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The processing of complex information! A comparison on hypothetical and performance based payoff decisions

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Abstract

This paper investigates the processing of repeated complex information. The focus of this study is whether additional information and the introduction of performance-based payoffs have an influence on judgment. Therefore, an experiment is designed to investigate the degree of precision and of quality in interval estimates. The data shows that providing additional information decreases the precision of stated estimates, while it improves its quality. The same result is obtained when performance-based payoffs are introduced to an otherwise hypothetical decision environment. This means that, while the variation in the treatment variables increases the quality of the estimate, the precision as a reflection of the decision maker's confidence is reduced.

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1. Introduction

This paper investigates the performance of judgment tasks when the subject is receiving complex information. We use a laboratory experiment to determine how subjects perform in a task involving the estimation of information in a complex signal.. A subject's performance is determined by the degree of their confidence in the estimate and the precision of the estimate. Specifically we will show how (1) the repetition of the signal, (2) the observation of the judgment of a group, and (3) performance-based payoffs influence performance.

Whenever judgments are made on the basis of complex or incomplete information, estimates are required. Processing of complex information is important for judging one's surroundings. Since the human brain has a limited capacity for processing information (Miller 1982), estimates are used to simplify the processing tasks (San Minguel 1976, Siegler and Opfer 2003). As choice tasks increase in complexity, so does the processing of information by human beings (Miller 1988).

It is assumed that people use simple statistical methods (sample means as an estimate of true values) to simplify choice tasks (Evans and Pollard 1985). However, task simplification through estimation has a direct impact on the judgment of received signals in the form of reduced precision. This means that a limited capacity to process complex information leads to imprecise judgment (Miller 1956).

Decision makers associate varying degrees of imprecision in estimates with similarly varying degrees of uncertainty in their judgment. The higher the imprecision of an estimate, the higher will be the uncertainty associated with the judgment performed (Halberg and Teigen 2009). Following this argument we expect the estimates to be biased (Huttenlocher et al. 1990), even when people perform a task repeatedly (San Miguel 1976). Our experiment confirms this expectation by showing that repetition of the signal does improve estimates, but the degree of precision remains lower than rational models predict.

Various experiments show that the judgment of a group is better than the judgment of most of the individuals in the group (Surowiecki 2004, González et al. 2005, Bloomfield and Hales 2009). Thus, the average performance of a group is better than that of most of its members (Klugmann 1947). We analyze precision as well as quality of estimates in our experiment. While the group has a positive effect on the quality of the estimate, it decreases the individuals' confidence in their own estimate.

The economic literature generally assumes that monetary incentives have a direct impact on the performance of decision makers—although some experiments show that performance-based payment can, under certain conditions, reduce performance (Connolly et al. 1999). The latter is also the case in our experimental setting. When introducing performance-based payoffs the quality of estimates decreases as well as their precision.

2. Experiment

The experiment was conducted at the laboratory of the Otto-von-Guericke University Magdeburg. A total of 189 subjects participate in the experiment who were students from different academic backgrounds at the Otto-von-Guericke University Magdeburg. These were randomly selected using the ORSEE system (Greiner 2004) and assigned to four experimental treatments. The experimental tasks were implemented using a computerized decision environment implemented in ztree (Fischbacher 2007).

The experiment consists of the following steps. First, each participant sees a randomly generated scatter plot for 10 seconds. During this time period the participants are not able to count all the points of the scatter plot. The number of points in this case varied between sessions in a range of 130 to 250. After the scatter plot is shown to the participants they are asked to estimate the number of points shown to them. The participants are asked to specify an interval framing the true number of points in the scatter plot (Höfelmeier 1996). The upper interval bound should specify the maximal number of points and the lower bound of the interval should specify the minimal number of points the participants saw on the screen. This task is performed 10 times. The number of points remains the same, but the distribution of points in the scatter plot varies, while this fact is included in the experimental instructions handed out at the beginning of the experiment.

The experiment consists of 4 treatments in a 2x2 factorial design. The first treatment variable is the information provided to the participants. The experimental task described above represents the case where subjects do not receive any information about the estimates of other subjects (Treatment: I-). In an extension of this treatment the participants receive information about the stated intervals of the other participants in their session after each round (Treatment I+).

