The Framing of Information Nudge Affects Students' Anticipated Effort: A Large-Scale, Randomized Survey Experiment

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ABSTRACT

We investigate how framing an information nudge impacts university students' anticipated effort. We test the conflicting predictions of two social theories. According to prospect theory, a negatively framed nudge increases students' anticipated effort in general. However, according to regulatory focus theory, the beneficial effect of negative framing is concentrated in prevention focus when people orient toward negative outcomes. In promotion focus, when people orient toward positive outcomes, a positively framed nudge motivates students better. We conducted a large-scale randomized survey experiment among Hungarian university students. Between different vignettes (nudges), we systematically manipulated the particular vignette's framing and regulatory focus. In line with the predictions of prospect theory, we find that a negatively framed nudge generally increases students' anticipated effort relative to a positively framed nudge. In contrast with the predictions of regulatory focus theory, the negative framing increases students' anticipated effort in both prevention and promotion foci, but it boosts students' anticipated effort more in prevention than in promotion focus. Therefore, students' temporary induced regulatory focus does not moderate the framing effect according to the pattern predicted by the regulatory focus theory.

1. Introduction

The appropriate presentation of information is a precondition for successful communication. An increasing literature has emerged in recent years on the use of behavioral nudges in educational settings (Damgaard & Nielsen, 2018; Escuenta et al., 2017; Yeager & Walton, 2011). Nudges—interventions that gently channel people's behaviors toward socially desirable goals (Thaler & Sunstein, 2008)—are potentially low-cost instruments for use by schools and universities.

However, several studies caution against the overly rapid adoption of nudges, pointing to key concerns that affect the generalizability of empirical results and the scalability of such interventions (Damgaard & Nielsen, 2018; Levitt et al., 2016; Yeager & Walton, 2011). The empirical evidence is growing regarding key aspects of educational nudges. Damgaard and Nielsen (2018) discussed differences in the effects of interventions according to students' socioeconomic status. Levitt et al. (2016) explored the role of the timing of rewards and differential impacts by age. Fischer and Wagner (2018) found that relative

performance feedback can have positive effects on students' test scores as long as it is provided at least 1–3 days before an exam rather than immediately before it.

Our study contributes to this educational literature by providing evidence on how to frame a nudge that aims to motivate students' anticipated effort in the arena of higher education. Our nudge takes the form of a message that provides historical exam outcome statistics to students before their exams. We investigate whether negative framing (stating the past fail rate) has more motivational power than positive framing (stating the past pass rate).

Our inquiry is driven by two prominent social theories of behavioral economics and psychology (prospect theory and regulatory focus theory) that we knit together. Prospect theory in behavioral economics posits that people are loss averse—they react more sensitively to losses than to equivalent-sized gains (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981). An extension of this theory is described by Levin et al. (1998) concerning the positive/negative consequences of an action or event. Empirical research finds that people can be motivated more

with negative framing—by highlighting the negative consequences of an action or event (Banks et al., 1995; Ganzach & Karsahi, 1995; Meyerowitz & Chaiken, 1987). These findings suggest that the valence of describing an action or event impacts information processing.

Regulatory focus theory adds an important layer to the framing effect. People's regulatory focus describes their motivation in goal pursuit concerning desired end-states (Higgins, 1997). It is both a state (temporary condition) and a trait (part of personality). As a state, it can be induced situationally, and as a trait, it can be investigated by exploring people's dominant tendency (trait) via survey questions.

The regulatory focus theory claims that people's motivational orientation moderates how they perceive differently framed information. In particular, the theory distinguishes two specific regulatory foci that govern how people approach desired goals and avoid undesired goals (Crowe & Higgins, 1997; Higgins, 1997). In promotion focus, people's motivational orientation is to pursue *ideal* goals related to their hopes and aspirations. Thus, they orient toward accomplishment to secure gains or avoid non-gains and might be motivated more by positively framed messages (referred to as eager framing in Cesario et al., 2008). By contrast, in prevention focus, people's motivational orientation is to pursue *ought* goals related to duties and obligations. Thus, they orient toward security to ensure non-loss or avoid loss and might be motivated more by negatively framed messages (referred to as vigilant framing in Cesario et al., 2008).

