

Social Influence on Predictions of Simulated Stock Prices

Maria Andersson, Ted Martin Hedesström, and Tommy Gärling

Andersson, M., Hedesström, T. M., & Gärling, T. Social Influence on Predictions of Simulated Stock Prices. *Göteborg Psychological Reports*, 2007, 37, No. 4. In two experimental simulations of a financial market participants predicted the future price of a stock given the current price and the predictions made by five fictitious others. Experiment 1, employing 96 undergraduates, showed an influence of the others' predictions when these were correlated. In Experiment 2, employing another 72 undergraduates, the influence increased with the number of other's correlated predictions. Since the others' predictions lacked predictive validity and the influence increased with the number of others, the results indicate that the operation of a consensus heuristic may account for herd influences on stock price predictions.

Keywords: Group influence, financial markets, prediction, consensus heuristic

Investors in financial markets are frequently imitating each other. This phenomenon is referred to as herding (for a review, see Hirshleifer & Teoh, 2003). If a large number of investors make similar decisions, it is a possible cause of market booms and bursts. For this reason, the popular press often holds investors' tendency to herd as responsible. However, research points in opposing directions; while some studies confirm the existence of herding in financial markets (e.g., Guedj & Bouchaud, 2005), others do not (e.g., Drehmann, Oechssler, & Roeder, 2005).

When investors are making the same decisions as others it may result from indirect influences (Drehmann et al., 2005; Sias, 2004), including common knowledge (Grinblatt, Titman, & Wermers, 1995), fads (Sias, 2004), or common investment styles (Wermers, 2000). It is challenging to empirical studies to distinguish direct from indirect influences. An experimental approach is therefore useful.

Experiments are reported in which participants make choices sequentially based on private information and information about the choices made by others preceding them (Anderson, 2001; Anderson & Holt, 1997; & Celen & Kariv, 2004). After a number of participants have made their choices, the participants tend to disregard their private information and instead imitate the others. In financial markets, when observation of others' choices provides valid information, it is optimal for individual investors to follow the others without regard to their private information. This form of herding is referred to as information cascades (Bikhchandani, Hirshleifer, & Welch, 1992). For a general discussion of herding and information cascades, see Smith and Sorensen (2000).

This research was supported by grants from Mistra to the program Behavioral Impediments to Sustainable Investment. Thanks are due to Boel Siljebråt for assistance in collecting the data.

In many other areas of life the issue of whether or not it is beneficial to follow others is raised. For instance, in Festinger's (1954) theory of social comparison processes a tenet is that when one disagrees with a number of apparently unrelated sources that are in agreement, and there is no plausible explanation for their agreement, it is sensible to infer that the others are correct. Since people strive to be correct, this will induce a comparison between their own views and the views by other individuals. Task difficulty is known to affect the outcome of such comparisons (see Bond & Smith, 1996, for a review). In general, a more difficult task elicits more conformity. Yet, people may conform even in simple perceptual tasks, such as in the experiments by Asch (1952, 1956). Another factor that impacts conformity is the number of individuals. A general conclusion is that a majority has a stronger influence than a minority (Brown, 2000; Bond et al., 1996; Martin, Gardikiotis, & Hewstone, 2002). Previous research (e.g., Hodges & Geyer, 2006; Lascu, Bearden, & Rose, 1995; Clark & Maass, 1990; Arbutnot & Wayner, 1982; Mugny & Papastamou, 1980; Nemeth, Wachtler & Endicott, 1977) has also shown that both the absolute size and the relative size of a majority or a minority increase its influence. Furthermore, small may be beneficial since it increases the minority's distinctiveness and therefore attracts attention to its message (Moscovici, 1976). It has also been found (e.g., Arbutnot et al., 1982; Wood, Lundgren, Ouellette, Busceme, & Blackstone, 1994; Bray, Johnson & Chilstrom, 1982; Nemeth et al., 1977) that the degree of consistency in judgments increases the influence of both minorities and majorities.

Comparisons with others and validation of these comparisons have theoretically been posited to mediate influences from others (Wood et al., 1994). As proposed by Mugny and Perez (1991), comparison involves identification with the others and results in influences without deliberation, whereas validation that assesses the others' arguments results in influences after deliberation. In Moscovici's (1985) dual-process theory of conformity and conversion, people comply with the majority without thoroughly reflecting on its message because they wish to belong to the majority (conformity). Since people are unwilling to be identified with deviant groups, minorities are in contrast less likely to elicit a comparison process. Instead, primarily depending on its absolute or relative size and degree of consistency, a minority may trigger a validation process leading to that their arguments are considered in detail. This may result in a changed private opinion (conversion) that under certain circumstances would also lead to public adoption of the minority's opinion.