<table>
<tr><th>Step</th><th colspan="2">Treatment</th><th>Screen</th><th>Time Frame</th></tr>
<tr><td>1</td><td rowspan="2">I-</td><td rowspan="3">I+</td><td>Scatter plot</td><td>10 sec.</td></tr>
<tr><td>2</td><td>Provide upper and lower bound of interval</td><td>Press OK</td></tr>
<tr><td>3</td><td></td><td>Table with answers of all the other participants</td><td>Press OK</td></tr>
</table>

Table I: Experimental setting

The second treatment variable concerns the remuneration of the subjects. The first experimental conditions provide a hypothetical choice scenario, where subjects receive a fixed show-up fee of 7 euros regardless of the quality of their estimates during the experiment (Treatment: HY). The second experimental condition provides performance based payoffs, the amount of the payment being dependent on the quality of the decisions of the participants (Treatment PY). The payment is calculated by the following rule: After the expiration of the ten rounds, one round is randomly selected for payoff. In this case the payoff is determined to be incentive compatible and is calculated as described below. The subject only receives a payoff if the true number of points is within the interval stated by the participant. The monetary amount rewarded in this case depends on the width of the interval and was in this case 200 euros divided by the width of the stated interval.

	hypothetical payment	Performance based payment
without information	HYI- 48 subjects	PYI- 36 Subjects
with information	HYI+ 48 subjects	PYI+ 57 subjects

Table II: 2x2 factorial experimental design

3. Results

In the experiment, interval estimates for complex information are elicited. For the analysis, the interval width can be interpreted as a reflection of the individual's degree of confidence about the estimate. That means the smaller the stated interval the more confident the subject is with her estimate. Furthermore, a smaller interval is considered to provide higher estimate precision.

Due to the payoff formula for the interval estimate, subjects may have an incentive to decrease the interval width in the PY treatment while this incentive is not existent in the HY treatment. Therefore, we add another measure for the confidence of estimates on the group level. We calculate for every group the variance of the midpoints of the intervals to reflect the variance of interval estimates.[1] This way, we can analyze the influence of payoffs on the variance of interval estimates without the direct influence to reduce variance due to the payoff mechanism.

In addition to the precision of an estimate, within the context of this experiment, the quality of an estimate is evaluated. The degree of the quality of an estimate is investigated in the following analysis by using the distance of the midpoint of the stated interval estimate and the true number of points in the scatter plot. This way, the quality measure reflects the distance between the true value and the estimate.[2]

[1] An anonymous referee pointed this issue out to us. The comparison of influences of information on interval estimates and the influence of repetition on confidence on the individual level is unaffected by the payoff mechanism we chose. The comparison of HY and PY, however, requires the measure on the group level.

[2] Note that the literature generally uses hitrates to measure the quality of interval estimates. The hitrate indicates, how often the real number of points of the scatter plot lays within the estimated interval (Yanvi and Foster 1997). However, since the comment of the anonymous referee (see above) shows that the payoff mechanism may create an incentive to reduce the width of the interval, we use a different measure.

The following analysis deals with the question whether the precision of an estimate differs between I+ and I-. For this purpose we compare the width of the stated intervals for HYI- with HYI+, and the same for PYI- and PYI+. We find the same influence of I- and I+ for both conditions, with and without payoffs. The precision of the estimates for both I+ and I- decreases over the rounds. Furthermore, there are no significant differences between the two treatments, although subjects who have information about others' estimates have more independent observations for their estimate of the received signal (see Figure 1). However, subjects of I- in round ten have the same number of independent observations as subjects of I+ in round two. When comparing interval width for the estimates between the conditions of I+ and I-, one has to account for the fact that in I+ subjects receive more information about the initial signal than they do in I-. For the treatment I-, subjects can see a signal about the true number of points in the scatter plot ten times during the ten rounds. In I+, they receive information about the signal and 9 estimates of other participants each round. Considering the theoretical implications of forming an estimate using all available independent observations, the estimate is expected to have the same quality in round two of I+ as it has in round ten of I-. In the analysis of the interval width as a measure of estimate quality comparing the treatments I+ and I-, we compare round ten of I- with round 2 of I+.

