The Influence of a Competition on Non-Competitors

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Abstract

We report a series of experimental studies that investigate the influence of a competition on non-competitors who do not participate in it but are aware of it. Our work is highly relevant across many domains of social life where competitions are prevalent, as it is typical in a competition that the competitors are far outnumbered by these non-competitors. In our field experiment involving pay-what-you-want entrance at a German zoo (N = 22,886), customers who were aware of a competition over entrance payments, but did not participate in it, paid more than customers who were unaware of the competition. Further experiments provide confirmatory and process evidence for this contagion effect, showing that it is driven by heightened social comparison motivation due to mere awareness of the competition. Moreover, we find evidence that the reward level for the competitors could moderate the contagion effect on the non-competitors. Even if an individual does not participate in a competition, their behavior can still be influenced by it; and this influence can change with the characteristics of the competition in an intriguing way.

Significance Statement

Competitions are prevalent in social life, but it is typical in a competition that the competitors are far outnumbered by people who do not participate in it but are aware of it. In a series of experimental studies, we find that the mere awareness of a competition can affect a non-competitor's performance in similar tasks. In our field experiment involving pay-what-you-want entrance at a German zoo, customers who were aware of a competition over entrance payments, but did not participate in it, paid more than customers who were unaware of it. Further experiments provide confirmatory evidence for this contagion effect, and suggest that it is due to non-competitors becoming motivated to act more competitively upon being aware of the competition.

From workplace to classrooms, from social media to sports fields, competitions are ever-present in social life. The recent rise in gamification strategies (1) in areas such as education, crowdsourcing, and marketing, further popularizes attempts to motivate people by engaging them in competitions. However, such initiatives may not always induce full or majority participation among the target population: it is typical in a competition that the competing individuals are far outnumbered by people who do not participate in it but are aware of it. Consider a fundraising event organizer who charges attendees on a pay-what-you-want basis for entry to the event, and in addition advertises a voluntary competition with rewards for the top donors. If the competition has a participation fee or requests personal contact information for participation, many attendees may not enter into it. What impact might the competition still have on the entrance payments of these non-competing attendees?

Alternatively, consider a business organization in which two senior partners vie for the role of the managing partner. It is pertinent for the firm's board of directors to promote the senior partner with the better performance. It might then be natural to expect that the two senior partners, when told they are in consideration for the promotion, would respond competitively with improved effort and performance at work. Would the other staff, who are aware of the competition but are not participating in it themselves, be influenced by this competition in their own office work?

A third example comes from the fact that, in innovative market places, competition is often encouraged and winners are rewarded by public bodies. If these incentives are targeted at only a few leading players, what influence could they have on the rest of the industry?

In these cases, as in other similar circumstances, could the competition have any power in influencing the non-competitors? Could simply making people aware of an ongoing competition

produce a contagion effect on their behavior? If yes, the design and public communications of competitions should factor in influences on non-competitors too. These questions highly warrant investigations and are the central objectives of the present article, in which we report affirmative evidence from a large-scale field experiment and three follow-up studies.

Note that, throughout this article, we define *competitors* as individuals who are performing a task with the knowledge that the best-performing individual(s) among themselves will receive rewards; the rewards can be material (e.g., cash) or symbolic (e.g., recognition by the organizer). In the context of a specific competition, *non-competitors* can broadly mean anyone who is not a competitor; here, we use the term as a shorthand to particularly refer to individuals who are aware of the ongoing competition and are performing an identical or similar task as the competitors, but without the competition rewards as incentives. Non-competitors in this sense abound in many scenarios, as in the examples above.

Lastly, the term *contagion* as used here should be distinguished from its use in the context of social contagion or social influence (2-6). Social contagion is largely about how people might be affected by observations of the expressions or behavior of others. Here, the term "contagion" refers specifically to any behavioral impact of the *mere awareness* of an ongoing competition on non-competitors' task performance, without any information about the actual behavior of the competitors. The designs of our studies do not involve communicating information about competitors' performance – or behavior in general – to the non-competitors. The non-competitors in our studies are only informed that there is a competition; in other words, they are merely aware of the competition. Yet we still obtain supporting evidence for the contagion effect.

Theoretical Development

There has been substantial research on behavior in competitions, from works in the early and mid-20th century (7,8) to recent studies in psychology, economics, and management (9-11). These studies have largely focused on competitors' behavior and how it is motivated by social comparison – the human tendency to self-evaluate by comparing oneself with others (12). For example, Garcia et al. (10) proposed a general model in which various situational and individual factors could influence social comparison concerns, which could in turn influence competitive behavior. But the model was proposed for individuals who are directly engaged in competitions; this and other related models have rarely, if ever, touched on the influence of a competition on non-competitors.

Here, in a departure from the theorizing in previous literature, we surmise that the awareness of a competition can induce in non-competitors perceptions of rivalry among competitors, if only in a *vicarious* form: "sensing the heat of the game" despite not participating in it. Perceptions of rivalry can be understood as the consciousness that the competitors would strive towards overtaking each other's competition performance, in order to achieve the goal of winning the competition (9). A major driver of such competitive activities is social comparison. Perceptions of rivalry might then also induce in non-competitors a heightened social comparison motivation, such as by making social comparison more salient (see the General Discussion for further details). The result is increased effort and improved performance among non-competitors, and hence the contagion effect.

In the following sections, we report a series of experimental studies that establish positive evidence for the contagion, as well as process evidence in the support of our theoretical development.

Study 1: Contagion in Monetary Payment

Study 1 is a large-scale field experiment that provides evidence for the existence of the posited contagion effect in a monetary payment context. The experiment involved pay-what-you-want (PWYW) entrance at a German zoo. Under PWYW pricing, all customers face the decision of how much to pay (which can be zero or any positive amount) for the target product (good or service). PWYW can be a tool by which we can study how people's economic decisions can be affected by behavioral factors, whether situational or individual (13-16). Study 1 leverages this possibility by superimposing a customer competition over PWYW pricing. Our setup demonstrates how customers who were aware of the competition, but opted to not participate in it, might still be influenced by the very existence of that competition, as manifested in those customers' monetary payment under PWYW.

We also examine the robustness of our hypothesized contagion effect across competitions with different framing and reward structures – which can be subsumed under the situational factor of incentive structures in models of competitive behavior such as (10). It is plausible that, if the contagion effect exists at all, it might be significant only when the competition is very explicitly worded as it is communicated to the non-competitors; or that the reward structure needs to give the impression of fierce competition, such as having only one prize for the very best performer. Our experimental design addresses these possible boundary conditions.