A so-called cognitive response framework has been used to connect the processes of comparison and validation to heuristic and systematic processing (Maass & Clark 1983, 1984; Martin, Martin, Smith, & Hewstone, 2007; Martin & Hewstone, 2003; Martin et al., 2002; Moskowitz, & Chaiken, 2001). In heuristic processing influence is triggered by some cue in the environment (signaling, e.g., status or size) or results from the use of a consensus heuristic (i.e., "the majority is always right"). In systematic processing, which entails careful evaluation of arguments and interrelated information, influence occurs if the target of influence is persuaded by the source of influence. In the heuristic/systematic model of attitude change (Chen & Chaiken, 1999), a similar distinction is made between two strategies of information processing, also referred to as systematic processing and heuristic processing.

In the difficult task that financial investments constitute, following a majority is a heuristic that investors to some extent are likely to use. In line with this, Shiller (2000) refers to herding as "mindless" behavior in financial markets. In a recent study (Andersson, Lee, Hedesström, & Gärling, 2007) it was shown that monetary rewards of individual performance decreased and monetary rewards for following a majority increased herding. Since in the latter condition herding did not lead to economically optimal performance, the hypothesis was supported that heuristic processing, preventing critical assessment of the others' performance, mediates majority influences. Consistent with that minorities elicit systematic

processing involving critical assessment, a minority had no influence when following the minority was not economically beneficial.

The present experimental simulations of predictions of stock prices aimed at investigating the effects on influence of consistency among both majorities and minorities. As already noted, consistency has previously been shown in other contexts to be an important factor (e.g., Arbuthnot & Wayner, 1982; for a review, see Wood et al., 1994) and it is implied in any definition of herding that one follows others who are in agreement with each other. In Andersson et al. (2007) a majority-minority classification was employed based on the performance of three others on each trial, that is whether the participants made the same prediction of an “upmarket” or “downmarket” as two or three others (the majority) or one other (the minority). Since the majority or minority did not consist of the same others from trial to trial, consistency of prediction was equated with the majority-minority classification. Furthermore, in actual financial markets it is likely that perceptions of consistency are based on repeated observations over time. Consistency may then be perceived as the degree of agreement across time between investors’ predictions. In addition, consistency may be related to variance over time in investors’ predictions. Investors who are in agreement with others and do not vary their predictions substantially from time to time may appear more trustworthy and therefore exert a stronger influence.

In two experimental simulations a multiple cue probability learning (MCPL) paradigm (Busemeyer, Byun, Delosh, & McDaniel, 1997) was adopted to investigate investors’ repeated predictions of stock prices. In this paradigm the current stock price and others’ predictions are cues that are utilized in predicting the future stock price. Since the stock prices varied randomly across trials, the optimal strategy to make predictions of the price on each trial would be to use a moving mean of the price and the others’ predictions if these are uncorrelated. Otherwise, both correlations among the others and differences in variance would be necessary to take into account.

In the present study consistency in the others’ predictions is defined as variance in and correlation between others’ predictions across trials. In Experiment 1 all others’ predictions were either correlated or not, whereas in Experiment 2 the number of correlated others’ predictions was varied. In addition, Experiment 1 the variance in the others’ predictions was varied.

Experiment 1

In Experiment 1 participants repeatedly made predictions of a future stock price when they were presented with information about both the current price of the stock and the predictions made by five fictitious participants. It was hypothesized that the participants would conform to the others’ predictions when these were correlated and therefore rely less on the current price compared to when the others’ predictions were uncorrelated. The variance in each of the other participant’s predictions was also varied across trials. When the others’ predictions varied more, they were hypothesized to have less influence.

Method

Participants. The participants were 96 undergraduates (64 women and 32 men) at Göteborg University volunteering to participate in return for SEK 50 (approximately US\$18). They were recruited through sign-up sheets and electronic mails. The women’s mean age was 28.1 years ($SD = 10.8$) and the men’s mean age 29.9 years ($SD = 10.1$).

Design. Equal numbers of participants with sex and age balanced were randomly assigned to six between-groups conditions forming a 2 (Correlation: With vs. Without) by 3

(Variance: Low vs. Medium vs. High) by 50 (Trial) factorial design with trial as a repeated-measures factor.

