First-place loving and last-place loathing: How rank in the distribution of performance affects effort provision

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Supplementary Web Appendix

(Intended for Online Publication)

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A Experimental instructions

The envelope that you collected on your way in contains the instructions for this session. Please now open this envelope.

[SUBJECTS OPEN ENVELOPE]

Please look at the first page of the instructions. I am reading from these instructions. Mobile phones and any other electronic devices must now be turned off. These must remain turned off for the duration of this session. Please do not use or place on your desk any personal items, including phones, calculators, pens, pencils, etc. Please do not look into anyone else's booth at any time.

Thank you for participating in this session on decision-making. You were randomly selected from the Nuffield Centre for Experimental Social Sciences' pool of subjects to be invited to participate in this session. I remind you that the Nuffield Centre for Experimental Social Sciences has a strict no deception policy. This means that I will not mislead, misinform or lie to you at any point during this session.

During this session there will be a number of pauses for you to ask questions. During such a pause, please raise your hand if you want to ask a question. After you raise your hand, you will be approached by my assistant who will provide you with a pen and paper. You should write your question on the paper and then pass the pen and paper back to my assistant, who will pass the paper to me. I will write my answer on the paper and my assistant will then pass the paper back to you. You should read my answer and then give the paper back to my assistant. Apart from asking questions in this way, you must not communicate with anybody in this room or make any noise.

Are there any questions?

This session will last around 90 minutes. There are 17 participants taking part in this session (excluding myself and my assistants). This session will be divided into 7 rounds. The first round will be a practice round, for which you will not be paid. The remaining 6 rounds will be paying rounds. You will receive a payment of £2.50 per paying round. Additionally, you will be paid a show-up fee of £5 for your attendance today. You will be paid in cash upon your departure today. You will be paid individually in a separate room by a laboratory assistant. In each round, including the practice round, you will have 3 minutes in which you may attempt a verbal task followed by 3 minutes in which you may attempt a numerical task.

I will now describe the verbal task.

The verbal task is a "word spotting" task. A grid of letters will be displayed on your screen. You will be able to search for and select English words appearing in the grid of letters. Valid words may appear horizontally, vertically or diagonally, and may occur forwards or backwards. Valid words are taken to be those appearing in the "WordNet" or "iSpell" English dictionaries. Both British and American spellings will be recognized, and both singular and plural word forms will be permitted. However, names and abbreviations will not be recognized. Word selections can be made using your mouse. To propose a sequence of letters as a word, you should position your cursor over the first letter of the proposed word, hold down the cursor, drag the cursor to the end of the word, and release the cursor. If the selected sequence of letters is a valid word

then the selected letters will turn yellow. Please note that valid words may partly overlap and you may use the same letters in multiple words.

In each round, your performance in the verbal task will be measured by your points score in the verbal task. Your points score in the verbal task will be number of valid word selections made within the permitted time of 3 minutes. You will not be penalized for any attempts to select invalid words.

While you are completing the verbal task your screen will display the number of the current round, the remaining time for the verbal task in the current round and your current points score in the verbal task. After the 3 minutes allocated to the verbal task have elapsed, you will be moved automatically to the numerical task.

Are there any questions?

I will now describe the numerical task. The numerical task is an adding up task. This task consists of a number of questions. For each question, you will be presented with 2 2-digit numbers and you will be asked to add the numbers together. You may enter your answer using the mouse and the number-pad which will be displayed on your screen. Please note that the number keys on your keyboard have been disabled and hence you should enter your answer using your mouse. If your answer is correct then you will be moved to the next question and new numbers for adding up will appear on your screen. If your answer is incorrect then you will remain on the same question and you will be able to enter another answer. You will only be moved to the next question once you have answered the current question correctly.

In each round, your performance in the numerical task will be measured by your points score in the numerical task. Your points score in the numerical task will be the number of questions answered correctly within the permitted time of 3 minutes. You will not be penalized for any incorrect answers. While you are completing the numerical task your screen will display the number of the current round, the remaining time for the numerical task in the current round and your current points score in the numerical task.

Are there any questions?

In each round all participants in this room will be presented with the exact same versions of the verbal and numerical tasks. This means that in any given round everybody will see the exact same grid of letters in the verbal task and will be presented with the exact same questions, in the same order, in the numerical task. The verbal and numerical tasks will vary randomly from round to round. However, the difficultly of the tasks will not vary systematically over rounds.

After the practice round there will be a pause for questions and then the 6 paying rounds will start. In each of the 6 paying rounds, after completion of the 2 tasks, there will be a 4 minute break. During this 4 minute break, you will receive feedback about your total points score in that round. Note that by "total points score in that round" I mean the number obtained by adding together your points score in the verbal task in that round and your points score in the numerical task in that round.

The feedback that you will receive during the 4 minute break after completion of the 2 tasks will be as follows:

- {Baseline group and Sub-treatments 1-3}

  Your total points score in that round will be displayed on your screen for 1 minute.

- {Sub-treatment 1}

  During the remaining 3 minutes of the break, your rank among the participants in this room in that round will be displayed on your screen.

- {Sub-treatment 2}

  During the remaining 3 minutes of the break, I will personally and privately inform each of you about your rank in that round among the participants in this room. I will do this by handing you a card indicating your rank and I will point to where your rank is written on the card.