The major findings are summarized in Table 1. In the control condition, the mean PWYW payment at the entrance is 5.42 Euros, which is predictably lower than the regular adult admission fee of 14 Euros. But the fact that the mean payment is non-negligibly positive, as opposed to zero (as standard economic reasoning might predict), is consistent with previous empirical findings that people often make a positive payment under PWYW. Also, the mean

PWYW payment among competing customers in every treatment condition is significantly higher than the mean payment under the control condition.

What is most surprising, but in agreement with the contagion effect of a competition on non-competitors, is that the mean payment of *non-competing* customers in every treatment conditions is significantly higher than the control condition mean. The overall mean payment of non-competing customers is 5.76 Euros (s.d. = 2.99 Euros, 95% CI: [5.69,5.82])), which is 0.34 Euros higher than the mean payment in the control condition, representing a 6.27% increase that is statistically significant ($t(21,232)=8.43$, $P<0.01$). As noted in Table 1, the same conclusions hold for pairwise *t*-tests comparing each treatment condition with the control condition.

On the surface, our results are subject to several potential confounding factors that are peculiar to this field setting. They are related to the non-competitors possibly feeling guilty or inferring that the zoo needed to raise funds, as well as more general self-selection issues. In the *SI Appendix*, we discuss why the design of our study and our observations from the field do not lend support to the first two confounding factors. But the third confounding factor, namely self-selection, is a potential concern. It is thus important to identify the contagion effect when participation in competition is exogenously assigned. We address these issues in Study 2A.

Study 2A: Contagion in the Performance of a Real Effort Task

Study 2A provides confirmatory evidence for the existence of the contagion effect in a more controlled experimental setting. In the design of this study, we assign competition participation exogenously and randomly to study participants, and therefore the self-selection confounding factor in the setting of Study 1 is not applicable. Our primary purpose is to observe whether non-competing participants' performance scores in a task *change* (resulting in a within-subjects difference) once they are informed that some other participants are competing over the

same task. Our second purpose is to demonstrate the contagion effect in a highly different context from Study 1's monetary payment. Instead of monetary payment, participants in Study 2A are asked to perform a well-defined real effort task conducted through a computer interface. The design consists of six rounds of the task. The first four rounds are identical for all participants; but in round 5-6, participants in the treatment conditions are informed that they have been randomly assigned into a 50-person group, half of which are further randomly assigned to be competitors for a cash reward (manipulated at two levels across conditions) while the other half are assigned to be non-competitors.

In our data analysis, we divide the six rounds into three blocks of two rounds each. We then calculate, for the control condition and then for each role in each treatment condition, descriptive statistics of the performance scores. The results are summarized in Table 2. As is apparent from the table, there is a learning effect over the first four rounds in all conditions and with both roles in the treatment conditions. But there is a plateauing in the control condition from block 2 (round 3-4) to block 3 (round 5-6), so that there is no significant difference in performance scores over those two blocks. By contrast, performance scores increase significantly among *non-competitors*, once they are informed about the competition, at both reward levels in the treatment conditions. Unlike the competitors, non-competitors have no incentives to perform differently in round 5-6, when they know about an ongoing competition that does not involve them. Thus, we have obtained evidence for the contagion effect in the treatment conditions across both reward levels. Lastly, as might be expected, performance scores increase significantly between blocks 2 and 3 among competitors in every treatment condition.

Since all participants went through the same four initial rounds in the experiment, potential between-subjects effects in round 5-6 might have been diminished by the identical

initial experience. But pairwise *t*-test comparisons still reveal significant differences in performance scores over round 5-6 between the control condition and all but one of the treatment conditions, with marginally significant difference for the remaining treatment condition (see Table 2). Moreover, all pairwise *t*-test comparisons of mean performance scores in block 3 among the treatment conditions yield $P > 0.1$. Lastly, between-subjects differences in any of the first two blocks between the control and any treatment condition are all non-significant ($P > 0.1$ in all relevant *t*-tests). These results, wherever pertaining to non-competitors, lend further support to the contagion effect.

Study 2B: The Necessity of the Awareness of a Competition; Eliminating Alternative Mechanisms

Study 2B provides evidence that the awareness of a competition is necessary for the contagion effect in the two previous studies; for this purpose, Study 2B has an experimental design that closely follows that of Study 2A, except that there is no competition.

Study 2B is important, as the previously observed contagion is subject to explanations via alternative mechanisms that do not require the awareness of a competition. In the *SI Appendix*, we propose, in detail, several examples of such alternative mechanisms; they are respectively related to group dynamics, the presence of an additional incentive, and a potential anchoring effect induced by non-competitors hypothesizing higher performance levels among competitors. To address these concerns, the design of Study 2B involves an incentive scheme in place of a competition. A participant of the scheme will be entered into a lottery draw to win a cash reward if his/her performance scores reaches a threshold. As in Study 2A, participation roles are randomly assigned within each 50-person groups - with half of the group being assigned to be participants and the other half being assigned to be non-participants. We therefore maintain the

group assignment, the presence of an additional incentive, and the possibility of an induced anchoring effect among non-participants; the only change is that there is no competition. If we observe no contagion effect in Study 2B, we would obtain evidence that the contagion effect in previous studies is necessitated by the awareness of a competition, and none of the alternative mechanisms proposed in the *SI Appendix* could account for it.

We use a similar data analysis approach as in Study 2A by dividing the six rounds into three blocks of two rounds each, and focus on the presence or absence of within-subjects effects. The block-by-block descriptive statistics are summarized in Table 3. There is a learning effect over the first four rounds in all but one of the conditions. Once the incentive scheme is introduced in block 3 (round 5-6), there was – as noted in Table 3 – a statistically significant improvement in performance among participants in the scheme, when the reward is sufficiently high at $10. But otherwise, there is no significant improvement in performance, in particular among non-participants of the scheme ($P > 0.25$ in all within-subjects *t*-test comparisons between block 2 and block 3), unlike among the non-competitors in Study 2A; in fact, non-participants of the scheme perform slightly *worse* on average upon learning about the scheme and their non-participating role. In addition, we find no significant differences between any condition in Study 2B and the control condition in Study 2A ($P > 0.5$ in all pairwise *t*-test comparisons). To sum up, despite maintaining similar group assignment design and reward levels as in Study 2A, the incentive scheme in Study 2B does not lead to any significant contagion effect. Study 2B thus provides support for the fact that the contagion effect in Study 1 and 2 is necessitated by non-competitors being aware of a competition.

Study 3: Further Process Evidence; Contagion Moderated by Competition Reward

Study 3 has two major objectives. First, it aims to provide more direct process evidence for the contagion effect. The process measurements would have been highly prone to demand effect in Study 2A, because participants in the treatment conditions in that study would have experienced a change of role from round 4 to round 5. In the present study, the competition roles were assigned from the beginning of the study, thereby minimizing demand effect concerns.