Materials. The same sequence of 50 prices of a fictitious stock was presented in all conditions. The numbers corresponding to the prices were randomly sampled from a normal distribution ($M = \text{SEK } 500$, $SD = \text{SEK } 92$). All deviations from SEK 500 were thus random errors, rendering the expected value of the price equal to SEK 500. Predictions ostensibly made by five other participants were presented at the same time as the price. The sequences of numbers corresponding to the others' predictions were randomly sampled from three normal distributions with the same mean as the price and either low variance ($SD = 60$, range SEK454-SEK549), medium variance ($SD=100$, range SEK410-SEK594), or high variance ($SD=140$, range SEK367-SEK635). In each case the others' predictions were either highly correlated ($r >.95$) or uncorrelated ($r <.20$). All the others' predictions were uncorrelated ($r <.20$) with the price. Four random sequences of the others' predictions were presented to different participants in each condition.

Procedure. Participants were appointed via electronic mails to come to the laboratory. Upon arrival they were seated in separate cubicles. They were given a questionnaire to fill out at their own pace. A session lasted for approximately 25 minutes.

The task was to predict the price of the fictitious stock the following day. On each of the 50 trials the price of the stock on that day was presented. Additional information was given about the predictions made by five other fictitious participants who ostensibly had taken part in the experiment under identical conditions. After stating their prediction of the stock price, participants were asked to rate their confidence in the prediction by choosing a number between 0 (completely uncertain) and 100 (completely certain). The price on the next page (the next day) constituted the feedback on the accuracy of the prediction.

After having completed the task, the participants were requested to answer three questions. The first question read "To what extent did you perceive that the others' predictions varied across trials?" (awareness of variation in the others' predictions), the second question "Did you believe that the others were in agreement when they made their predictions?" (awareness of agreement among the others' predictions), and the third question "To what extent were you able to predict how much the price of the stock was going up or down the next day?" (accuracy belief). Answers to these questions were given on 9-point rating scales ranging from never (1) to always (9). Participants were finally debriefed and paid.

Results

Predictions. The squared product-moment correlations (r^2) between the price and the predictions by each participant were computed across 10 trials in each of five blocks. In multiple linear regression analyses conducted to calculate R^2 in each block, the predictions were the dependent variable and the price and the predictions of the five others the independent variables. The difference $R^2 - r^2$ is used as a measure of the influence of the others' predictions. All the following statistical analyses are performed on Fisher's z_r transformed values. Performance in the first block is excluded.

Table 1. Mean Fisher z_r transformed correlations with price across blocks in conditions with low, medium, or high variance with or without correlation (Experiment 1)

Block	Low Variance Correlation		Medium Variance Correlation		High Variance Correlation	
	Without	With	Without	With	Without	With
1	1.236	.794	1.083	.792	1.612	.840
2	1.048	.983	1.128	.957	1.166	.655
3	.765	.735	.875	.634	1.133	.722
4	.803	.579	.815	.623	1.091	.578
5	.850	.704	.952	.603	1.154	.677

The effects of the price on the predictions are displayed in Table 1. A 2 (Correlation: With vs. Without) by 3 (Variance: Low vs. Medium vs. High) by 4 (Block: 2 to 5) analysis of variance (ANOVA) with block as repeated-measures factor was performed. The results revealed no significant main effect of variance, $F(2, 90) < 1$, but in the conditions where others' predictions were uncorrelated, the participants relied reliably more on the price than did the participants in the conditions where the others' predictions were correlated ($M_{uncorrelated} = .982$ vs. $M_{correlated} = .705$), $F(1, 90) = 4.51$, $p = .036$, $\omega^2_{partial} = .04$. The main effect of block was also significant, $F(3, 270) = 5.18$, $p = .003$, Greenhouse-Geisser $\epsilon = .90$, $\omega^2_{partial} = .04$, and was associated with the linear, $t(90) = -2.57$, $p = .013$, and the quadratic trends, $t(90) = -3.18$, $p = .002$, reflecting that the reliance on the price decreased from block 2 to 4 ($M_{block2} = .991$, $M_{block3} = .811$, and $M_{block4} = .748$) but increased in the last block ($M_{block5} = .823$).