People experience regulatory fit if their motivational orientation (their static or induced regulatory focus) fits with the strategic means through which they aim to achieve the desired goal (Cesario et al., 2004, 2008). There are two regulatory fit conditions. On the one hand, there is a regulatory fit if people are in promotion focus (focusing on ideal goals) and pursue their goals with means oriented towards positive outcomes. On the other hand, there is also regulatory fit if people are in prevention focus (focusing on ought goals) and pursue their goals with means oriented toward negative outcomes (Cesario et al., 2004).

We identify potential conflicts associated with the predictions of prospect and regulatory focus theories. These affect the particular framing of a nudge. Following the prediction of prospect theory, a negatively framed nudge will induce people's motivation in general. By contrast, the prediction of regulatory focus theory is more specific. It claims that the negative framing only has a motivational power in prevention focus, while in promotion focus, a positively framed nudge is more appropriate for motivating people. Since exploring people's regulatory focus (i.e., whether they are in promotion or prevention focus) is costly and complex, exploring the potential boundaries of prospect theory concerning the effect of negative framing is a relevant question in behavioral economics.

We conducted a large-scale survey experiment at the University of Szeged in Hungary to test the assumptions of prospect and regulatory focus theories. Each participant received one random vignette (out of eight possible vignettes) that described a forthcoming hypothetical exam. We systematically manipulated the exam's description across vignettes to test the impact of positive or negative framing (stating historical pass or fail rate), as well as regulatory focus (a subject studied as an obligation or for enjoyment) and exam difficulty (high/low fail/success rate). Our treatment was exposure to different vignettes.

We manipulated the framing of the vignettes in concordance with the regulatory focus theory, which posits that when people choose between the means of pursuing a goal, they consider the framing of that goal (Higgins, 2000). We used either a positive framing that described the success rate of the hypothetical exams or a negative framing that described the failure rate of the hypothetical exam (failure rate = 100 − success rate). By manipulating the framing, we induced the strategic means that orient people towards a positive/negative outcome.

We manipulated regulatory focus by temporarily inducing it via the description of the hypothetical exams provided in the vignettes. This approach is similar to that taken in Study 1 by Cesario et al. (2004). Specifically, we induced the promotion focus by exposing students to an ideal goal. Therefore, in the vignette, we communicated to students that the exam was in a subject close to their interests—a subject they enjoy learning. In contrast, the prevention focus was induced by exposing students to an ought goal; the wording of the vignette emphasized to students that the exam was in a subject they are obliged to pass to obtain a diploma—a subject they do not enjoy learning.

Our study differs from prior scholarship that has investigated the motivational power of nudges in the following respects. First, we knit together regulatory focus theory with prospect theory. Prior studies have investigated nudges' motivational power exclusively through the lenses of regulatory focus theory (Cesario et al., 2004; Latimer et al., 2008; Shah et al., 1998) or prospect theory (Banks et al., 1995; Ganzach & Karsahi, 1995; Meyerowitz & Chaiken, 1987).

Second, our study is a large-scale experiment that is well-powered. Its size protects us from small-case-study biases (Kühberger et al., 2014). Prior scholarship is based almost exclusively on small case studies involving a few hundred respondents (Cesario et al., 2004; Ganzach & Karsahi, 1995; Latimer et al., 2008; Shah et al., 1998). By contrast, more than 3500 respondents were involved in our study.

Third, to the best of our knowledge, this is the first study to test the predictions of regulatory focus theory with a pre-registered design. This design protects against specification search and p-hacking (Nosek et al., 2015, 2018).

Fourth, we merged our survey experiment data with student background data obtained from the university's register, providing us with high-quality information about the survey respondents. Furthermore, along with the background data available for all university students, we could compare survey respondents with those who did not participate in the survey. In short, we can speculate about the external validity of our results. Merging survey and administrative data makes our data set unique since (to the best of our knowledge) no prior experiments in this field have been able to analyze such a data set.

Fifth, our outcome (university students' anticipated effort) is socially relevant and has practical implications concerning students' intentions to invest effort into studying for an exam. Behavioral intentions predict real behavior (Ajzen, 1991; Fishbein & Ajzen, 1975), so understanding how to motivate university students has substantial significance at the social level. Therefore, our outcome differs from that of prior studies that deployed outcomes with fewer consequences at the social level, such as physical activity (Latimer et al., 2008), fruit and vegetable consumption (Cesario et al., 2004, Study 1), or performance on an anagram test (Shah et al., 1998).