The second objective of Study 3 is to demonstrate how non-competitors' performance could change as the competition reward increases across conditions. Since the non-competitors are not competing for the reward, any moderating effect of the reward level provides additional support for a contagion effect. In relation, we introduce a no-monetary-reward competition condition in the design. This serves as a clear low-end boundary of reward level; it is also motivated by findings from previous research (17) that symbolic social incentives, in addition to monetary incentives, could play a significant role in motivating task performance.

The process evidence objective of this study is intertwined with the objective to demonstrate a moderating effect of the competition reward on contagion. We propose that, as the reward increases, non-competitors have heightened perceptions of rivalry among the competitors, which result in heightened social comparison motivation and more positive contagion. But we also conjecture that, if the reward level is sufficiently high compared with what the non-competing participants are receiving from the task, it can possibly induce an additional, counteracting reference effect (18). That is, the non-competitors compare their task payment with what a competitor *could* earn from the experiment, and perceive their task payment as substantially low in comparison; this perception can have a general negative impact on the monetary and social comparison motivational drivers of performance. At sufficiently high reward levels, it can possibly lead to a negative moderating effect as reward further increases.

Recall that, in Study 2A, reward level did not seem to moderate contagion in round 5-6, as non-competitors' performance scores in round 5-6 did not differ across reward levels with statistical significance. But, as pointed out before, Study 2A was not primarily designed to detect such between-subjects effect: since all participants went through the same four initial rounds in the experiment, potential between-subjects effects in round 5-6 might have been diminished.

This calls for a different design that is more conducive to detecting between-subjects effects. As such, Study 3 consists of four rounds of the same task as in Study 2A, *but* without any initial no-competition rounds. That is, from round 1 onwards, the participant is either a competitor or non-competitor, and the competition is based on the total performance score over all four rounds. The reward of the competition is manipulated at three levels across conditions. These include a $0-reward level, which is motivated by (17) as explained above. The other two reward levels are $0.5 and $10. They are, respectively, commensurate with and much higher than the typical earnings from an MTurk task with a similar duration (around 10 minutes) as the study (19). Moreover, the high reward level of $10 is designed to be much higher than the payment to non-competitors (a participation fee of $0.5), so as to facilitate the demotivating reference effect discussed earlier. Approximately one-third (as opposed to half in Study 2A) of the participants are assigned to be competitors. To give further contrast to our posited effects and process evidence, we also conducted a number of lottery control conditions. The design of those conditions closely follows the positive cash reward conditions among the competition conditions, except that, where there would be a competition, in its place is a lottery in which every lottery participant had an equal probability to receive the reward in addition to the participation fee.

Table 4 lists the mean total performance score in each condition; see also the top panels of Fig. 1. We first analyze how non-competitors' performance in the competition conditions

changes according to the reward level, and find an inverted-U pattern that is consistent with our conjectured moderation effects of the reward level on contagion: when the reward is low (reward = \$0.5), the performance of non-competitors is higher than when the reward is nil (reward = \$0; $t(169)=2.37$, $P=0.019$), as well as when the reward is high (reward = \$10; $t(170)=2.33$, $P=0.021$). Also, competitors' performance scores across reward levels has a U-shaped pattern that is consistent with previous research such as (12) (see the *SI Appendix*). Meanwhile, in the lottery control conditions, the lottery itself does not create differences in scores by participation role or reward level. A 2(lottery reward) × 2(lottery participation role) between-subjects ANOVA does not yield any significant main effects or interaction ($P > 0.25$ in all cases). Consistent with similar results from Study 2B, there is no contagion effect in the lottery control conditions.

Process Evidence. In all conditions, we administer three self-report questions to all participants at the end of the experiment. These questions are: "How hard did you try?" (a measure of effort), "To what extent were you motivated by the payment you could receive?" (a measure of monetary motivation) and "To what extent were you motivated by a wish to score higher than other participants?" (a measure of social comparison motivation). Every question is to be answered over a seven-point response scale. Analysis on the self-report measures reveals that, when the reward level increases from nil (\$0) to low (\$0.5), non-competitors' effort increases significantly ($t(169)=2.75$, $P<0.01$), while their social comparison motivation increases marginally ($t(169)=1.71$, $P=0.089$). When the reward level increases from low (\$0.5) to high (\$10), non-competitors' effort decreases significantly ($t(170)=-2.59$, $P = 0.011$) and so does their social comparison motivation ($t(170)=-2.09$, $P = 0.039$). It thus appears that the non-competitors' social comparison motivation changes with the reward level of the competition. These changes follow a similar pattern as their effort as well as performance scores.

General Discussion

In investigating the influence of a competition on non-competitors, the present research dives into important but underexplored domains of a major area of human behavior. We provide evidence that the awareness of a competition leads to heightened social comparison motivation among the non-competitors, resulting in the contagion effect.

We conjecture that the detailed psychological mechanisms behind this phenomenon could consist of two stages. In the first stage, the mere awareness of a competition induces in non-competitors perceptions of rivalry among competitors, even if only in a vicarious form. The second stage possibly consists of two types of psychological effects. One is the activation of mental representations – such as imageries or ideas – related to competition. This then leads to a heightened social comparison motivation as the result of a priming effect. The priming effect can make non-competitors act *as if* they were competitors, and can produce significant behavioral influence; see (20) and the studies discussed therein. Meanwhile, non-competitors' perceptions of rivalry could also lead to a vicarious form of competitive arousal. As defined in (9) and (21), competitive arousal is an emotional state that can arise during competitive interaction; it is highly irrational and does not require economic interests, or actual participation in a competition, to be effective. Thus it is plausible that a competition can induce competitive arousal even for non-competitors, which then heightens the non-competitors' social comparison motivation.

In sum, the awareness of an ongoing competition can induce perceptions of rivalry among the non-competitors, which might then lead to possible priming effect and vicarious competitive arousal, which could coexist and could both cause a heightened social comparison motivation. The heightened social comparison motivation then results in the contagion effect. These possible intermediate processes merit future research.

The contagion effect we investigate has general relevance in many social domains in the real world. Attempts to motivate people by competitions, as often seen in gamification strategies, might involve only a limited number of competitors. Yet, competitions can influence competitors as well as a potentially much larger number of non-competing individuals who are aware of them. It is therefore important to consider these non-competitors when designing competitions. For instance, as we have shown, higher rewards might motivate competitors more, but can also become demotivating to non-competitors.

Non-competitors can be important to the success of a fundraising event, a company's productivity, a team's strength, or a classroom's progress. Just because an individual does not take part in a competition does not mean they are unaffected by the social comparison dynamics created by it. Our work provides evidence that there can indeed be an influence, and moreover, the influence can change in an intriguing way according to the characteristics of the competition.