Table 2. Mean Fisher z_r transformed correlations with others' predictions across blocks in conditions with low, medium, or high variance with or without correlation (Experiment 1)

Block	Low variance Correlation		Medium variance Correlation		High variance Correlation	
	Without	With	Without	With	Without	With
1	.485	.880	.739	1.138	.447	1.288
2	.616	.948	.717	.818	.690	1.331
3	.819	.923	.848	1.077	.718	.965
4	.954	1.199	.960	1.186	.737	1.069
5	.767	1.288	.860	1.150	.670	.999

The means of the impact of the others' predictions are displayed in Table 2. A 2 (Correlation: With vs. Without) by 3 (Variance: Low vs. Medium vs. High) by 4 (Block: 2 to 5) ANOVA with block as a repeated-measures factor yielded a significant main effect of correlation, $F(1, 90) = 8.07$, $p = .006$, $\omega^2_{partial} = .07$; the participants in the conditions where the others' predictions were correlated were significantly more influenced by the others'

predictions than were those in the conditions where others' predictions were uncorrelated ($M_{correlated} = 1.080$ vs. $M_{uncorrelated} = .780$). A significant main effect of block, $F(3, 270) = 2.84, p = .041$, Greenhouse-Geisser $\epsilon = .95, \omega^2_{partial} = .02$, was associated with the linear trend, $t(90) = 2.06, p = .042$, indicating that the others' influence increased across blocks ($M_{block2} = .853, M_{block3} = .892, M_{block4} = 1.018$, and $M_{block5} = .956$). The interaction between block and variance was also significant, $F(6, 270) = 2.43, p = .029$, Greenhouse-Geisser $\epsilon = .95, \omega^2_{partial} = .13$, associated with the linear trend, $t(90) = 2.15, p = .012$. In the conditions with low and medium variance, the influence from the others' predictions increased across blocks, from $M_{low} = .782$ and $M_{medium} = .767$ in block 2 to $M_{low} = 1.027$ and $M_{medium} = 1.005$ in block 5, whereas the influence from the others' predictions decreased across blocks in the conditions with high variance, from $M_{high} = 1.010$ in block 2 to $M_{high} = .834$ in block 5.

Confidence Ratings. Means of the confidence ratings were aggregated across individuals and blocks (see Table 3).

Table 3. Mean confidence ratings across blocks in conditions with low, medium, or high variance with or without correlation (Experiment 1)

Block	Low variance Correlation		Medium variance Correlation		High variance Correlation	
	Without	With	Without	With	Without	With
1	49.7	46.3	42.8	47.4	28.9	33.6
2	43.3	43.2	40.8	41.8	28.4	29.9
3	41.7	39.9	39.6	43.1	20.1	28.9
4	42.0	39.3	36.9	42.0	20.1	28.3
5	39.9	36.7	36.7	36.9	20.8	30.5

A 2 (Correlation: With vs. Without) by 3 (Variance: Low vs. Medium vs. High) by 4 (Blocks: 2 to 5) ANOVA with blocks as repeated-measures factor yielded no significant main effect of correlation, $F(1, 90) < 1$, but a significant main effect of variance, $F(2, 90) = 3.72, p = .028, \omega^2_{partial} = .05$. Tukey post-hoc tests revealed that participants in the conditions with low and medium variance were significantly more confident in their predictions than were participants in the conditions with high variance ($M_{low} = 41.0$ vs. $M_{medium} = 39.7$ vs. $M_{high} = 25.9$). The main effect of block was significant, $F(3, 270) = 6.41, p = .001$, Greenhouse-Geisser $\epsilon = .78, \omega^2_{partial} = .05$, associated with the linear trend, $t(90) = -3.31, p = .001$, substantiating that confidence decreased from block 2 to 5 ($M_{block2} = 37.9$ vs. $M_{block3} = 35.6$ vs. $M_{block4} = 34.8$ vs. $M_{block5} = 33.9$).