- {Sub-treatment 3}

  During the remaining 3 minutes of the break, all participants will be asked to stand up and I will publicly inform each of you about your rank in that round among the participants in this room.

- {Sub-treatments 1-3}

  The participant with the highest total points score in that round will be ranked first, the participant with the second highest points score will be ranked second, and so forth. Any ties will be broken at random.

Are there any questions?

The practice round will start shortly. During this practice round, you will have 3 minutes to complete the verbal task, followed by 3 minutes to complete the numerical task. After completion on the 2 tasks you will be told your total points score. Because this is a practice round, you will not be paid for this round.

Are there any questions?

Please look at your screen now and press the start button. If you have a technical problem with your computer during the practice round then please raise your hand.

[PRACTICE ROUND]

The practice round is now over. Are there any questions?

We will shortly move to the paying rounds. Recall, you will receive a payment of £2.50 per paying round. Note that your payment will not depend on your points scores in the tasks. In each round, after completion of the 2 tasks there will be a 4 minute break during which you will receive feedback about your total points score. Specifically:

[INFORMATION ABOUT TREATMENT-SPECIFIC FEEDBACK REPEATED]

Once the first paying round commences there will be no further opportunities for questions. Are there any questions at this point?

Please look at your screen now. If you have a technical problem with your computer during any of the 6 paying rounds then please raise your hand. Reminder, you must not speak at any time.

[6 PAYING ROUNDS]

The session is now complete. Please fill in the questionnaire. When you have submitted it, please raise your hand and wait to be called to a separate room where you will be paid by a laboratory assistant. Once you have been paid you are free to leave the building. Thank you for participating.

B Appendix on response to the content of rank-order feedback

B.1 Response to session characteristics

As explained in Section 3.2, the tied-groups estimator uses across-session ties from round 1 that only include subjects from the same sub-treatment. As noted in footnote 24, it is valid to use these within-sub-treatment across-session ties if, within sub-treatment, subjects do not condition first-round effort on any characteristics of the session itself, such as characteristics of the other subjects in the session or the time or day of the session. To test whether, within sub-treatment, subjects condition effort on session characteristics, we test the joint significance of the effects of the session dummies on effort provision after controlling for sub-treatment level effects by including sub-treatment dummies. To increase precision, we also control for sub-treatment-specific effects of a subject's own demographic characteristics on effort provision.

Formally, we estimate the following equation for effort in round 1:

$$\begin{aligned} \text{Effort}_{n,s,1} &= \sum_{k\in\mathcal{S}} \varrho_k \mathbf{1}_{\{k\}}(s) + \sum_{m=1}^{3} \phi_m \mathbf{1}_{\{m\}}(\text{Sub–treatment}) + \sum_{m=1}^{3} \theta_m X_{n,s} \mathbf{1}_{\{m\}}(\text{Sub–treatment}) \\ &+ \xi_{n,s,1} \qquad \text{for } n = 1, ..., N;\ s = 1, ..., S, \end{aligned} \tag{1}$$

where the indicator function $\mathbf{1}_{\{\cdot\}}(x)$ takes the value 1 if $x = \cdot$ and zero otherwise. In the above, $\mathcal{S}$ is the set of sessions forming the Treatment group, excluding one arbitrarily chosen session per sub-treatment. The vector $X_{n,s}$ contains a dummy variable for each possible combination of the subject's own demographic characteristics (see Section 2.4 for a description of the demographic characteristics), excluding one arbitrarily chosen reference category. Finally, $\xi_{n,s,1}$ denotes the unexplained component of first-round effort.

As noted above, our aim is to test the joint significance of the effects of the session dummies on effort provision. The first column of Table SWA.1 shows the p value for the joint null hypothesis that $\varrho_k = 0$ for all $k \in \mathcal{S}$: we comfortably fail to reject the hypothesis that subjects do not condition effort on session characteristics. Further, if subjects do not condition effort on any characteristics of the session itself, then the coefficients on the session dummies should be jointly zero for any transformation of first-round effort. Columns 2-4 report p values for three such transformations. For all three transformations, again we comfortably fail to reject the hypothesis that subjects do not condition effort on session characteristics.

	(1) $\text{Effort}_{n,s,1}$	(2) $\text{Effort}_{n,s,1} \leq 50$	(3) $\text{Effort}_{n,s,1} \leq 75$	(4) $\text{Effort}_{n,s,1} \leq 100$
p value	0.346	0.554	0.301	0.472
Mean of dependent variable	74.129	0.110	0.549	0.910
Subjects	255	255	255	255

Notes: p values are for the joint test that $\varrho_k = 0$ for all $k \in \mathcal{S}$ in (1) and use heteroskedasticity-consistent standard errors. In Column 1 the dependent variable is effort in round 1. In Columns 2, 3 and 4 the dependent variable takes the value 1 if effort in round 1 is less than or equal to 50, 75 and 100, respectively, and is zero otherwise.

Table SWA.1: Tests for response to session characteristics.

B.2 Comparisons to standard panel data estimators

In this section, we show that the tied-groups estimation procedure is critical to obtaining reliable results on how effort responds to the content of rank-order feedback. In more detail, we show that the rank response functions obtained from standard random and fixed effects panel data estimators differ markedly from the rank response function obtained using the tied-groups estimator and illustrated in Figure 2. In particular, the standard panel data estimators do not detect first-place loving or last-place loathing. These results suggest that the standard panel data estimators suffer from the confounds due to serial dependence discussed in Section 3.2.

