guarantees a clean ceteris paribus analysis. Note, that the experimental design implies that the respective two players – individual and shadow group – are exactly in the same decision situation, i.e., they see the same history and the same private signal. To check for the robustness of our results in the subsequent analysis we also compare average behaviour of all individuals with average behaviour of the group players. If not stated otherwise statistical significances are obtained by applying the exact Wilcoxon sign-rank test for two related samples.

**4.1 Descriptive statistics and comparison of focal decision pairs**

Table 1 provides a descriptive overview of cascades, indifference situations, and Bayesian behaviour for the focal decision pairs for each position in the decision sequence. By definition, in our setting cascade situations can only be observed beginning with decision node 3. The first and third players in a decision sequence cannot be indifferent. The fifth player in a decision sequence can only be indifferent if a break of a cascade occurred before.\(^5\) Bayesian decisions are reported including or excluding indifferences.

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\(^5\) Note that in Tables 1-4 the number of indifferences at node 5 has to be the same as the corresponding one in [ ] which indicates the number of indifferences that are preceded by an unambiguous violation of Bayesian behaviour, i.e., a break of a cascade.
Table 1: Descriptive statistics for focal decision pairs

<table>
<thead>
<tr>
<th>Decision</th>
<th>Total</th>
<th>Cascade</th>
<th>Indifference</th>
<th>Focal individuals</th>
<th>Groups</th>
<th>Bayesian exl. indifferences</th>
<th>Bayesian exl. indifferences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bayesian</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>node 1</td>
<td>24</td>
<td>-</td>
<td>-</td>
<td>23 (23)</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>node 2</td>
<td>37</td>
<td>-</td>
<td>10</td>
<td>37 (27)</td>
<td>37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>node 3</td>
<td>27</td>
<td>5</td>
<td>-</td>
<td>24 (24)</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>node 6</td>
<td>20[1]</td>
<td>8</td>
<td>0</td>
<td>18[1] (18[1])</td>
<td>20[1]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage</td>
<td>100.00</td>
<td>16.111</td>
<td>11.111</td>
<td>91.111 (80.000)</td>
<td>97.222</td>
<td>86.111</td>
<td></td>
</tr>
</tbody>
</table>

“Total” gives the total number of focal decision pairs. “Cascade” denotes the number of cascade situations faced by the focal individual players and the group players. “Indifference” denotes the number of situations in which the focal individual players and the group players are indifferent according to Bayes. “Bayesian” denotes the number of cases in which the focal individual players / group players decided according to Bayes or decided anything when they were indifferent. “Bayesian exl. indifference” denotes the number of cases in which the focal individual players / group players decided according to Bayes excluding indifference situations. Percentages are given relative to total number of 180 focal decision pairs. Values in [ ] give the number of focal decision pairs that are preceded in their round by an unambiguous violation of Bayesian behaviour.

A first inspection of Table 1 reveals that we observe at least as many (decision nodes 1 and 2) or more (decision nodes 3 to 6) Bayesian decisions for the group players compared to the individual players. The same is true when excluding indifference situations.

Observation “Rationality”

The average percentage of Bayesian decisions for the 12 independent observations of focal individual players is 91.11 and it is 97.22 for the group players. In fact the number of Bayesian decisions of group players is significantly higher than the one of focal individual players (z=1.841, p=0.039, exact, one-sided). We therefore reject the null hypothesis that the level of rationality for groups is equal or lower than the level of rationality for individuals in favour of hypothesis “Rationality” which suggests a more rational behaviour of groups.

To learn more about the ability of groups to abandon their private signal when it is rational to do so we inspect the behaviour of focal decision pairs in more detail by differentiating between situations where players follow their own signal (Table 2) or deviate (Table 3). Focal individuals follow their own signal significantly more often than groups (z=1.951, p=0.031, exact, one-sided). This tendency can be observed in indifference situations (17 out of 20 vs.
11 out of 20, $z=0.813$, $p=0.25$, exact, one-sided) as well as in cascades (12 out of 29 vs. 3 out of 29, $z=2.214$, $p=0.016$, exact, one-sided).

### Table 2: Decision following own signal

<table>
<thead>
<tr>
<th>Decision</th>
<th>Focal individuals</th>
<th>Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Cascade</td>
</tr>
<tr>
<td>node 1</td>
<td>23</td>
<td>-</td>
</tr>
<tr>
<td>node 2</td>
<td>35</td>
<td>-</td>
</tr>
<tr>
<td>node 3</td>
<td>23</td>
<td>2</td>
</tr>
<tr>
<td>node 6</td>
<td>14[1]</td>
<td>2</td>
</tr>
<tr>
<td>Percentage</td>
<td>86.667</td>
<td>41.379</td>
</tr>
</tbody>
</table>

Percentage for “Total” is given relative to all 180 focal decision pairs. Percentages for “Cascade” and “Indifference” are given relative to total number of cascade (29) and indifference (20) situations. Percentage for “Other” is given relative to 180 – 29 – 20 = 131 instances. Values in [ ] give the number of focal decision pairs that are preceded by an unambiguous violation of Bayesian behaviour in their round. Grey shaded areas show focal decisions not in line with Bayesian behaviour.