Answers to Post-Experimental Questions. Three separate 2 (Correlation: With vs. Without) by 3 (Variance: Low vs. Medium vs. High) ANOVAs were conducted on the dependent variables awareness of variation in the others' predictions, awareness of agreement among the others' predictions, and accuracy beliefs. No significant differences were observed on accuracy beliefs. On the ratings of awareness of agreement, a significant main effect of correlation was revealed, $F(1, 89) = 55.57, p < .001, \omega^2_{partial} = .36$, substantiating that participants in the conditions where the others' predictions were correlated believed that the others were more in agreement than did the participants in the conditions where others' predictions were uncorrelated ($M_{correlated} = 6.8$ vs. $M_{uncorrelated} = 3.9$). With respect to awareness of variation, significant main effects of both correlation, $F(1, 89) = 19.23, p < .001, \omega^2_{partial} = .16$, and variance, $F(1, 89) = 4.49, p < .014, \omega^2_{partial} = .07$, were observed. The

participants in the conditions where the others' predictions were correlated believed that the others' predictions varied less than did the participants in the conditions where the others' predictions were uncorrelated ($M_{correlated} = 4.9$ vs. $M_{uncorrelated} = 6.4$). Awareness of variation was larger for the participants in the condition with high variance than in the condition with medium variance and larger in the condition with medium variance than in the condition with low variance in the others' predictions ($M_{high} = 6.3$ vs. $M_{medium} = 5.6$ vs. $M_{low} = 5.0$).

Discussion

As the present results showed, the participants tended to rely less on the price and conformity increased when the others' predictions were correlated compared to when they were uncorrelated. The influence from the others' predictions became stronger and the impact of the price decreased across blocks, perhaps because participants needed a number of trials to detect that the price variable lacked predictive validity. This insight might have made them to rely more on the others' predictions.

Variance in the others' predictions had no influence on conformity. Yet, high variance decreased confidence. This observation as well as the answers to the post-experimental questionnaire indicated that the differences in variance were detected. The overall impact of the others' predictions increased across blocks, whereas confidence decreased. Either this suggests that a lower confidence increases reliance on the others' predictions or that reliance on the others' predictions decreases confidence.

A possible account of the different effects of variance on conformity and confidence is that, conformity depends on a comparison of the variance in the others' predictions with the variance in the price, whereas confidence is based on the variance in the others' predictions. It was also found that conformity increased across blocks in different ways depending on the variance in the others' predictions. In the conditions with low and medium variance the conformity increased across blocks, whereas in the conditions with high variance the conformity decreased across blocks. Consistent with the account of the different effects of variance on conformity and confidence, a possibility is that participants compared the variance in the others' predictions to the variance in the price, and in the conditions with high variance, the others might have made an increasingly less reliable impression, and thus the tendency to be influenced by the others decreased. The reverse might have been true for those with low variance in their predictions.

Experiment 2

Experiment 2 investigates whether the number of correlated others modify the effect demonstrated in Experiment 1 that the correlation between the others' predictions increased conformity. It was hypothesized that increasing the number of others would increase the probability of heuristic processing, that is that the consensus heuristic is adopted. As a consequence, conformity would increase with the number of correlated others' predictions. In Experiment 2, two, three, or four of the five others' predictions were correlated.

Method

Participants. Another 72 undergraduates (49 women and 23 men) at Göteborg University volunteered to participate in return for SEK 50. They were recruited through sign-up sheets and via electronic mails. The women's mean age was 27.5 years ($SD = 9.9$) and the men's mean age 26.2 years ($SD = 9.1$).

Design. Equal numbers of participants with sex and age balanced were randomly assigned to one of three between-groups conditions in which the number of others' correlated predictions was varied at three levels (2, 3, or 4). Trial (50) was a repeated-measures factor.

Materials and Procedure. The materials were similar to the materials in Experiment 1 and presented according to the same procedure. The main change in the materials was that the predictions made by either 2, 3, or 4 other participants were correlated ($r > .95$), whereas the remaining were uncorrelated ($r < .20$). The others' predictions were uncorrelated with price ($r < .20$), and the variance in their predictions was approximately equal to the variance in price.

In order to assure that the correlations between the other participants' predictions were possible to perceive, another 18 undergraduates were recruited. These participants were upon arrival to the laboratory placed in separate cubicles where they received a booklet. On each page of the booklet representing one trial, they were shown predictions of a daily stock price ostensibly made by five other fictitious participants, each labelled by a letter (A to E). After the first ten trials, the participants were requested to state which others made similar predictions across trials. They could indicate from none to all letters representing the other participants. The procedure was repeated twice with other fictitious participants labeled F to J and K to O. The number of correlated others was varied from two to four within participants in a counterbalanced order. The positions of the correlated others was also counterbalanced. The results showed that it was somewhat easier for the participants to accurately perceive two than three or four others' correlated predictions ($M_{two} = 100\%$ compared to $M_{three} = 72\%$ and $M_{four} = 78\%$).