Materials and Methods

Study 1. The field experiment took place at a zoo in a major German city from mid-December 2013 to early January 2014, when PWYW entrance was offered to all customers. Prior to the experiment, ethical clearance was obtained from RWTH Aachen University, the second author's institution at that time; the experiment was exempt from informed consent at the institution. Four treatment conditions, each a competition over entrance payments, took place simultaneously during part of this period; the remainder of the PWYW period constituted the control condition for comparison. Every customer in the treatment conditions was randomly assigned to one condition and did not know about the existence of the other conditions. The treatment conditions differ according to whether the competition is presented as a reward scheme in neutral wordings, or explicitly presented as a contest among customers; and, whether there are

one or seven prizes (see the *SI Appendix*). The total value of the prizes is controlled across treatment conditions to be equivalent to one annual family pass to the zoo (worth 145 Euros) plus 400-Euros worth of Amazon Gift Cards.

In every treatment condition, the customer was given a short, one-page questionnaire at the entrance to the zoo. The questionnaire begins with information about the relevant competition. The customer was then requested to state whether he/she would like to participate in the competition; if the customer opted to be a competitor, he/she would need to provide contact details in the questionnaire. Regardless of the reply to the question about participation in the competition, the customer then needed to write down how much he/she would like to pay for their entrance to the zoo. If the customer was accompanying one or more children, he/she would also need to state the additional price(s) paid for them. In the control condition, the questionnaire did not mention any competition, but began directly with the request to state payments for entrance. In all conditions, the customer was also asked to state whether he/she was visiting the zoo for the first time during the period of the experiment, as well as their gender. After completing the questionnaire, the customer took it to the admission counter, and paid the stated amounts on the questionnaire. Note that the non-competing customers in the treatment conditions were not informed about the payments of competing customers. Moreover, the winners of the competitions were only announced after the PWYW period was over.

Study 2A. We conducted Study 2A in an Amazon Mechanical Turk (MTurk) environment following commonly accepted standards of practice (22). After excluding participants based on attention checks and honesty checks, the observations of 557 participants are included in the study (out of an initial number of 720 participants), including 352 (63.20%) females and 205 (36.80%) males. Most (434, or 77.92%) of the participants were aged between

25 and 54. Prior to the experiment, ethical clearance was obtained from Cambridge Judge Business School, the first author's institution. Informed consent was obtained from all participants at the beginning of the study using an online form.

The experimental task (see the *SI Appendix*) is an adaptation from (23) using the Qualtrics interface. In the task, the participant is presented with 60 identical sliders on the computer screen; each slider is positioned at 0 on a scale with markings that range from 0 to 100. The task is to move, by dragging or clicking the computer mouse, as many of these sliders as possible from the starting position at 0 to exactly 50, the mid-point of the scale, within one minute and 15 seconds. The participant's performance score in the task is the number of sliders (out of 60) that he/she has positioned at the mid-point of the scale at the end of the task. The experimental design consists of one control condition and eight treatment conditions across which competition context, competition role, and competition reward are manipulated (see the *SI Appendix* for further discussion). In all conditions, participants are informed at the start that they would be paid a fixed participation fee of $0.5. They are also informed that the study consists of two sections, namely Section A to be followed by Section B.

Section A is identical in all conditions, and consists of four rounds of the slider task. Participants in all conditions are fully informed about the tasks in Section B at the beginning of Section B, but not before. In the control condition, Section B consists of two more rounds of the slider task with no additional incentives. In the treatment conditions, the two sections are the within-subjects competition context manipulations of the experiment: at the beginning of Section B, every participant is informed that he/she is randomly matched with 49 other participants to form a 50-person group; they are then informed that half of their group are assigned to compete over their total performance scores. Within the same group, the competing participant with the

highest total performance score among competing participants would be the winner and could receive a monetary reward; ties would be settled by a coin toss. The remaining half of the participants are fully informed about the competition, but are assigned to be non-competitors. The assignment of competitors and non-competitors forms the between-subjects manipulation of competition role. Lastly, to examine the robustness of our hypothesized contagion effect, we vary the competition cash reward level between $0.5 (low) and $10 (high) across treatment conditions. These form the between-subjects manipulation of competition reward.

Study 2B. We conducted Study 2B over MTurk following the same standards of practice as in Study 2A. After excluding participants based on attention checks and honesty checks, the observations of 328 participants are included in the study (out of an initial number of 400 participants), including 196 (59.76%) females and 132 (40.24%) males. Most (248, or 75.61%) of the participants were aged between 25 and 54. Prior to the experiment, ethical clearance was obtained from Cambridge Judge Business School, the first author's institution. Informed consent was obtained from all participants at the beginning of the study using an online form.

Study 2B closely follows the six-round slider task design of the treatment conditions in Study 2A. But, instead of a competition and a random assignment of roles into competitors and non-competitors in round 5-6 (Section B), there is an incentive scheme in that section without any competitive elements, and a random assignment of roles into participants and non-participants of that scheme. The incentive scheme is such that, if a participant of the scheme achieves a total performance score of 100 (5/6 of the maximum possible score of 120) or more over round 5-6, he/she will be entered into a lottery in which one entrant will be randomly chosen to earn a pre-specified cash reward; all entrants into the lottery have an equal chance of winning the reward. Across conditions the cash reward is manipulated at $0.5 and $10, as with

the reward levels in Study 2A. We choose the threshold of 100 for the incentive scheme because, across the conditions in Study 2A, 100 is approximately the upper quartile among the total performance scores in round 5-6. As in the treatment conditions in Study 2A, study participants in Study 2B are informed at the start of Section B that they are randomly assigned to a 50-person group, half of whom are further randomly assigned to be participants of the incentive scheme.

Study 3. We conducted Study 3 over MTurk following the same standards of practice as in Study 2A. After excluding participants based on attention checks and honesty checks, the observations of 657 participants are included in the study (out of an initial number of 805 participants), including 356 (54.19%) females and 301 (45.81%) males. Most (491, or 74.73%) of the participants were aged between 25 and 54. Prior to the experiment, ethical clearance was obtained from Cambridge Judge Business School, the first author's institution. Informed consent was obtained from all participants at the beginning of the study using an online form. Every participant does four rounds of the slider task for a participation fee of $0.5. In the competition treatment conditions, participants at every level of competition reward ($0 versus $0.5 versus $10) are informed that approximately one-third of them are assigned to be competitors. In the lottery control conditions, participants at every level of lottery reward ($0.5 versus $10) are informed that approximately one-third of them are assigned to be lottery participants.