Figure SWA.1 compares the fully flexible rank response function, obtained in Section 3.4.1 using the tied-groups estimation procedure and illustrated in Figure 2, to the rank response functions obtained from standard random and fixed effects panel data estimators. To maintain comparability, we continue to normalize the average value of the rank response function over the $N = 17$ possible ranks to zero. Figure SWA.1 shows that the standard panel data estimators are unable to replicate the results obtained using the tied-groups estimator.

We now describe formally the random and fixed effects panel data estimators that we use. First, we estimate the fully flexible rank response function (2) using the following panel regression of effort with a linear control for lagged effort and subject random effects:

$$\begin{aligned}\text{Effort}_{n,s,r} = \sum_{k=1}^{N} v_k \mathbf{1}_{\{k\}}(\text{Rank}_{n,s,r-1}) + g_r + bX_{n,s} + \psi \text{Effort}_{n,s,r-1} + \mu_{n,s} + e_{n,s,r} \\ \text{for} \quad n = 1, ..., N; \;\; s = 1, ..., S; \;\; r = 2, ..., R, \end{aligned} \tag{2}$$

where the indicator function $\mathbf{1}_{\{k\}}(\text{Rank}_{n,s,r-1})$ takes the value 1 if $\text{Rank}_{n,s,r-1} = k$ and zero otherwise. In this model: g_r for $r = 2, ..., R$ are round fixed effects; $X_{n,s}$ consists of dummy variables for each combination of demographic characteristics; $\mu_{n,s}$ is a permanent subject-level unobservable, assumed to be a random effect; and $e_{n,s,r}$ denotes all further unobserved effort shifters.

Second, we estimate the rank response function using the following panel regression of first differenced effort with subject random effects:

$$\begin{aligned}\text{Effort}_{n,s,r} - \text{Effort}_{n,s,r-1} = \sum_{k=1}^{N} v_k \mathbf{1}_{\{k\}}(\text{Rank}_{n,s,r-1}) + g_r + bX_{n,s} + \mu_{n,s} + e_{n,s,r} \\ \text{for} \quad n = 1, ..., N; \;\; s = 1, ..., S; \;\; r = 2, ..., R. \end{aligned} \tag{3}$$

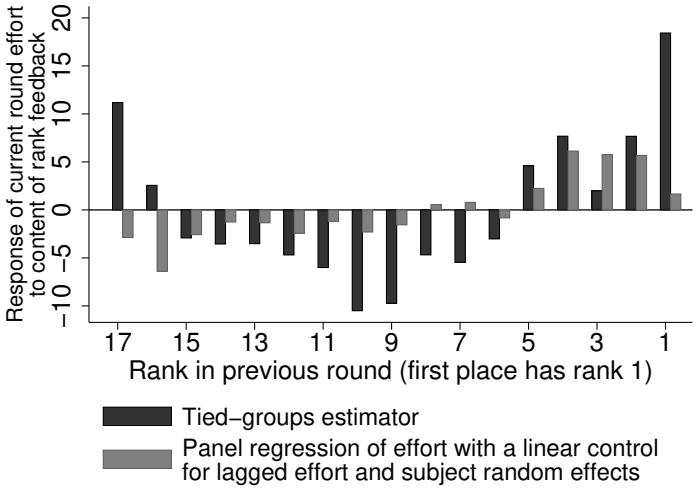
This model was adopted by Charness et al. (2014, p.47), and is identical to that given by (2) except that here the coefficient on effort in the previous round is fixed at unity instead of being estimated.

Third, we estimate the rank response function using the following panel regression of effort with subject fixed effects:

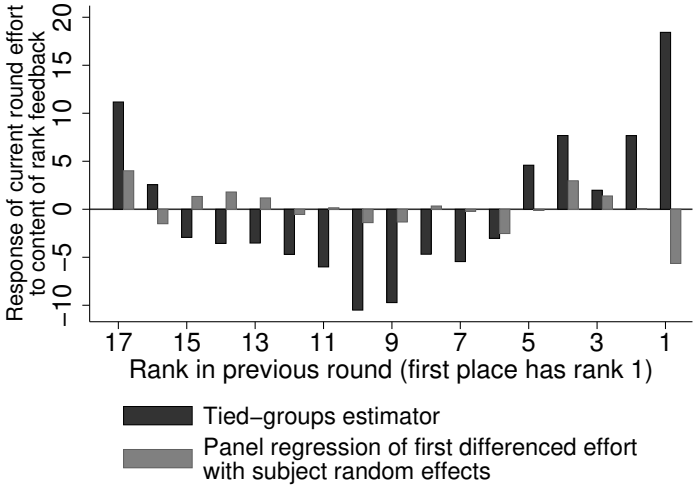
$$\begin{aligned}\text{Effort}_{n,s,r} = \sum_{k=1}^{N} v_k \mathbf{1}_{\{k\}}(\text{Rank}_{n,s,r-1}) + g_r + \mu_{n,s} + e_{n,s,r} \\ \text{for} \quad n = 1, ..., N; \;\; s = 1, ..., S; \;\; r = 2, ..., R. \end{aligned} \tag{4}$$