Results

A measure of the influence of the correlated others' predictions on each participants predictions was obtained for each block of 10 trials as the difference between an R^2 from multiple regression analyses with price and all others' predictions as independent variables and an R^2 obtained from multiple regression analyses with only price and the uncorrelated others' predictions as independent variables. The squared correlation (r^2) with the price was also computed. The following statistical analyses were performed on Fisher's z_r transformed values. The first block was excluded. The means are shown in Tables 4 and 5.

Table 4. Mean Fisher z_r transformed correlations with price across blocks in conditions with two, three or four others' correlated predictions (Experiment 2)

Block	Number of correlated others		
	2	3	4
1	1.495	1.011	1.018
2	1.120	0.724	1.008
3	0.762	0.561	0.565
4	0.721	0.556	0.613
5	0.918	0.661	0.649

Table 5. Mean Fisher z_r transformed correlations with others' predictions across blocks in conditions with two, three, or four others' correlated predictions (Experiment 2)

Block	Number of correlated others		
	2	3	4
1	.294	.586	.781
2	.334	.634	.687
3	.534	.623	.974
4	.373	.636	.991
5	.471	.692	.842

The influence of price was analyzed by means of a 3 (Number of Correlated Others: 2 vs. 3 vs. 4) by 4 (Block: 2 to 5) ANOVA with block as a repeated-measures factor. No significant main effect of the number of correlated others was revealed, $F(2, 69) = 1.28$, $p = .284$, $\omega^2_{partial} = .01$, but the participants in the conditions with two correlated others seemed to rely more on the price than did the participants in the conditions with three and four correlated others ($M_{two} = .896$ vs. $M_{three} = .626$ vs. $M_{four} = .709$). The main effect of block was significant, $F(3, 270) = 11.21$, $p < .001$, Greenhouse-Geisser $\epsilon = .94$, $\omega^2_{partial} = .13$, and was associated with the linear, $t(69) = -2.73$, $p = .008$, and the quadratic trends, $t(69) = -5.02$, $p < .001$, substantiating that participants relied more on the price in blocks 2 and 5 compared to in blocks 3 and 4 ($M_{block2} = .896$ vs. $M_{block3} = .626$ vs. $M_{block4} = .709$ vs. $M_{block5} = .709$).

Another 3 (Number of Correlated Others: 2 vs. 3 vs. 4) by 4 (Block: 2 to 5) ANOVA with block as a repeated-measures factor was performed on the measure of the influence of the others' correlated predictions. The main effect of the number of correlated others was significant, $F(2, 69) = 16.05$, $p < .001$, $\omega^2_{partial} = .31$. Tukey post-hoc tests yielded significant differences between all pairs of means ($M_{two} = .428$ vs. $M_{three} = .646$ vs. $M_{four} = .873$). The main effect of block was significant, $F(3, 270) = 3.62$, $p < .001$, Greenhouse-Geisser $\epsilon = .92$, $\omega^2_{partial} = .04$, and was associated with the linear, $t(69) = 2.05$, $p = .044$, and the quadratic trends, $t(69) = 2.18$, $p = .033$, substantiating that influence from the others' correlated predictions increased over blocks ($M_{block2} = .552$ vs. $M_{block3} = .710$ vs. $M_{block4} = .666$ vs. $M_{block5} = .668$) with a maximum in block 3.

Discussion

The results showed that conformity increased from two to three and from three to four correlated others' predictions. In the pilot study it was easier for participants to detect correlations among two correlated others compared to three and four correlated others. It is possible then that the effect of the number of others would have been even stronger if the correlations among three and four had been easier to detect. Similar to the results of Experiment 1, the conformity increased across blocks in all conditions.

General Discussion

In line with the hypothesized effect of consistency of the others' predictions across blocks of trials, in both experiments the others' predictions had more influence when they were correlated. In Andersson et al. (2007) consistency was confounded with the number of others who made the same prediction on each trial. The present results therefore more clearly demonstrate the role of consistency for herding in financial markets, where perceptions of

consistency may be based on repeated observations over time. The results of Experiment 2 showed that conformity also increased with the number of correlated others' predictions.

Experiment 1 did not show that reduced variance in the others' predictions increased conformity. One possible explanation is that variance in the others' predictions was compared to the variance in the price. The variance in the price was approximately equal to the variance in the others' predictions in the medium-variance condition. Thus, the hypothesized monotonous increase in conformity would not be expected. Another possibility is that variance in the others' predictions, like in financial markets interpreted as variation in risk taking, would make following the herd more or less attractive depending on the investors' risk attitude. This is also consistent with that confidence decreased with variance in the others' predictions.