### Table 3: Decisions deviating from own signal

<table>
<thead>
<tr>
<th>Decision</th>
<th>Focal individuals</th>
<th>Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Cascade</td>
</tr>
<tr>
<td>node 1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>node 2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>node 3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>node 4</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>node 6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Percentage</td>
<td>13.333</td>
<td>58.621</td>
</tr>
</tbody>
</table>

Percentage for “Total” is given relative to all 180 focal decision pairs. Percentage for “Cascade” and “Indifference” are given relative to total number of cascade (29) and indifference (20) situations. Percentage for “Other” is given relative to 180 – 29 – 20 = 131 instances. Values in [ ] give the number of focal decision pairs that are preceded by an unambiguous violation of Bayesian behaviour in their round. Grey shaded areas show focal decisions not in line with Bayesian behaviour.

### Observation “Herding Behaviour”

When comparing the fraction of herding decisions in cascades for focal decision pairs (12 matched pairs) we find a significantly higher average fraction of follow the herd decisions for groups than for individuals which supports the hypothesis of stronger group herding behaviour ($z=2.220$, $p=0.016$, exact, one-sided).
The observed higher group rationality should result in higher payoffs for groups. Indeed, the average earning of group players is 11.58 Euro compared to 10.33 Euros for individual players. A Wilcoxon-test shows that groups perform significantly better and guess the right urn more often than individuals ($z=2.434$, $p=0.010$, exact, one-sided).

4.2 Robustness of results

To provide additional evidence for the robustness of our findings we summarise descriptive statistics for all individual players including the focal player in Table 4. Note that in this section we compare average decisions of similar but not necessarily identical situations of groups and individuals. About a third of all individuals in cascade situations trust their private signal more than the information inferred from the decisions of their predecessors. While this fraction is lower than the respective percentage of focal individual players in cascade situations it is still considerable higher than the number of groups following their own signal compared to all group decisions in cascade situations. The same is true when inspecting the decisions of individuals in indifference situations. While 85% of all decisions of focal individuals in indifference situations are decisions complying with the private information (see Table 2), the percentage is 77.5% for all individuals which is also well above the number of 55% for groups.

Table 4: Descriptive statistics for all individuals

<table>
<thead>
<tr>
<th>Decision</th>
<th>Total</th>
<th>Cascade</th>
<th>Indifference</th>
<th>Other</th>
<th>Total</th>
<th>Cascade</th>
<th>Indifference</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>node 1</td>
<td>172</td>
<td>-</td>
<td>-</td>
<td>172</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>node 2</td>
<td>171</td>
<td>-</td>
<td>53</td>
<td>118</td>
<td>9</td>
<td>-</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>node 3</td>
<td>149</td>
<td>27</td>
<td>-</td>
<td>122</td>
<td>31</td>
<td>24</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>Percentage</td>
<td>82.592</td>
<td>32.995</td>
<td>77.500</td>
<td>96.199</td>
<td>17.407</td>
<td>67.001</td>
<td>22.500</td>
<td>3.801</td>
</tr>
</tbody>
</table>

Percentage for “Total” is given relative to all 1,080 instances. Percentages for “Cascade” and “Indifference” are given relative to total number of cascade (197) and indifference (120) situations. Percentage for “Other” is given relative to 1,080 – 197 – 120 = 763 instances. Values in [  ] give the number of instances that are preceded by an unambiguous violation of Bayesian behaviour in their round. Grey shaded areas show decisions not in line with Bayesian behaviour.

Supporting evidence for our results on the rationality and the herding behaviour of groups is summarised in Table 5. In particular, we report statistical tests of differences in the
percentages of Bayesian decision within a session between the group and the focal player when i) excluding instances preceded by an unambiguous violation of Bayesian behaviour within their round (which might have confused subsequent players), ii) excluding instances with indifference situations as well as iii) excluding both, instances with indifference situations as well as instances preceded by an unambiguous violation of Bayesian behaviour in the preceding decisions. The hypothesis of higher group rationality is supported by the results presented in Table 5 for comparisons between groups and focal individuals as well as all individuals. We find significant evidence that focal individuals trust their own signal more than groups even when excluding instances preceded by an unambiguous violation of Bayesian behaviour within their round. The comparison of total decisions in accordance with the private signal between groups and all individuals shows no significant differences. The supportive evidence in favour of our second hypothesis that groups decisions in cascade situations comply to a larger extent with rational herding than that of individual decisions is robustly found when excluding decisions in cascade situations preceded by an unambiguous violation of Bayesian behaviour. When extending the comparison to one between group decisions and all individual decisions we also find clear confirmative evidence in favour of our second hypothesis (cf. right hand side columns in Table 5).