In this model: $\mathbf{1}_{\{k\}}(\text{Rank}_{n,s,r-1})$, g_r and $e_{n,s,r}$ are as in (2); and $\mu_{n,s}$ is a subject fixed effect. The subject fixed effects absorb all effects of demographic characteristics on the level of effort provision, and hence $X_{n,s}$ is absent from (4). In addition to the confounds due to serial dependence discussed in Section 3.2, we note that the fixed effects specification given by (4) also suffers from a further problem: since rank in the previous round is not strictly exogenous with respect to the errors, $e_{n,s,r}$, the inclusion of subject fixed effects will give rise to an endogeneity problem.[1] We note that this further problem does not apply to the models given by (2) and (3) because the permanent subject effects in these models are random effects instead of fixed effects.

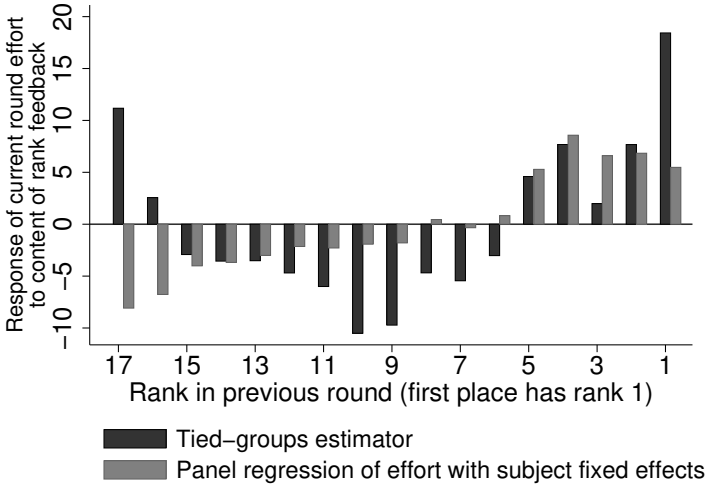
[1] In more detail, note that: (i) previous rank is a function of previous effort and thus of the error term in the previous round; and (ii) including subject fixed effects is equivalent to differencing each observation relative to the subject-specific mean. In the differenced equation, therefore, both differenced previous rank and the differenced error depend on errors from all rounds, which implies mechanical correlation between differenced previous rank and the differenced error. The Arellano and Bond (1991) IV estimator can help with this issue, but does not eliminate the confounds due to serial dependence discussed in Section 3.2.



(a)



(b)



(c)

Figure SWA.1: Rank response functions obtained from the tied-groups estimator and from random and fixed effects panel data estimators.

C The impact of providing rank-order feedback on average effort

In this section, we start by considering how rank-order feedback affects average effort, and we then analyze the impact of rank-order feedback on the dynamics of how effort provision evolves over rounds. Figure SWA.2 shows round-by-round average effort for the Baseline group and each of the sub-treatments.

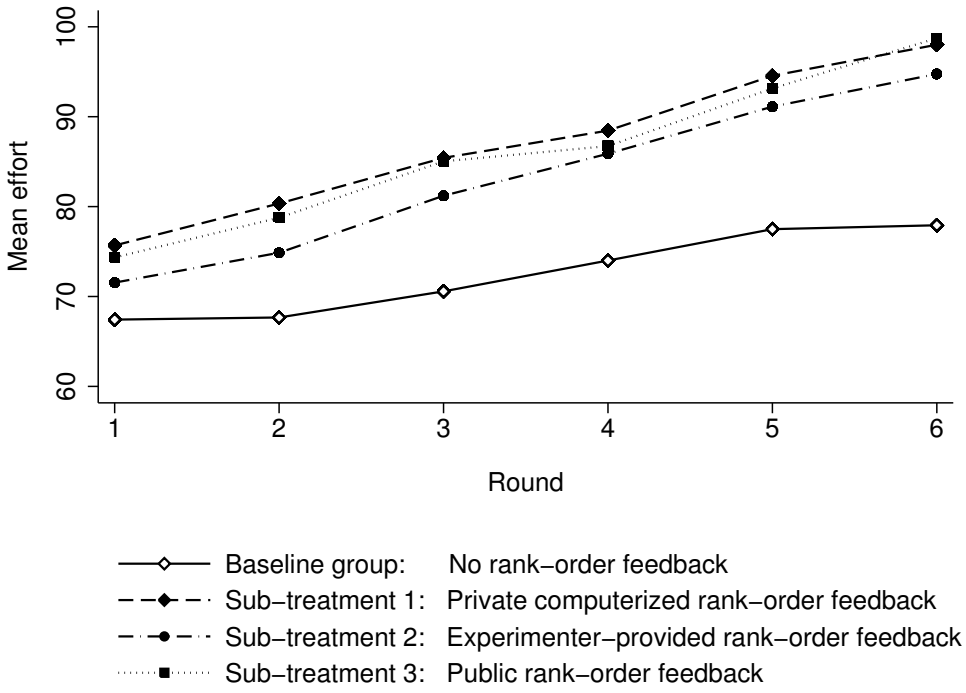


Figure SWA.2: Round-by-round mean effort by sub-treatment.

