The influence of a competition on noncompetitors

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We report a series of experimental studies that investigate the influence of a competition on noncompetitors 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 noncompetitors. 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 noncompetitors. 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.

competition | noncompetitors | contagion effect | real-effort tasks | field experiment

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 noncompeting 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 noncompetitors? 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 noncompetitors 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, noncompetitors can broadly mean anyone who is not a competitor; here, we use the term as 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. Noncompetitors in this sense abound in many scenarios, as in the examples above.

Last, 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, contagion refers specifically to any behavioral impact of the mere awareness of an ongoing competition on noncompetitors' 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 noncompetitors. The noncompetitors in our studies are only informed that there is a competition; in other words, they are merely aware of the competition. However, 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

Significance

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 noncompetitor'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 noncompetitors becoming motivated to act more competitively upon being aware of the competition.

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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 noncompetitors.

Here, in a departure from the theorizing in previous literature, we surmise that the awareness of a competition can induce in noncompetitors 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 toward overtaking each other's competition performance, 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 noncompetitors a heightened social comparison motivation, such as by making social comparison more salient (see *General Discussion* for further details). The result is increased effort and improved performance among noncompetitors, 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 noncompetitors, 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 nonnegligibly 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 noncompetitors, is that the mean payment of noncompeting customers in every treatment conditions is significantly higher than the control condition mean. The overall mean payment of noncompeting customers is 5.76 Euros (SD = 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 noncompetitors possibly feeling guilty or inferring that the zoo needed to raise funds, as well as more general self-selection issues. In *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 noncompeting 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), and the other half assigned to be noncompetitors.

Table 1. Main results from study 1: Mean payments at entrance (in Euros)

	Frame: Contest		Frame: Neutral		
No. of prizes	Competing customers	Noncompeting customers	Competing customers	Noncompeting customers	Control
One	6.14 (3.37) [5.85, 6.44]**; $n = 489$	5.68 (2.75) [5.56, 5.80]**; $n = 2,025$	6.36 (4.42) [5.94, 6.78]**; $n = 426$	5.86 (3.04) [5.73, 5.99]**; $n = 2,101$	5.42 (2.76) [5.37, 5.47]; $n = 13,056$
Seven	6.52 (4.01) [6.14, 6.89]**; $n = 440$	5.76 (3.06) [5.62, 5.89]**; $n = 1,978$	6.37 (3.41) [5.98, 6.76]**; $n = 297$	5.72 (3.09) [5.59, 5.86]**; $n = 2,074$	5.42 (2.76) [5.37, 5.47]; $n = 13,056$

SDs in parentheses; 95% confidence intervals (CIs) in square brackets. 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).

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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 noncompetitors, once they are informed about the competition, at both reward levels in the treatment conditions. Unlike the competitors, noncompetitors 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. Last, as might be expected, performance scores increase significantly between blocks 2 and 3 among competitors in every treatment condition.

Because all participants went through the same four initial rounds in the experiment, potential between-subject 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 (Table 2). Moreover, all pairwise t test comparisons of mean performance scores in block 3 among the treatment conditions yield $P > 0.1$. Finally, between-subjects differences in any of the first two blocks between the control and any treatment condition are all nonsignificant ($P > 0.1$ in all relevant t tests). These results, wherever pertaining to noncompetitors, 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, because the previously observed contagion is subject to explanations via alternative mechanisms that do not require the awareness of a competition. In *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 noncompetitors 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 assigned to be participants and the other half assigned to be nonparticipants. We therefore maintain the group assignment, the presence of an additional incentive, and the possibility of an induced anchoring effect among nonparticipants; 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 *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 nonparticipants of the scheme ($P > 0.25$ in all within-subjects t test comparisons between block 2 and block 3), unlike among the noncompetitors in study 2A; in fact, nonparticipants of the scheme perform slightly worse on average upon learning about the scheme and their nonparticipating 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). In summary, 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 studies 1 and 2 are necessitated by noncompetitors 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 noncompetitors' performance could change as the competition reward increases across conditions. Because the noncompetitors 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

Table 2. Main results from study 2A: Mean performance scores in two-round blocks

Condition	Competition role	Competition reward	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	Noncompetitor	\$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]

SDs in parentheses; 95% confidence intervals (CIs) in square brackets. 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]$P < 0.1$).

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Table 3. Main results from study 2B: Mean performance scores in two-round blocks

Participation in incentive scheme	Incentive scheme reward	*N*	Round 1–2	Round 3–4	Round 5–6
Nonparticipant	$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]*

SDs in parentheses; 95% confidence intervals (CIs) in square brackets. 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. (*$P < 0.05$, **$P < 0.01$).

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, noncompetitors 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 noncompeting participants are receiving from the task, it can possibly induce an additional, counteracting reference effect (18). That is, the noncompetitors 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 noncompetitors' 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 onward, the participant is either a competitor or noncompetitor, 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 ref. 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 (~10 min) as the study (19). Moreover, the high reward level of $10 is designed to be much higher than the payment to noncompetitors (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 is 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 (Fig. 1, *Upper*). We first analyze how noncompetitors' 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 noncompetitors 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 have a U-shaped pattern that is consistent with previous research such as (12) (*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.