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Fig. 1. Means of major dependent variables in Study 4 by cash reward level condition ($0, $0.5, $10) and plotted with 10% error bars. Thick and dotted lines refer to the competition (*N*=449) and lottery conditions (*N*=208), respectively.

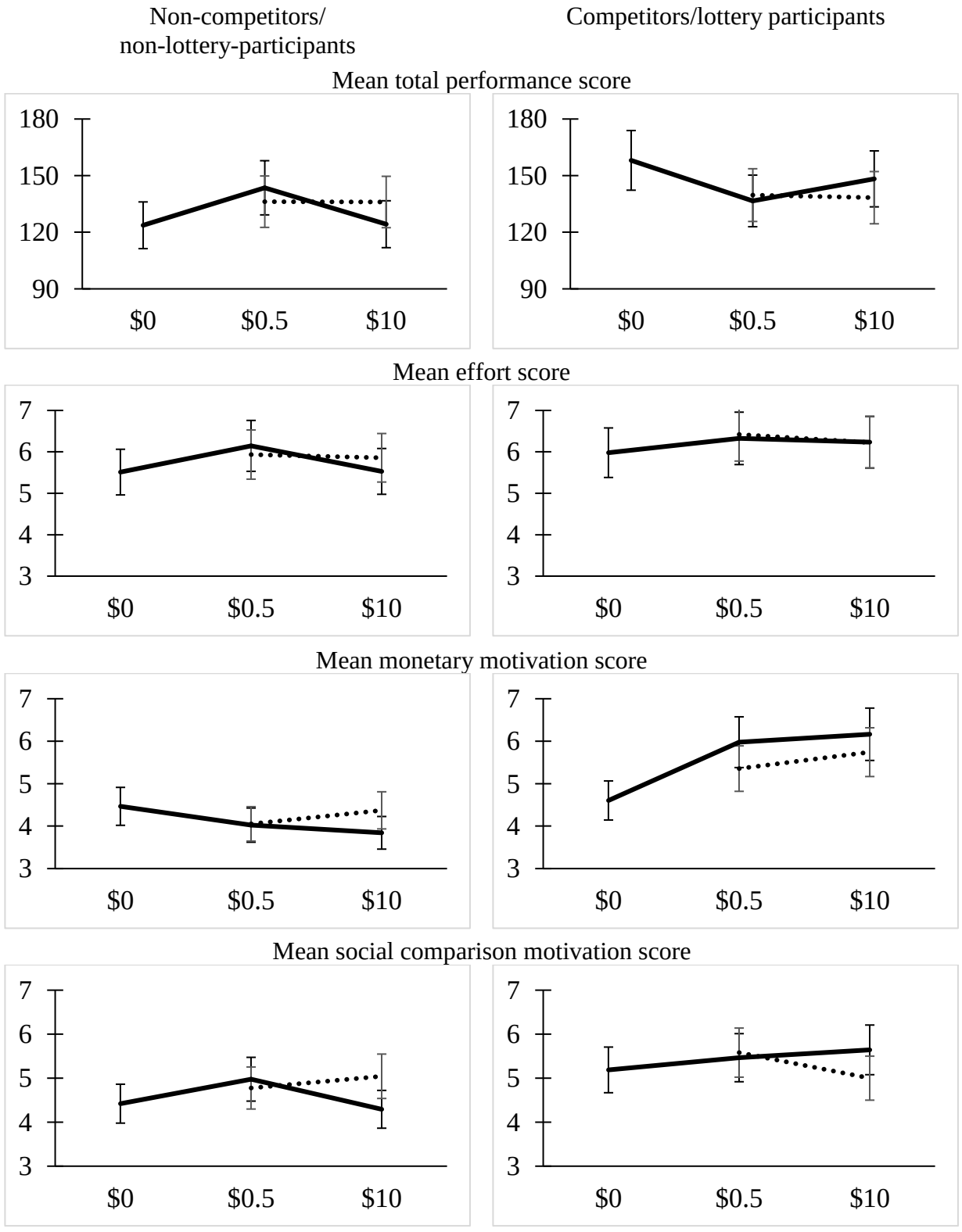


Table 1. Main Results from Study 1: Mean Payments at Entrance (in Euros)

	Frame: Contest		Control
	Competing customers	Non-competing customers	
1 prize	6.14 (3.37) [5.85,6.44]**	5.68 (2.75) [5.56,5.80]**	5.42 (2.76) [5.37,5.47]
	N = 489	*N* = 2,025	*N* = 13,056
7 prizes	6.52 (4.01) [6.14,6.89]**	5.76 (3.06) [5.62,5.89]**	
	N = 440	*N* = 1,978	
	Frame: Neutral		
	Competing customers	Non-competing customers	
1 prize	6.36 (4.42) [5.94,6.78]**	5.86 (3.04) [5.73,5.99]**	
	N = 426	*N* = 2,101	
7 prizes	6.37 (3.41) [5.98,6.76]**	5.72 (3.09) [5.59,5.86]**	
	N = 297	*N* = 2,074	

Note: Standard deviations in parentheses; 95% confidence intervals (CIs) in square brackets. The asterisks indicate significant differences between the mean of the corresponding treatment condition and the control mean according to *t*-tests ($P < 0.01$ in all comparisons).

Table 2. Main Results from Study 2A: Mean Performance Scores in Two-round Blocks

Condition		*N*	Round 1-2	Round 3-4	Round 5-6
Control		83	34.06 (10.87) [31.67,36.43]	37.56 (12.92) [34.74,40.38]**	38.28 (13.37) [35.36,41.20]
Treatment:					
Competition role	Competition reward				
Non-competitor	$0.5	110	35.78 (10.57) [33.78,37.78]	39.82 (10.37) [37.86,41.78]**	42.03 (11.17) [39.92,44.14]**[b]
	$10	111	34.93 (11.31) [32.80,37.06]	38.84 (12.14) [36.56,41.13]**	41.41 (12.16) [39.13,43.70]**[c]
Competitor	$0.5	124	35.13 (11.87) [33.02,37.24]	38.53 (11.97) [36.40,40.66]**	41.88 (11.75) [39.79,43.97]**[b]
	$10	129	35.33 (11.22) [33.37,37.28]	38.20 (12.08) [36.09,40.30]**	42.73 (11.31) [40.76,44.70]**[a]

Note: Standard deviations in parentheses; 95% confidence intervals (CIs) in square brackets. The asterisks indicate significant differences between the mean of the current block and the previous block within the same condition/role according to paired *t*-tests (* $P < 0.05$, ** $P < 0.01$). [a,b,c] Entry is significantly or marginally significantly different from the corresponding mean in the control condition according to a between-subjects *t*-test ([a] $P = 0.010$, [b] $P < 0.05$, [c] $P < 0.1$).