We can see from Figure SWA.2 that average effort is substantially higher when subjects are given rank-order feedback. The regressions reported in Table SWA.2 formalize this finding. Looking first at the left-hand-side column of Panel I, we see that rank-order feedback increases effort by about 20% on average, and the increase is statistically significant at the 1% level. The left-hand-side column of Panel II shows that public, private and experimenter-provided feedback all increase effort substantially and statistically significantly. Finally, the left-hand-side column of Panel III shows that the differences in effort provision according to the nature of the rank-order feedback are small and statistically insignificant. Thus, we find no evidence that public and private rank-order feedback motivate our subjects differently. The middle column of Table SWA.2 shows that the anticipation of rank-order feedback motivates our subjects to work harder even in the first round before they have received any rank-order feedback. The right-hand-side column of Table SWA.2 shows the effect of rank-order feedback after the first round, when subjects have been exposed to the feedback at least once. Table SWA.3 shows that the results in Table SWA.2 are robust to including demographic controls. Table SWA.4 provides the regression results round by round.

As described in Section 2.1, we used a flat-wage payment scheme: subjects were paid the

same fixed amount per round independent of performance. The flat wage allows us to isolate the pure effect of feedback about rank in the distribution of performance uncontaminated by any preference over rank in the distribution of earnings or a desire for monetary benefits associated with higher rank. The fact that we find that our subjects respond strongly to private rank-order feedback suggests that the subjects care about their own (first-order) beliefs about their rank in the distribution of performance; that is subjects have a desire for 'self esteem'. The fact that we find no difference in the degree to which public and private rank-order feedback motivate our subjects suggests that the subjects do not care about their (second-order) beliefs about the beliefs of others about their rank in the distribution of performance; that is subjects have little desire for 'social esteem'. Our laboratory setting with random selection of subjects ensures that any taste for social esteem is independent of longer-term reputational concerns.

Next, we consider the impact of rank-order feedback on the dynamic evolution of effort provision over rounds. We can see from Figure SWA.2 that effort increases over rounds and that this increase is particularly pronounced when subjects are given rank-order feedback. Table SWA.5, which reports the results of regressions of effort on a linear round trend, formalizes these findings (note that the estimated linear round trends are invariant to the inclusion of demographic controls, since demographics are round-invariant). The left-hand-side column of Panel I shows a statistically significant positive linear round trend for the subjects exposed to rank-order feedback: the per-round increase in effort is 5.5% of the average level of effort across all rounds for subjects in the Treatment group. The rest of Panel I shows that the round trend varies little according to the nature of the rank-order feedback.[2] Panel II shows that there is a more modest, but still statistically significant, positive round trend for subjects not exposed to rank-order feedback: the per-round increase in effort is 3.4% of the average level of effort across all rounds for subjects in the Baseline group. The left-hand-side column of Panel III (together with Panel II) shows that effort increases almost twice as fast over rounds for subjects exposed to rank-order feedback when compared to subjects that never receive such feedback, with the difference statistically significant at the 1% level. Finally, the rest of Panel III shows that effort increases faster over rounds with rank-order feedback, irrespective of whether the feedback is provided publicly or privately.

In summary, the path of effort over rounds is substantially steeper when subjects are given rank-order feedback. It seems that the desire to rank highly in the distribution of performance spurs the subjects to learn more quickly how to improve their performance over time in the real-effort tasks. Once again, a desire for self esteem rather than social esteem appears to drive behavior, since moving from private to public feedback has no influence on the evolution of effort provision over rounds.

[2]The differences are small and far from being statistically significant. Using the regressions underlying Panel I, the difference between the round trends in ST1 and ST3 has a two-sided $p = 0.623$; for ST1 and ST2, $p = 0.559$; and for ST2 and ST3, $p = 0.888$.

	All rounds	Round 1	Rounds 2–6
Panel I: Regressions of effort on rank-order feedback treatment indicator			
Treatment indicator	13.219***	6.698**	14.523***
	[0.000]	[0.023]	[0.000]
	(3.431)	(2.928)	(3.596)
Intercept	72.513***	67.431***	73.529***
	[0.000]	[0.000]	[0.000]
	(3.140)	(2.658)	(3.294)
Subject-round observations	1836	306	1530
Panel II: Regressions of effort on sub-treatment indicators			
Sub-treatment 1 (ST1) indicator	14.562***	8.245**	15.825***
	[0.000]	[0.013]	[0.000]
	(3.813)	(3.307)	(3.993)
Sub-treatment 2 (ST2) indicator	10.715***	4.113	12.035***
	[0.008]	[0.242]	[0.004]
	(3.984)	(3.505)	(4.171)
Sub-treatment 3 (ST3) indicator	13.610***	6.910**	14.951***
	[0.001]	[0.046]	[0.001]
	(4.053)	(3.445)	(4.250)
Intercept	72.513***	67.431***	73.529***
	[0.000]	[0.000]	[0.000]
	(3.142)	(2.667)	(3.296)
Subject-round observations	1836	306	1530
Panel III: Differences in average effort between sub-treatments			
ST1 minus ST3	0.952	1.335	0.875
	[0.777]	[0.649]	[0.803]
	(3.350)	(2.930)	(3.504)
ST1 minus ST2	3.847	4.132	3.790
	[0.240]	[0.169]	[0.267]
	(3.266)	(3.000)	(3.408)
ST2 minus ST3	-2.896	-2.797	-2.915
	[0.414]	[0.376]	[0.432]
	(3.543)	(3.152)	(3.706)