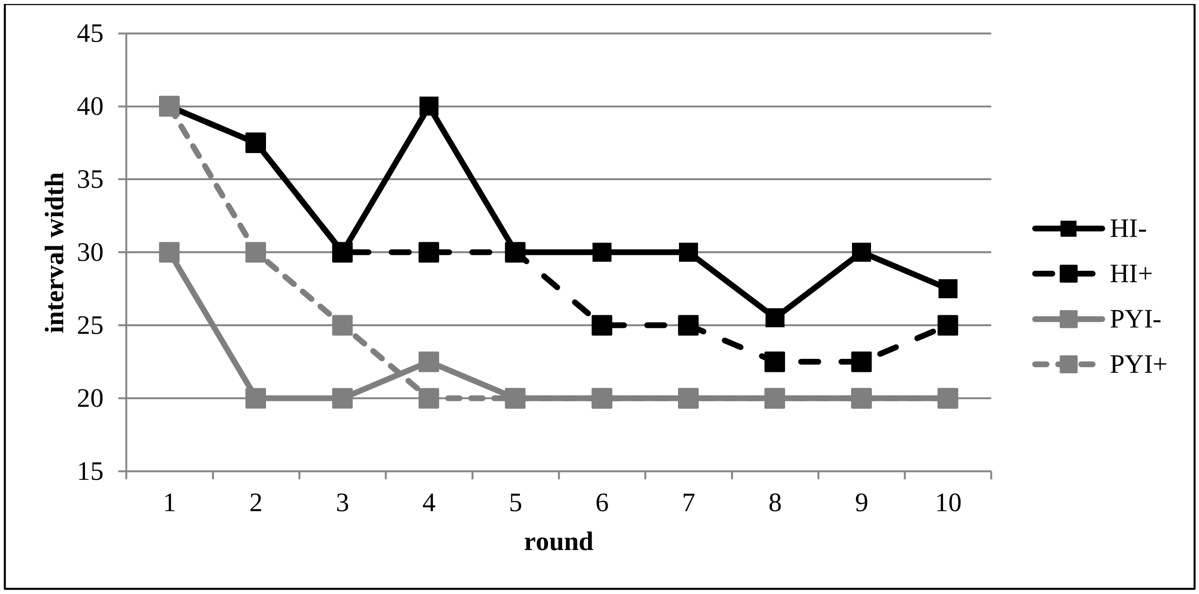

Figure 1: Interval width over the rounds

The second treatment variable makes it possible to analyze whether having a hypothetical setting or performance based payoffs has an effect on the precision of an estimate.

The variance of the midpoints shows, that the treatments I- have a higher level of variance than the treatments I+. This can also be seen by a significant difference between the variance of the treatments PYI- and PYI+ over the ten rounds (Wilcoxon-Test, 1%-level). Similarly, a significant difference between HYI- and HYI+ can be observed (Wilcoxon-Test, 1%-level). In addition the variance decreases for both treatments HYI+ and PYI+ over the experimental rounds. Therefor the decrease of the variance between the first experimental round of the treatment PYI+ and the last round PYI+ is significant (Wilcoxon-Test, 1%-level). This is also observable for the Treatment HYI+ (Wilcoxon-Test, 5%-level). In summary it can be concluded that the precision of the estimates in the I+ condition is higher than the precision of the estimates when the estimation is based on I- .

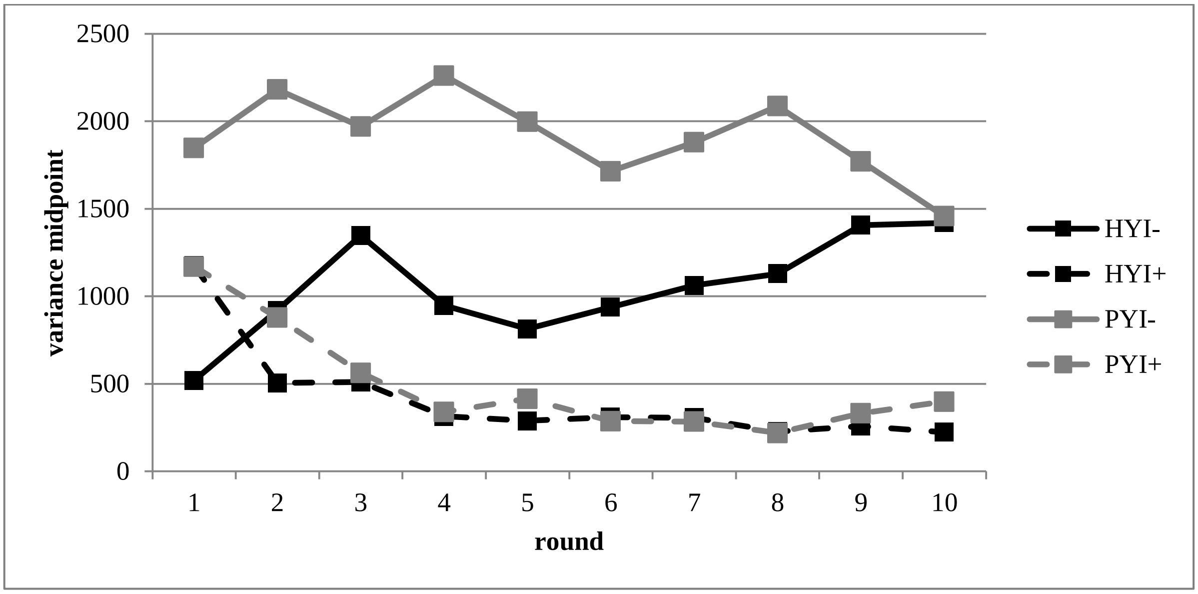

Figure 2: variance of the interval midpoint over the rounds

In the next step the influence of the treatment variables on the quality of the stated estimates is analyzed. To assess the quality of the estimates the average distance between the midpoint of the stated interval and the true number of points is considered for all rounds.