Tanford and Penrod (1984) claimed that conformity does not change across trials. However, studies examining this claim have yielded mixed results, supporting that conformity is constant across trials (Asch, 1952), increases across trials (Nemeth, Swedlund, & Kanki, 1974), or decreases across trials (Sistrunk, 1969). The present results showed increasing conformity across trials. A possible explanation is that, due to the definition of consistency as correlations across trials, it would take some time for participants to detect these correlations.

Andersson et al. (2007) showed that monetary rewards of individual performance decreased and monetary rewards for following a majority increased conformity. They therefore argued that the existence of heuristic processing (Maass et al., 1983, 1984; Chen et al., 1999) mediated the majority influence. The present results showed an effect of the correlations between others' predictions. Detection of such correlations across trials appears to require some degree of systematic processing. However, this degree of systematic processing did not seem to entail a critical assessment of the information in the others' predictions, which actually lacked predictive validity. Perhaps the systematic processing did not do more than trigger the use of the consensus heuristic. In Experiment 2 the number of correlated others' predictions may also have triggered the use of the consensus heuristic.

A remaining issue concerns how consistency is perceived in a stock market. Anderson et al.'s (2007) definition of consistency as agreement on a single occasion downplays the fact that stock investments are made repeatedly over time. It may therefore to a larger extent involve a building up of confidence in others. Both variance in and agreement among others' predictions over time seem relevant. However, the statistical measures of variance and correlation may not fully capture these concepts. Therefore, future research should be directed towards developing better such measures.

We suggest that the present findings are valid for herding in financial markets (Hirshleifer et al., 2003). In the present experiments, following the herd was not based on a critical assessment of its performance. At the same time, an assessment had to be made of whether or not the others' were in agreement. An important lesson then is perhaps that herding is not totally but partially "mindless" (Shiller, 2000).

References

- Anderson, L. R. (2001). Payoff effects in information cascade experiments. *Economic Inquiry*, 39, 609-615.
- Anderson, L. R., & Holt, C. (1997). Informational cascades in the laboratory. *American Economic Review*, 87, 847-62.

- Andersson, M., Lee, C., Hedesström, T. M., & Gärling, T. (2007). *Effects of Financial Incentives on Herding in a Simulated Financial Market* (Göteborg Psychological Reports 3:37). Göteborg, Sweden: Göteborg University, Department of Psychology.
- Arbuthnot, J., & Wayener, M. (1982). Minority influence: Effects of size, conversion, and sex. *Journal of Psychology*, *111*, 285-295.
- Asch, S. E. (1952). *Social psychology*. Engelwood Cliffs, NJ: Prentice-Hall.
- Asch, S. E. (1956). Studies of independence and conformity: A minority of one against a unafilmous majority. *Psychological Monographs*, *70* Whole No. 416.
- Bikhchandani, S., Hirshleifer, D., & Welch, I. (1992). A theory of fads, fashion, custom and cultural change as informational cascades. *Journal of Political Economy*, *100*, 992-1026.
- Bond, R. & Smith, P.B. (1996). Culture and conformity: A meta-analysis of studies using Asch's (1952, 1956) line judgment task. *Psychological Bulletin*, *119*, 111-137.
- Bray, R. M., Johnson, D., & Chilstrom, J. T. (1982). Social influence by group members with minority opinions: A comparison of Hollander and Moscovici. *Journal of Personality and Social Psychology*, *43*, 78-88.
- Brown, R. (2000). *Group processes*. Oxford: Blackwell.
- Busemeyer, J. R., Byun, E., Delosh, E. L., & McDaniel, M. A. (1997). Learning functional relations based on experience with input-output pairs by humans and artificial neural networks. In K. Lamberts & D. Shanks (Eds.), *Knowledge concepts and categories* (pp.403-437). Cambridge, MA: MIT Press.
- Celen, B., & Kariv, S. (2004). Distinguishing informational cascades from herd behaviour in the laboratory. *American Economic Review*, *94*, 484-498.
- Chen, S. & Chaiken, S. (1999). The heuristic-systematic model in its broader context. In S. Chaiken & Y. Trope (Eds.), *Dual-process theories in social psychology* (p.73-96). New York: Guilford.
- Clark, R. D. & Maass, A. (1990). The effects of majority size on minority influence. *European Journal of Social Psychology*, *20*, 99-117.
- Drehmann, M., Oechssler, J., & Roider, S. (2005). Herding and contrarian behavior in financial markets: an internet experiment. *American Economic Review*, *95*, 1403-1426.
- Festinger, L. (1954). A theory of social comparison processes. *Human Relations*, *7*, 117-140.
- Grinblatt, M., Titman, S., & Wermers, R. (1995). Momentum investment strategies, portfolio performance, and herding: A study of mutual fund behavior. *American Economic Review*, *85*, 1088-1105.
- Guedj, O., & Bouchaud, J. P. (2005). Experts' earning forecasts: Bias, herding and gossamer information. *Science & Finance, Capital Fund Management*, 500062.
- Hirshleifer, D., & Teoh, S. H. (2003). Herd behaviour and cascading in capital markets: A review and synthesis. *European Financial Management*, *9*, 25-66.
- Hodges, B. H., & Geyer, A. L. (2006). A nonconformist account of the Asch experiments: Values, pragmatics, and moral dilemmas. *Personality and Social Psychology Review*, *10*, 2-19.
- Lascu, D. N., Bearden, W. O., & Rose, R. L. (1995). Norm extremity and interpersonal influences on consumer conformity. *Journal of Business Research*, *32*, 201-212.
- Maass, A. & Clark, R. D. (1983). Internalization versus compliance: Differential processes underlying minority influence and conformity. *European Journal of Social Psychology*, *13*, 197-215.
- Maass, A., & Clark, R. D. (1984). Hidden impact of minorities: Fifteen years of minority influence research. *Psychological Bulletin*, *95*, 428-450.