Notes: Panel I reports results from Ordinary Least Squares regressions of effort on an indicator for being in the Treatment group (the Baseline group forms the reference category). Panel II reports results from Ordinary Least Squares regressions of effort on indicators for being in Sub-treatment 1, Sub-treatment 2 and Sub-treatment 3 (the Baseline group forms the reference category). Panel III reports average effort differences between sub-treatments, computed from the regressions underlying Panel II. Two-sided p values are shown in square brackets and heteroskedasticity-consistent standard errors, with clustering at the subject level to account for within-subject non-independence across rounds, are shown in round brackets. *, ** and *** denote significance at the 10%, 5% and 1% levels (2-sided tests).

Table SWA.2: Effect of rank-order feedback on effort provision.

	All rounds	Round 1	Rounds 2–6
Panel I: Regressions of effort on rank-order feedback treatment indicator			
Treatment indicator	13.348***	6.521**	14.714***
	[0.000]	[0.041]	[0.000]
	(3.749)	(3.176)	(3.947)
Intercept	72.723***	67.571***	73.753***
	[0.000]	[0.000]	[0.000]
	(4.352)	(3.815)	(4.598)
Subject-round observations	1836	306	1530
Panel II: Regressions of effort on sub-treatment indicators			
Sub-treatment 1 (ST1) indicator	13.988***	7.516**	15.282***
	[0.001]	[0.038]	[0.000]
	(4.117)	(3.603)	(4.320)
Sub-treatment 2 (ST2) indicator	10.421**	4.040	11.698***
	[0.012]	[0.275]	[0.007]
	(4.117)	(3.695)	(4.319)
Sub-treatment 3 (ST3) indicator	15.027***	7.395**	16.554***
	[0.001]	[0.045]	[0.000]
	(4.393)	(3.667)	(4.636)
Intercept	72.913***	67.584***	73.979***
	[0.000]	[0.000]	[0.000]
	(4.278)	(3.784)	(4.523)
Subject-round observations	1836	306	1530
Panel III: Differences in average effort between sub-treatments			
ST1 minus ST3	-1.040	0.120	-1.272
	[0.760]	[0.969]	[0.721]
	(3.406)	(3.062)	(3.561)
ST1 minus ST2	3.566	3.475	3.584
	[0.268]	[0.270]	[0.284]
	(3.211)	(3.147)	(3.337)
ST2 minus ST3	-4.606	-3.355	-4.856
	[0.197]	[0.304]	[0.195]
	(3.563)	(3.256)	(3.735)

Notes: All results were obtained as described in the notes to Table SWA.2, except that the regressions additionally include a dummy variable for each combination of demographic characteristics with the reference category being female, born in the United Kingdom, aged below 22 and studying a STEMM subject (see Section 2.4 for a description of the demographic characteristics). Two-sided p values are shown in square brackets and heteroskedasticity-consistent standard errors, with clustering at the subject level to account for within-subject non-independence across rounds, are shown in round brackets. *, ** and *** denote significance at the 10%, 5% and 1% levels (2-sided tests).

Table SWA.3: Robustness of results in Table SWA.2 to including demographic controls.

	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6
Panel I: Regressions of effort on rank-order feedback treatment indicator						
Treatment indicator	6.698**	10.690***	13.600***	13.192***	15.675***	19.459***
	[0.023]	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]
	(2.928)	(3.485)	(3.832)	(3.397)	(3.948)	(4.273)
Intercept	67.431***	67.667***	70.569***	74.000***	77.490***	77.922***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
	(2.658)	(3.153)	(3.527)	(3.088)	(3.617)	(3.889)
Subject-round observations	306	306	306	306	306	306
Panel II: Regressions of effort on sub-treatment indicators						
Sub-treatment 1 (ST1) indicator	8.245**	12.676***	14.853***	14.451***	17.059***	20.088***
	[0.013]	[0.001]	[0.001]	[0.000]	[0.000]	[0.000]
	(3.307)	(3.938)	(4.261)	(3.821)	(4.369)	(4.862)
Sub-treatment 2 (ST2) indicator	4.113	7.201*	10.637**	11.882***	13.627***	16.828***
	[0.242]	[0.083]	[0.015]	[0.002]	[0.003]	[0.001]
	(3.505)	(4.140)	(4.341)	(3.885)	(4.592)	(5.066)
Sub-treatment 3 (ST3) indicator	6.910**	11.098***	14.467***	12.729***	15.651***	20.808***
	[0.046]	[0.008]	[0.002]	[0.002]	[0.001]	[0.000]
	(3.445)	(4.164)	(4.533)	(4.124)	(4.707)	(4.974)
Intercept	67.431***	67.667***	70.569***	74.000***	77.490***	77.922***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
	(2.667)	(3.164)	(3.539)	(3.099)	(3.629)	(3.902)
Subject-round observations	306	306	306	306	306	306
Panel III: Differences in average effort between sub-treatments						
ST1 minus ST3	1.335	1.578	0.386	1.722	1.408	-0.720
	[0.649]	[0.660]	[0.917]	[0.625]	[0.716]	[0.865]
	(2.930)	(3.582)	(3.696)	(3.522)	(3.861)	(4.234)
ST1 minus ST2	4.132	5.475	4.216	2.569	3.431	3.260
	[0.169]	[0.124]	[0.224]	[0.428]	[0.357]	[0.453]
	(3.000)	(3.554)	(3.458)	(3.239)	(3.719)	(4.341)
ST2 minus ST3	-2.797	-3.897	-3.829	-0.847	-2.024	-3.979
	[0.376]	[0.306]	[0.313]	[0.814]	[0.623]	[0.374]
	(3.152)	(3.802)	(3.787)	(3.591)	(4.111)	(4.466)