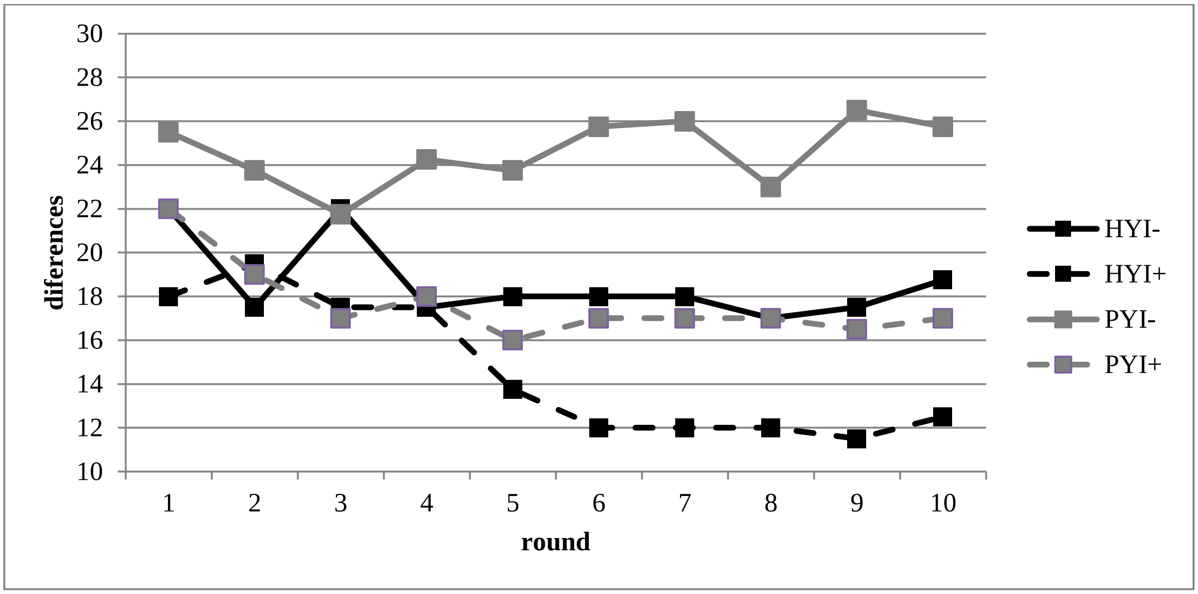

Figure 3: differences over the rounds

Again the differences of the data in the treatment conditions HYI-, HYI+, PYI- and PYI+ (Figure 1) are used to analyze the quality of the estimations which are performed repeatedly. For the data of HYI-, HYI+ and PYI+ a decrease of the differences can be seen. In other words, the quality of the estimates increases over the rounds. Furthermore the data shows that the quality of the estimates of HYI+ in round oneis significantly lower than the quality of the estimates of HYI+ in round ten (Wilcoxon-Test, 1%-level). The same result is observable for the estimates of PYI+ compared to PYI- (Wilcoxon-Test, 5%-level).

To answer the question whether the estimates are of higher quality which are performed by the participants of HY compared to those of PY, it can be seen that the estimates of HYI- have a higher quality as the estimates of PYI-. The comparison of the results of HYI+ and PYI+ also shows a higher level of quality for the estimates of HYI+.

4. Conclusion

This paper analyses the processing of repeated complex information and individual judgments of the perceived signals. Two factors are the focus of our experimental setting. One experimental setup analyses the influence of additional information on judgment and a second experimental setup addresses the question, whether the introduction of performance related payoff affects individual judgments. For the purpose of this paper, two characteristics of the performed judgment are subject to investigation: the precision and the quality of estimates.

Contrary to assumptions of economic models and models about the statistical man, providing additional information does not improve the precision of an estimate. That means it does not increase the confidence of the individuals in their stated estimates. However, providing additional information does significantly increase the quality of an estimate.

The second experimental treatment variable shows that estimates performed under conditions including performance based payoffs have a higher precision than those which are made under hypothetical conditions. Although subjects state a higher degree of confidence with their estimates, the analysis shows that the quality of their estimates is significantly reduced by the introduction of performance related payoffs.

It is striking that additional information decreases the precision of an estimate while its quality actually increases. This means that, although the quality of the estimate increases, the individual decision maker feels less confident about the statement. Furthermore it is emphasized that the introduction of performance based payoffs leads to higher precision, which is a statement of higher confidence, while the quality of estimates under these conditions is reduced. This means that, for both experimental treatment variables, confidence is reduced for situations actually leading to higher quality.

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