Table 3. Main Results from Study 2B: Mean Performance Scores In Two-round Blocks

Condition		*N*	Round 1-2	Round 3-4	Round 5-6
Participation in incentive scheme	Incentive scheme reward				
Non-participant	\$0.5	77	35.06 (12.94) [32.12,38.00]	38.77 (14.01) [35.59,41.95]**	37.10 (17.08) [33.23,40.98]
	\$10	77	35.55 (12.70) [32.66,38.43]	37.07 (15.53) [33.55,40.60]	36.82 (17.40) [32.87,40.77]
Participant	\$0.5	86	35.14 (12.34) [32.49,37.78]	37.40 (14.81) [34.22,40.57]*	38.27 (15.91) [34.86,41.68]
	\$10	88	32.90 (12.75) [30.20,35.61]	36.36 (13.67) [33.46,39.25]**	38.59 (14.53) [35.51,41.66]*

Note: Standard deviations in parentheses; 95% confidence intervals (CIs) in square brackets. The asterisks indicate significant differences between the mean of the current block and the previous block within the same condition/role according to paired *t*-tests (* $P < 0.05$, ** $P < 0.01$).

Table 4. Main Results from Study 3: Mean Total Performance Scores

		Reward		
		\$0	\$0.5	\$10
Competition treatment conditions	Non-competitor	123.69 (90.54)** [a] [110.87,136.52] *N* = 88	143.55 (47.94) [a,b] [133.09,154.02] *N* = 83	124.26 (59.39)** [b] [111.75,136.77] *N* = 89
	Competitor	158.08 (55.57)** [141.95,174.22] *N* = 48	136.60 (54.34) [119.88,153.33] *N* = 43	148.29 (48.38)** [138.99,157.58] *N* = 98
Lottery control conditions	Non-lottery-participant	NA	136.20 (53.59) [123.95,148.44] *N* = 76	136.03 (56.10) [122.65,149.41] *N* = 70
	Lottery participant	NA	139.68 (36.70) [126.22,153.14] *N* = 31	138.32 (44.18) [122.12,154.53] *N* = 31

Note: Standard deviations in parentheses; 95% confidence intervals (CIs) in square brackets. The asterisks indicate significant differences between the means of competitors and non-competitors in the same column according to *t*-tests (both at $P < 0.01$). The superscripts "*a*" and "*b*" indicate significant differences in means across different reward levels according to *t*-tests (both at $P < 0.05$).

The Influence of a Competition on Non-Competitors

Supporting Information (SI Appendix)

Further Discussion on the Studies

Study 1. As stated in the main text, the results from Study 1 are subject to several potential confounding factors that are peculiar to this field setting. One potential confounding factor is that the non-competitors might have felt guilty and obliged to pay more because they had turned down the zoo's invitation to participate in the competition. But note that the customers could pay whatever they liked whether they were competitors or not. In turning down the option to participate in the competition, the non-competitors had not shut themselves off from paying any amount to the zoo, nor had they compromised any moral obligations.

Another potential confounding factor is that customers in the treatment conditions could have perceived the competition as a new means to raise funds, and by implication, that the zoo might be in dire need of revenues. Therefore, it could be argued, non-competitors would be motivated to pay more than they would have done without being aware of the competition. However, from our observations in the field, the zoo had a public image to the local population (who made up a large majority of its customers) of being very well funded. We find no evidence that the PWYW initiative or the competitions were perceived as fundraising exercises.

A third confounding factor can be put forward based on self-selection. The policy of the zoo dictated that customers who entered the zoo on the days of the competitions must be entitled to compete. That is, any non-competitor observations could only be from customers who voluntarily opted out of their assigned competition. The field experiment is in fact empirically useful in this sense, as many competitions in real life involve voluntary participation.

Nevertheless, the policy also implies potential self-selection issues, as customers self-selected into the role of competitors or non-competitors. As stated in the main text, we address these issues in Study 2A – from which we obtain confirmatory evidence of the contagion effect in a more controlled setting, with exogenous random assignment of competition roles.

Study 2B. Here, we propose three possible alternative mechanisms for the observed contagion in the two previous studies. One alternative mechanism is that the non-competitors might have been conscious of being assigned into one half of a group with the other half being the competitors. This group assignment might have increased social comparison motivations among the non-competitors leading to improved performance (1, 2). While the group assignment is part of the implementation of the experimental conditions, its potential effect is not necessitated, in principle, by the awareness of a competition, but by more general group dynamics. Another alternative mechanism is that the presence of an additional incentive among competitors might have created a vicarious motivating effect on non-competitors. A third alternative mechanism can be proposed based on an anchoring effect mechanism: the awareness of a competition might have induced the non-competitors in our studies to hypothesize that the performance levels of the competitor would be higher than had there been no competition at all; the hypothesized performance levels could have in turn induced an anchoring effect (3) that caused the non-competitors to perform better. While this alternative mechanism is driven by the awareness of a competition, it is not necessitated, in principle, by that awareness, but by the anchoring effect that follows it.

In Study 2B, participation roles are randomly assigned within each 50-person groups - with half of the group being assigned to be participants and the other half being assigned to be non-participants; an additional incentive is present among the participants of the scheme; and

non-participants of the scheme might hypothesize that the participants of the scheme would perform better than had there been no incentive scheme, which could then induce an anchoring effect. As discussed in the main text, we observe no contagion effect in Study 2B. As such, we obtain evidence that the contagion effect in previous studies is necessitated by the awareness of a competition, and none of the proposed alternative mechanisms could account for it.

Notes on Methods and Further Data Analysis Results

Study 1. Formally, the treatment conditions form a 2(framing: neutral versus contest) × 2(number of prizes: one versus seven) between-subjects design. The manipulations are as described in the next section of this document.

We analyze the payment data of customers who stated they were visiting the zoo for the first time during the period of the experiment, and focus on the price the customer decided to pay for his/her own entry. As such, we screen out questionnaire respondents who, as noted by the zoo staff at the entrance, were not adults, and thus were relatively likely to have not made independent payment decisions; these respondents made up 3.14% of the pre-screening payment observations. The final dataset consists of a total of 22,886 payment observations from 12,076 (52.77%) self-reported females and 10,212 (44.62%) self-reported males; the remaining 598 or 3.61% payment observations have missing data on gender.

Of the analyzed payment observations, 13,056 (57.05%) are from the control condition and 9,830 (42.95%) are from the treatment conditions. Among the latter, 1,652 are from customers who opted to participate in the competition, yielding a participation rate of 16.81%. The remaining 8,178 observations are from non-competing customers who were aware of the existence of an ongoing competition but were not taking part in it themselves.