Our empirical results are twofold. First, we found that negative framing produced a universal increase in university students' anticipated effort. Therefore, we experimentally confirmed the predictions of prospect theory. Second, we did not find support for the two parallel predictions of regulatory focus theory jointly. We found that negative framing motivated students more in prevention focus than positive framing—in concordance with the predictions of regulatory focus theory. However, we did not find evidence that the positive framing motivated students more in promotion focus than negative framing—in discordance with the predictions of regulatory focus theory. At best, it can be said that the beneficial (positive) effect of negative framing on students' anticipated effort is smaller in promotion than in prevention focus. However, the negative framing also boosted students' anticipated effort in promotion focus—contrary to the theory. In short, people's regulatory focus does moderate the framing effect, but not according to the pattern predicted by the theory.

We conclude that negative framing increases students' anticipated effort in general, regardless of students' motivational orientation or regulatory focus. Concerning the applicability of the results, these findings are promising, as students can be targeted with a single, negatively framed nudge. By contrast, it would require more effort and preparation to target students with different nudges that correspond to their regulatory focus.

2. Theoretical considerations and hypotheses

2.1. Prospect theory

Within the framework of prospect theory, the risky choice framing effect describes how positive framing (framing an outcome as a gain) or negative framing (framing an outcome as a failure or loss) influences people's willingness to take risks (Tversky & Kahneman, 1981). An extension of the risky-choice framing effect is the goal-framing effect, whereby information either stresses an action's positive or negative consequences (Levin et al., 1998).

Empirical research has shown that negative framing has stronger motivational power than positive framing. Women were more liable to conduct a breast self-examination if they were confronted with a message stressing the negative consequences of not doing this compared to a situation in which a message stressed the positive implications of doing a breast self-examination (Meyerowitz & Chaiken, 1987). A similar result was found concerning attendance at mammography screening (Banks et al., 1995). Furthermore, credit card owners who did not use their credit cards changed their behavior, and used their cards more if they received a message stressing the potential losses of not using the card than if they received a message that communicated the potential gains of using it (Ganzach & Karsahi, 1995).

The stronger motivational power of negative goal framing might be explained by the fact that negative information affects people's judgments more strongly than the equivalent positive information, even without implying a risk factor (Levin et al., 1998: 176).

Therefore, we formulated the following hypothesis:

H1. *Negative framing (stating the failure rate of an exam) increases students' anticipated effort more than positive framing (stating an exam's pass rate).*

2.2. Regulatory focus and fit theories

The regulatory focus theory of psychology highlights important heterogeneity in the goal-framing effect (Crowe & Higgins 1997; Higgins, Shah & Friedman 1997). The framing of a message has the strongest persuasive power if it is tailored to people's regulatory focus—if people experience regulatory fit (Cesario et al., 2004, 2008). People in regulatory fit conditions increase their task engagement and motivation (Higgins, 2000) and find information more persuasive (Cesario et al., 2004). Several small-case studies' deliver empirical evidence supporting this claim (Files et al., 2019; Mann et al., 2004; Shah et al., 1998; Van-Dijk & Kluger, 2004).

In line with the theory, Shah et al. (1998) found in their Study 1 that respondents with promotion-focused goal orientation achieved higher scores on an anagram test if they received a nudge fitted to their promotion-related goal orientation trait (i.e., a nudge emphasized that the experimenter wanted participants to find more than 90% of the words). By contrast, respondents with prevention-focused goal orientation achieved higher scores if they received a nudge fitted to their prevention-related goal orientation trait (i.e., a nudge emphasizing that the experimenter wanted participants *not* to fail to identify more than 10% of the words).