Notes: All results were obtained as described in the notes to Table SWA.2. Two-sided p values are shown in square brackets and heteroskedasticity-consistent standard errors are shown in round brackets. *, ** and *** denote significance at the 10%, 5% and 1% levels (2-sided tests).

Table SWA.4: Round-by-round effect of rank-order feedback on effort provision.

Panel I: Regressions of effort on linear round trend variable for Treatment group and sub-treatments				
	Treatment group (T)	Sub-treatments ST1	ST2	ST3
Linear round trend	4.677***	4.495***	4.842***	4.765***
	[0.000]	[0.000]	[0.000]	[0.000]
	(0.233)	(0.421)	(0.419)	(0.353)
Intercept	74.039***	75.838***	71.124***	74.212***
	[0.000]	[0.000]	[0.000]	[0.000]
	(1.306)	(2.117)	(2.287)	(2.358)
Subject-round observations	1530	612	408	510
Panel II: Regression of effort on linear round trend variable for Baseline group (B)				
Linear round trend	2.439***			
	[0.000]			
	(0.450)			
Intercept	66.416***			
	[0.000]			
	(2.804)			
Subject-round observations	306			
Panel III: Differences between Treatment group (T) or sub-treatment and Baseline group (B)				
	T minus B	ST1 minus B	ST2 minus B	ST3 minus B
Linear round trend	2.239***	2.056***	2.403***	2.326***
	[0.000]	[0.001]	[0.000]	[0.000]
	(0.503)	(0.614)	(0.612)	(0.569)
Intercept	7.623**	9.422***	4.708	7.795**
	[0.014]	[0.008]	[0.194]	[0.034]
	(3.070)	(3.498)	(3.604)	(3.649)

Notes: The results in Panels I and II were obtained from Ordinary Least Squares regressions of effort on a linear round trend variable that takes the value of 0 in round 1, and increases linearly to the value of 5 in round 6. The results reported in Panel III were computed from the regressions underlying Panels I and II. Two-sided p values are shown in square brackets and heteroskedasticity-consistent standard errors, with clustering at the subject level to account for within-subject non-independence across rounds, are shown in round brackets. *, ** and *** denote significance at the 10%, 5% and 1% levels (2-sided tests).

Table SWA.5: Trends in effort provision over rounds.

D The effect of rank-order feedback according to the competitiveness of subjects

At the end of each experimental session, we asked subjects to report their degree of competitiveness. The categories were as follows: (a) "I am strongly competitive. I am always interested in how my performance compares to the performance of others."; (b) "I am moderately competitive. I often take interest in how my performance compares to the performance of others."; and (c) "I am not competitive at all. I do not compare my performance to the performance of others." Fewer than 10% of subjects reported themselves to be not competitive at all. Thus, for the purposes of the analysis, we merge the second and third categories, giving a simple binary categorization of subjects as: (i) 'strongly competitive'; or (ii) 'not strongly competitive'.

Since our measure of competitiveness is based on a post-experimental self-report, we need to check that the proportion of subjects who reported themselves to be strongly competitive does not depend on whether the subjects were exposed to rank-order feedback during the experiment. We find that 33.7% of subjects in the Treatment group reported themselves to be strongly competitive, compared to 34.0% of subjects in the Baseline group.

The left-hand-side and middle columns of Table SWA.6 replicate the regression reported in the left-hand-side column of Panel I in Table SWA.2 for, respectively, strongly competitive subjects and not strongly competitive subjects. Looking first at the left-hand-side column of Table SWA.6, we see that for strongly competitive subjects rank-order feedback increases average effort across the six rounds substantially and statistically significantly. The middle column shows that rank-order feedback also increases average effort substantially and statistically significantly for the subjects that are not strongly competitive. The right-hand-side column shows that the effect of rank-order feedback on average effort varies little according to subject competitiveness: the difference in the effect of rank-order feedback is small and far from being statistically significant. The right-hand-side column further shows that when subjects are not exposed to rank-order feedback, strongly competitive subjects work about 20% harder than those that are not strongly competitive, with the difference statistically significant at the 5% level.

In summary, with or without rank-order feedback, strongly competitive subjects are motivated to work much harder on average, while the extra motivation induced by rank-order feedback is the same whether subjects are strongly competitive or not. To understand what might underlie this result, note that subjects might form beliefs about their rank in the distribution of performance even in the absence of rank-order feedback, and the subjects might care about these beliefs. Furthermore, recall that 'strongly competitive' was equated with always being interested in how one's performance compares to that of others. Thus, one possible explanation of our findings is that strongly competitive subjects are more highly motivated to work hard to improve their beliefs about their rank in the distribution of performance even when they do not receive any feedback, while the extra motivation induced by providing the rank-order feedback does not vary according to subject competitiveness.