- Martin, R., Gardikiotis, A., & Hewstone, M. (2002). Levels of consensus and majority and minority influence. *European Journal of Social Psychology, 32*, 645-665.
- Martin, R., & Hewstone, M. (2003). Majority versus minority influence: When, not whether, source status instigates heuristic or systematic processing. *European Journal of Social Psychology, 33*, 313-330.
- Martin, R., Martin, P. Y., Smith, J., & Hewstone, M. (2007). Majority versus minority influence and prediction of behavioral intentions and behavior. *Journal of Experimental Social Psychology, 43*, 763-771.
- Moskowitz, G. B., & Chaiken, S. (2001). Mediators of minority social influence: Cognitive processing mechanisms revealed through a persuasion paradigm. In C. K. W. de Dreu & N. K. de Vries (Eds.), *Group consensus and minority influence* (pp. 60-90). Oxford: Blackwell.
- Moscovici, S. (1976). *Social influence and social change*. London: Academic Press.
- Moscovici, S. (1985). Social influence and conformity. In G. Lindzey & E. Aronson (Eds.). *Handbook of social psychology* (Vol. 2, 3rd ed., pp. 347-412). New York: Random House.
- Mugny, G., & Papastamou, S. (1980). When rigidity does not fail: Individualization and psychologization as resistances to the diffusion of minority innovations. *European Journal of Social Psychology, 10*, 43-61.
- Mugny, G., & Pérez, J. (1991). *The social psychology of minority influence*. Cambridge: Cambridge University Press.
- Nemeth, C. J., Wachtler, J., & Endicott, J. (1977). Increasing the size of the minority: Some gains and some losses. *European Journal of Social Psychology, 7*, 15-27.
- Shiller, R. J. (2000). *Irrational exuberance*. Princeton, NJ: Princeton University Press.
- Sias, R. W. (2004). Institutional herding. *Review of Financial Studies, 17*, 165-206.
- Sistrunk, F. (1969). Conditioning and extinction of conformity behavior. *Journal of Personality and Social Psychology, 17*, 200-207.
- Smith, L., & Sorensen, P. (2000). Pathological outcomes of observational learning. *Econometrica, 68*, 371-398.
- Tanford, S., & Penrod, S. (1984). Social influence model: A formal integration of research on majority and minority influence processes. *Psychological Bulletin, 95*, 189-225.
- Wermers, R. (2000). Mutual fund performance: An empirical decomposition into stock picking talent, style, transaction costs, and expenses. *Journal of Finance, 55*, 1655-1695.
- Wood, W., Lundgren, S., Ouellette, J. A., Busceme, S., & Blackstone, T. (1994). Minority influence: A meta-analytic review of social influence processes. *Psychological Bulletin, 115*, 323-345.