In all conditions, we administer three self-report questions to all participants at the end of the experiment: "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

Table 4. Main results from study 3: Mean total performance scores

Condition	Role	Reward: $0	Reward: $0.5	Reward: $10
Competition treatment conditions	Noncompetitor	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

SDs in parentheses; 95% confidence intervals (CIs) in square brackets. Asterisks indicate significant differences between the means of competitors and noncompetitors in the same column according to *t* tests (both at $P < 0.01$). NA, not applicable.

[a, b]Significant differences in means across different reward levels according to *t* tests (both at $P < 0.05$).

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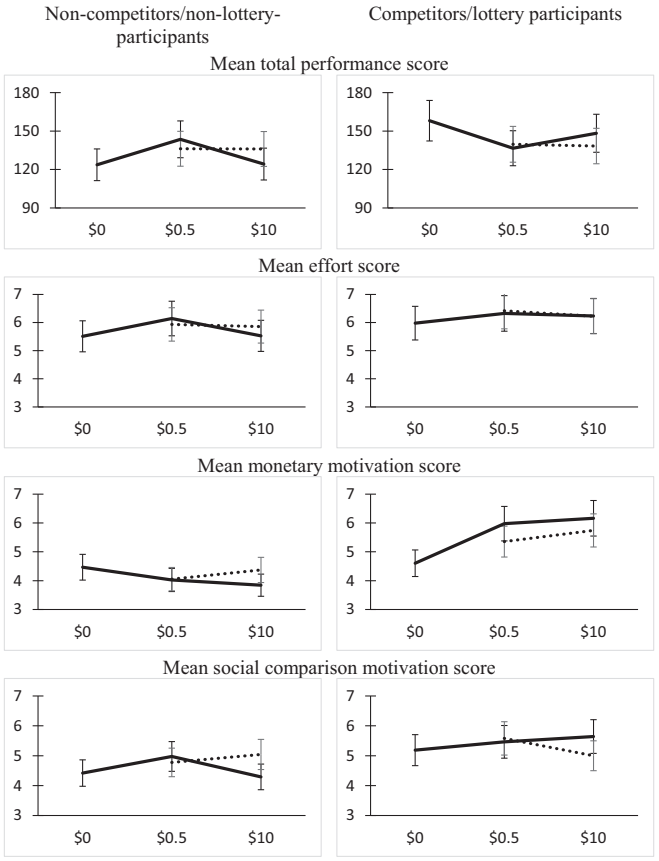

Fig. 1. Means of major dependent variables in study 4 by cash reward level condition ($0, $0.5, $10) and plotted with 10% error bars. Thick and dotted lines refer to the competition (n = 449) and lottery conditions (n = 208), respectively.

seven-point response scale. Analysis on the self-report measures reveals that, when the reward level increases from nil ($0) to low ($0.5), noncompetitors' effort increases significantly [$t(169) = 2.75$, $P < 0.01$], whereas their social comparison motivation increases marginally [$t(169) = 1.71$, $P = 0.089$]. When the reward level increases from low ($0.5) to high ($10), noncompetitors' effort decreases significantly [$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 noncompetitors' 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 noncompetitors, 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 noncompetitors, 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 noncompetitors 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 noncompetitors act as if they were competitors, and can produce significant behavioral influence (see ref. 20 and the studies discussed therein). Meanwhile, noncompetitors' perceptions of rivalry could also lead to a vicarious form of competitive arousal. As defined in refs. 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 noncompetitors, which then heightens the noncompetitors' social comparison motivation.

In sum, the awareness of an ongoing competition can induce perceptions of rivalry among the noncompetitors, 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. However, competitions can influence competitors as well as a potentially much larger number of noncompeting individuals who are aware of them. It is therefore important to consider these noncompetitors when designing competitions. For instance, as we have shown, higher rewards might motivate competitors more, but can also become demotivating to noncompetitors.

Noncompetitors 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. Before the experiment, ethical clearance was obtained from RWTH Aachen University (M.K.'s institution at that time). The experiment was exempt from informed consent at RWTH Aachen University. 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 (*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 noncompeting customers in the treatment conditions were not informed about

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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 (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. Before the experiment, ethical clearance was obtained from the Departmental Research Ethics Review Group at Cambridge Judge Business School, University of Cambridge. Informed consent was obtained from all participants at the beginning of the study using an online form.

The experimental task (*SI Appendix*) is an adaptation from ref. 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 midpoint of the scale, within 1 min and 15 s. The participant's performance score in the task is the number of sliders (of 60) that he/she has positioned at the midpoint 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 *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: 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 noncompetitors. The assignment of competitors and noncompetitors forms the between-subjects manipulation of competition role. Last, 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 (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. Before the experiment, ethical clearance was obtained from the Departmental Research Ethics Review Group at Cambridge Judge Business School, University of Cambridge. 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 noncompetitors 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 nonparticipants 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 prespecified 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 (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. Before the experiment, ethical clearance was obtained from the Departmental Research Ethics Review Group at Cambridge Judge Business School, University of Cambridge. 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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