	Strongly competitive	Not strongly competitive	Difference
Treatment indicator	12.642**	13.251***	-0.609
	[0.032]	[0.001]	[0.932]
	(5.823)	(4.090)	(7.099)
Intercept	81.618***	68.141***	13.476**
	[0.000]	[0.000]	[0.038]
	(5.264)	(3.781)	(6.467)
Subject-round observations	618	1212	1830

Notes: All results were obtained from Ordinary Least Squares regressions of effort on an indicator for being in the Treatment group (the Baseline group forms the reference category). One subject did not report her competitiveness. Two-sided p values are shown in square brackets and heteroskedasticity-consistent standard errors, with clustering at the subject level to account for within-subject non-independence across rounds, are shown in round brackets. *, ** and *** denote significance at the 10%, 5% and 1% levels (2-sided tests).

Table SWA.6: Effect of rank-order feedback on effort provision according to subject competitiveness.

Next, we consider how competitiveness interacts with the dynamic evolution of effort provision over rounds. The left-hand-side and middle columns of Table SWA.7 replicate the regressions reported in the left-hand-side column of Table SWA.5 for, respectively, strongly competitive subjects and not strongly competitive subjects. The left-hand-side column of Table SWA.7 shows that the qualitative findings reported in Table SWA.5 extend when we restrict attention to strongly competitive subjects: effort increases over rounds with and without rank-order feedback, but the path of effort over rounds is steeper when subjects are given rank-order feedback. The middle column of Table SWA.7 shows that the same qualitative findings also hold for subjects that are not strongly competitive. The right-hand-side column of Panel I in Table SWA.7 shows that when rank-order feedback is provided, effort increases faster over rounds for strongly competitive subjects compared to the rate of increase for subjects that are not strongly competitive. The right-hand-side column of Panel II shows that the same is true when rank-order feedback is not provided. Finally, the right-hand-side column of Panel III shows that the impact of rank-order feedback on the evolution of effort provision is a little weaker for strongly competitive subjects, but the difference is not close to being statistically significant.

In summary, the path of effort over rounds is substantially steeper for strongly competitive subjects, while both strongly competitive and not strongly competitive subjects increase their effort faster over rounds when rank-order feedback is provided. As discussed above, the more competitive subjects might be more highly motivated to work hard to improve their beliefs about their rank in the distribution of performance even when they do not receive any feedback: this extra motivation might also spur the strongly competitive subjects to learn more quickly how to improve their performance over time.

Finally, we consider whether competitiveness interacts with how subjects respond to the content of rank-order feedback. Using the same methodology as for the demographic characteristics (Section 3.4.3), we find no statistically significant differences according to competitiveness: a test of the joint significance of the interactions between the previous rank variables and an indicator for being strongly competitive gives $p = 0.607$. Thus we find that both strongly competitive

and not strongly competitive subjects exhibit first-place loving and last-place loathing.

The existing literature on how competitiveness interacts with the provision of relative-performance feedback is sparse. Using a different measure of competitiveness that emphasizes the desire to win rather than performance comparisons more generally, Gerhards and Siemer (2014) find that more competitive subjects work harder only in one of two tasks, and then only with feedback about the winner of an award. Girard and Hett (2013) measured competitiveness by the willingness to enter a tournament rather than be paid piece-rate, and find that more competitive teams work less hard and respond more strongly to interim rank information during the course of a between-team competition.

	Strongly competitive	Not strongly competitive	Difference
Panel I: Treatment group			
Linear round trend	5.597***	4.209***	1.387***
	[0.000]	[0.000]	[0.004]
	(0.392)	(0.284)	(0.483)
Intercept	80.268***	70.869***	9.399***
	[0.000]	[0.000]	[0.001]
	(2.296)	(1.536)	(2.754)
Subject-round observations	516	1014	1530
Panel II: Baseline group			
Linear round trend	4.092***	1.771***	2.321**
	[0.000]	[0.001]	[0.014]
	(0.786)	(0.487)	(0.911)
Intercept	71.387***	63.713***	7.674
	[0.000]	[0.000]	[0.200]
	(4.847)	(3.514)	(5.903)
Subject-round observations	102	198	300
Panel III: Differences between Treatment group and Baseline group			
Linear round trend	1.504*	2.438***	-0.934
	[0.083]	[0.000]	[0.362]
	(0.859)	(0.558)	(1.022)
Intercept	8.881*	7.156*	1.725
	[0.093]	[0.060]	[0.789]
	(5.243)	(3.790)	(6.453)

Notes: All results were obtained from Ordinary Least Squares regressions of effort on a linear round trend variable that takes the value of 0 in round 1, and increases linearly to the value of 5 in round 6. The results reported in Panel III were computed from the regressions underlying Panels I and II. One subject did not report her competitiveness. Two-sided p values are shown in square brackets and heteroskedasticity-consistent standard errors, with clustering at the subject level to account for within-subject non-independence across rounds, are shown in round brackets. *, ** and *** denote significance at the 10%, 5% and 1% levels (2-sided tests).

Table SWA.7: Trends in effort provision over rounds according to subject competitiveness.

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