Table 5: Summary of comparison of group and individual decisions

<table>
<thead>
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<th>Focal individuals</th>
<th>All individuals</th>
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<td>$&gt;$</td>
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Values in [ ] consider only those instances that are not preceded by an unambiguous violation of Bayesian behaviour in their round. All $p$-values refer to exact, one-sided Wilcoxon sign-rank tests for two related samples.
5. Conclusion

The present study compares the behaviour of groups and individuals as decision makers in a social learning game. Under the assumption of common knowledge of rationality among the other players decisions of groups turn out to comply consistently better with Bayesian rationality than the decisions of individuals. In particular groups rationally follow the herd significantly more often than individuals in cascade situations.

Our results have important implications for environments with room for social learning. For example, the data suggest that expert groups in financial markets might be better able to infer the right information from the actions of other market participants than individual traders. In particular, ceteris paribus, they are likely to easier refrain from putting too much weight on their own private information. An analogous effect might also be present in purchasing situations when comparing decisions of households consisting of one or more members.

Additionally, our findings promise to be particularly valuable for the design of organisations. When shaping an organisation and its decision making processes one can often arrange for an individual decision maker or alternatively employ a small group of people, like boards, committees, or teams, to take certain decisions. A recruiting decision, for example, might well be taken by a single personnel manager or by a hiring committee. Given our results, a hiring committee might be more inclined to reject an applicant on the basis of a longer unemployment history because the committee takes it as the result of a sequence of negative evaluations by other firms. A single recruiting specialist, on the other hand, might tend to follow his own impression in the job interview and thereby underemphasise the information revealed by an (unexplained) long unemployment period. Similar lines of reasoning can be applied to most strategic business decisions in which a variant of social learning is involved.

In the light of our findings, it can be argued that in such situations small groups might be the better decision makers. Groups as decision entity, of course, come with the cost of involving more personnel in the decision task. Thus, the designers of organisations are likely to have to deal with this particular trade-off.

Although our findings indicate that groups seem to be more rational actors in social learning environments, further research is still needed to identify the exact mechanisms that drive the results. Do groups perform in such situations like the most capable group member or do group discussions generate additional value in the group decision process? Video experiments, for example, might provide some illuminating insights regarding these questions. In our study groups are randomly formed. The question arises whether it is possible to strengthen our
results by identifying specific group compositions in which group members possess certain useful characteristics. It would certainly also be very interesting to investigate adequate field settings in order to confirm our results in real world environments. By raising these questions we hope that our study not only reports valuable findings but also initiates promising further research directions regarding the investigation of social learning by groups.

References


Appendix

Instructions
(Original instructions were in German. They are available from the authors upon request.)

Basic Information
- There are two urns, each containing 3 marbles.
- Urn A contains 2 black marbles and 1 red marble.
- Urn B contains 1 black marble and 2 red marbles.
- The distribution of the coloured marbles in the urns will be the same during the entire experiment.
- There are 6 players.
- The experiment consists of 15 periods.

Course of a period
- At the beginning of each period one urn (urn A or urn B) is chosen with equal probability by a random generator of the computer. Players are not informed about which urn has actually been drawn. The selected urn will not change during one period.
- In a randomly determined order the six players are asked one by one to guess which urn has been drawn. The order in which the six players have to state their guesses is randomly determined in each period.
- Before a player states his guess, one out of three marbles is drawn with equal probability from the selected urn and it is shown to the currently deciding player. The other players do not see the drawn marble.
- After having seen the randomly drawn marble, the currently deciding player is asked to guess whether the selected urn in this period is urn A or urn B.
- The guesses of all previous players in one period are shown to the currently deciding player before he states his guess.
- When all players have submitted their guesses about the selected urn, the period ends and the actual randomly chosen urn in this period is announced.

Additional Player
- When all players have submitted their guesses about the selected urn, the period ends and the actual randomly chosen urn in this period is announced.
- In addition to the six players there is one additional player who is constituted by a group of 3 participants.
- The additional player is permanently matched with one specific individual player and decides simultaneously with this player. The decision of the additional player has to be unanimous within the group.
• Before the additional player decides, every member of the group is shown the same marble draw as the matched individual player as well as all the guesses of the other players in the current period.

• The guess of the additional player is not announced to subsequent players.

Pay offs

• In case of a correct guess by a player, he is paid 1 Thaler.
• In case of a correct guess by the additional player, each group member is paid 1 Thaler.
• The exchange rate is: 1 Thaler = EUR 1.20.
• Every subjects is paid EUR 2.50 as a fix show up fee.

Please note:
During the entire experiment it is not allowed to communicate. Please keep wearing your ear muffs during the experiment. If you have any questions, please give a hand signal.

All decisions are made anonymously, i.e., none of the other participants has information about the identity of a certain decision maker. Also, the payoffs are anonymous, i.e., no participant learns the payoff of another participant.

We wish you success!
The sample screenshot shows the situation in round 1, at the 3rd decision node right after a random draw of a marble from the selected urn. The original screens were in German.

Cubicle arrangement in a session; individual decision makers $I_1, \ldots, I_6$ were seated in cubicles of one row and the three participants $G_1, G_2, G_3$ representing the shadow group player were seated in adjacent cubicles in a remote row. Cubicles denoted by $x$ remained empty. All participants were wearing ear muffs.