A 2 (framing) × 2 (number of prizes) between-subjects ANOVA on non-competitors' payments in the treatment conditions does not yield any significant main or interaction effects ($P > 0.25$ for the main effects; $P = 0.11$ for the interaction), suggesting that the contagion in our field experiment is robust across the treatment conditions: neither an explicit contest framing or a reward structure with a single prize, is needed for the contagion.

The overall mean PWYW payment of competing consumers is 6.34 Euros (s.d. = 3.84 Euros, 95% CI: [6.15,6.52]) across conditions, a 16.97% increase from the control that is statistically significant ($t(14,706)=12.17, P<0.01$). Participation in a competition over PWYW payments with prizes leads to higher payments, which is predictable from both psychological and economic perspectives. It is also useful to confirm that the payments of competitors are generally higher than those of non-competitors: aggregate comparison yields $t(9,828)=6.86$, $P < 0.01$, and the same conclusions hold for pairwise *t*-tests for each treatment condition ($P < 0.01$ in all comparisons).

Study 2A. Formally, the treatment conditions form a 2(competition context: no competition versus competition) × 2(competition role: competitor versus non-competitor) × 2(competition reward: $0.5 versus $10) mixed design, where competition context is a within-subjects factor while competition role and competition reward are between-subjects factors. Section A, the first four rounds (round 1-4) of the slider task, being identically setup as in the control condition, form the "no competition" manipulation in terms of the within-subjects factor of competition context. Section B, the final two rounds (round 5-6), form the "competition" manipulation of the competition context factor. The other two manipulations are as described in the Materials and Methods.

Study 2B. Formally, Study 2B has a 2(incentive scheme context: no incentive scheme versus presence of incentive scheme) × 2(incentive scheme participation role: participant in scheme versus non-participant in scheme) × 2(incentive scheme reward: \$0.5 versus \$10) mixed design, where incentive scheme context is a within-subjects factor while incentive scheme participation role and incentive scheme reward are between-subjects factors.

Study 3. Formally, the treatment conditions follow a 3(competition reward: \$0 versus \$0.5 versus \$10) × 2(competition role: competitor versus non-competitor) between-subjects design. The lottery control conditions have a 2(lottery reward: \$0.5 versus \$10) × 2(lottery participation role: lottery participant versus non-lottery-participant) between-subjects design.

As is apparent in Table 4, we managed to achieve, in two of the competitions and two of the lotteries, a proportion of 25%-36% participants to be competitors/lottery participants. For the competition with \$10 reward, due to unforeseeable exhaustion of the MTurk subject pool at the time of execution, we ended up assigning proportionally too many participants to be competitors. Nevertheless, the participants were informed before the tasks (as in other conditions) that approximately one-third of them would be competing, and at no point during the experiment could they have inferred otherwise.

Competitors' performance scores are higher than those of non-competitors when the reward level was nil (reward = \$0; $t(134)=3.26$, $P < 0.01$) or when the reward level was high (reward = \$10; $t(185)=3.10$, $P < 0.01$). Both are in predictable directions; the first effect is especially consistent with the possibility that, even without a cash incentive, participating in a competition can still lead to higher performance because of social incentives of the kind observed in (4) and other studies. The pattern of competitors' performance scores across reward levels also has a consistent U-shaped dependence although without significant statistical

evidence ($P = 0.066$ and $P = 0.19$ when comparing competitors' scores at reward=\$0.5 with reward=\$0 and reward=\$10, respectively).

However, performance scores do not differ significantly by participation role when the reward is positive but low (reward = \$0.5, $P > 0.25$). This is consistent with a contagion effect on non-competitors to the extent that non-competitors' performance can approach that of competitors. Another possibility is that the low but positive reward level has an adverse effect on competitors as in (4): as the monetary incentive increases from no cash reward to \$0.5, the competitors' focus might have switched from the social to the monetary aspect of the competition; but the reward level is so low that the competitors did not work too hard for it.

We find that the total performance score is positively correlated with self-reported effort in both the lottery ($r = 0.30$, $P < 0.01$) and the competition ($r = 0.43$, $P < 0.01$) conditions. Moreover, self-reported effort is positively correlated with both self-reported monetary and social comparison motivations in both the lottery and the competition conditions, with $r > 0.2$ and $P < 0.01$ in all four correlations.

Regarding the self-report measures, apart from the results reported in the main text, we also find that competitors' monetary motivation increases significantly ($t(89)=3.72$, $P < 0.01$) when the reward level increases from nil (\$0) to low (\$0.5). All other related pairwise *t*-test comparisons over changes in reward levels, including in the lottery control conditions, yield non-significant effects at $P > 0.15$.

It thus seems that competitors across different reward level manipulations do not perceive themselves to have exerted different effort (indeed their performance scores do not differ significantly by reward level), but their monetary motivation increases when the reward level increases from \$0 to \$0.5, signifying a change in focus from the social to the monetary aspect of

the competition. However, there are no corresponding changes in the lottery control conditions, despite the similar reward levels. This lends further supporting evidence that the contagion effect is necessitated by the awareness of a competition.

Instruments in the Experiments

Manipulations and Presentation of Competition Information in Study 1. In the neutral frame/1 prize condition of Study 1, the customer was presented with the following tabulated information at the outset (edited and translated from German):

Receive a Gift Card

If your payment is, among all participating customers' payments …	*… you will receive …*
… highest …	*an annual family pass to the zoo (145€) and a 400€ Amazon Gift Card*

In the contest frame/1 prize condition, the customer was instead presented with the following information:

Customer Competition

If your payment is, among all participating customers' payments …	*… you will receive the …*
… highest …	*<u>Winner prize:</u> an annual family pass to the zoo (145€) and a 400€ Amazon Gift Card*

In the contest frame/7 prize condition, the customer was presented with the following information:

Customer Competition

If your payment is, among all participating customers' payments …	*… you will receive the …*
… highest …	*Winner prize: an annual family pass to the zoo (145€) and a 135€ Amazon Gift Card*
…second highest…	*2nd prize: a 90€ Amazon Gift Card*
…third highest…	*3rd prize: a 60€ Amazon Gift Card*
…fourth highest…	*4th prize: a 40€ Amazon Gift Card*
…fifth, sixth, or seventh highest…	*5th prize: each a 25€ Amazon Gift Card*

The information presented to customers in the neutral frame/7prize condition can be inferred accordingly.

Sample Real Effort Task in Study 2A, Study 2B, and Study 3. The experiments in the three studies were conducted using the Qualtrics interface. The following is a sample of the task interface for the $10-reward/non-competitor treatment condition in Study 3. It presents the main decision tasks as seen by subjects on their computer screens. The highlighted passages in yellow are as appeared in the experimental interface to ensure participants took note of key information. On the other hand, any text in square brackets [ ] are notes on the procedures for the purpose of this document, and is not part of the experimental interface.

Instructions

Please read the following very carefully.

Please do not communicate with other participants for the entire duration of this study.

Overview

This study consists of 4 rounds. In each round, you will undertake an identical task within a time limit of 1 minute 15 seconds.

Every participant will receive $0.5 for his/her participation in the 4 rounds.

In addition, we have randomly assigned approximately one-third of the participants to compete against each other in this study. The participant with the highest performance score among the competing participants will be the winner. The winner will be announced among the competing participants after the study is over. The winner will receive an additional reward of **$10** on top of the $0.5 participation payment. Ties will be settled by a coin toss.

[page break]

Your role

You have been assigned to be a **non-competitor** in this study. As such, you **will not be competing** with other similarly assigned participants for the **additional $10 reward**.

[page break]

Task description

This study consists of 4 rounds. In each round you will undertake an identical task within a time limit of 1 minute 15 seconds. The task will consist of a screen with 60 sliders. Each slider is initially positioned at 0 and can be moved as far as 100. You can use the mouse in any way you like to move each slider. You can readjust the position of each slider as many times as you wish.

When moved, each slider will show a number indicating its current position. Your task is to move each slider to 50. You may drag the slider from its initial position to reach 50 or alternatively click at the middle of the slider bar. **Your performance score in the study will be the total number of sliders positioned at exactly 50 over all of the 4 rounds.**

[page break]

Task results

You will see your performance score at the end of the study. You have been provided a results form, which is on your desk. Once you have received your performance score, please write this score down on the results form along with your name and email address. Please leave this form on your desk.

If you have further questions, please raise your hand and wait until the study coordinator comes over to you.

Do not ask any question aloud!

Thank you for your participation!

Please click the button below when you are ready to begin.

[page break]

Round 1 of 4

There are 60 sliders in each round.

Your task is to move each slider to 50. You may drag the slider from its initial position to reach 50 or alternatively click at the middle of the slider bar.

You have a time limit of 1 minute 15 seconds for this round. At any point during the 1 minute 15 seconds, you can scroll to the bottom and click a button to skip to the next round immediately. Please note that your performance score in the study will be the total number of sliders positioned at exactly 50 over all 4 rounds.

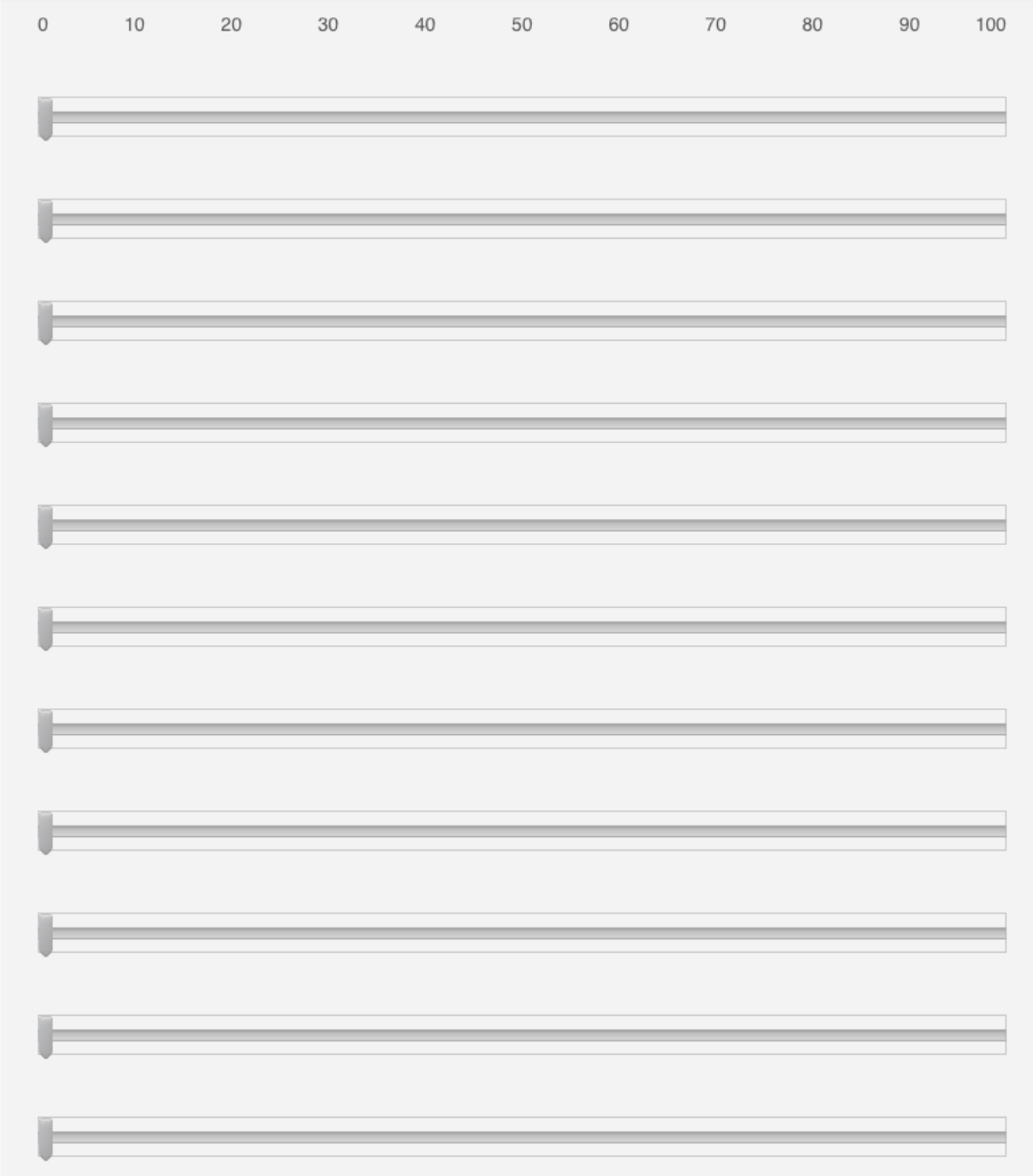
Please be aware that the 1 minute 15 seconds timer begins when you click the button.

[page break]

Round 1 of 4

As stated earlier, you can use the mouse in any way you like to move each slider. You can readjust the position of each slider as many times as you wish.

This round ends when the 1 minute 15 seconds time limit is over, or when you click the button at the bottom to skip to the next round. Your performance score in this round will be the number of sliders positioned at exactly 50 when it ends.



[There were 60 sliders in the task. Subsequent rounds had the same set up.]

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