Nevertheless, some other studies have failed to find clear evidence that supports the predictions of regulatory focus and fit theories (Cesario et al., 2004; Latimer et al., 2008). In a field experiment, Latimer et al. (2008) gave tailored messages to physically inactive people. They found that a positively framed message ("accumulating physical activity improves health") caused greater physical activity and positive feelings for those with a promotion focus than a negatively framed message ("failing to accumulate physical activity leads to poor health"). However, they failed to find that a negatively framed message motivated prevention-oriented people to engage in more physical activity (the coefficient was in the predicted direction but was not statistically

significant). Furthermore, in Study 1, described by Cesario et al. (2004)[1] the authors reported a significant interaction between regulatory focus and the positive/negative message framing. This indicates that the framing effect differs between promotion and prevention focus. However, within each category of regulatory focus (i.e., either in the promotion or in the prevention focus), there was no difference in the framing effect.

Clearly, these ambiguous findings call for more research. Therefore, we formulated two hypotheses regarding the framing effect under different regulatory foci:

H2A. *Negative framing (instead of positive framing) increases students' anticipated effort (has a positive effect) when students are in prevention focus (obligated to study).*

H2B. *Positive framing (instead of negative framing) increases students' anticipated effort (has a positive effect) when students are in promotion focus (enjoy studying).*

3. Experimental details and randomization

3.1. Recruitment

We conducted a factorial survey experiment among university students. All students ($N \approx 19{,}000$) at Hungary's second-largest university, the University of Szeged (SZTE), received an e-mail from the Directorate of Education.[2] Students could participate in the experiment by clicking on a link included in the e-mail, directing them to the survey's webpage. Among those students who participated in the survey, we randomly drew eight students who each won 10,000 HUF (32 USD). The e-mail message informed students about the lottery.

3.2. The factorial survey: vignettes and treatments

The factorial survey consisted of one vignette and a corresponding question. The vignette described a hypothetical exam. Students received the vignette randomly chosen from eight possible vignettes (the vignette universe). The vignettes in the vignette universe differed in three dimensions (framing, regulatory focus, and exam difficulty). There were two options in every dimension (varying parts of the vignette). Therefore, eight unique vignettes could be created corresponding to the various combinations of the varying parts in each dimension ($2 \times 2 \times 2 = 8$).

Students were assigned to different treatment arms corresponding to the vignette they received. Table 1, below summarizes how the vignettes differed in their varying parts.

The vignette manipulated the framing of the information by either communicating the exam's success rate (positive framing) or its failure rate (negative framing). Furthermore, we induced goal orientation or regulatory focus concerning the hypothetical exam by indicating that the exam was either in a subject favored by the students that they enjoyed learning (promotion focus) or from a subject that the students were obliged to pass (prevention focus). Lastly, we manipulated the difficulty of the exam by describing an easy (high success / low failure rate) or difficult (low success / high failure rate) exam.

Fig. 1 shows a sample vignette translated into English. The bold parts of the sentence represent one specific option out of the two possible options concerning each dimension. The alternative option concerning the same dimension is shown between {}. The original eight Hungarian

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[1] Here, undergraduate students read an approximately 150-word message. After reading it, they first rated the message's persuasiveness, and second, they reported their intention to eat more fruit and vegetables.

[2] We sent out 19,095 messages to 19,095 students, but we were unable to link 135 of them to the university's register data.

Table 1

The varying parts of the vignettes in the vignette universe.

Dimension	Option	Varying parts of the vignettes
Framing	Positive	The proportion of students who successfully passed the exam
	Negative	The proportion of students who failed the exam
Regulatory focus	Promotion	The exam is in a subject that is close to your interest and that you enjoy learning
	Prevention	The exam is in a subject that you are obliged to pass to obtain your diploma and that you do not enjoy learning
Exam difficulty	Easy	The success rate is 95% / The failure rate is 5% [100%−95%]
	Difficult	The success rate is 40% / The failure rate is 60% [100%−40%]

> Please tell me how much effort you would put into preparing for an exam in a subject ***that is close to your interests and that you enjoy studying*** {*in a subject that you are obliged to pass to obtain your diploma and that you do not enjoy studying*}, and about which you know ***that 95% {40%} of students usually pass on the first attempt*** {*5% {60%} of students usually fail to pass on the first attempt*}.

Fig. 1. Sample vignette translated into English.

vignettes are shown in the Appendix.

3.3. The survey question about anticipated effort

After reading the corresponding vignette, students answered one survey question that was the same for all vignettes and students. The English translation of the Hungarian question was:

"Please let us know how much effort you would put into preparing for the exam described above. Please indicate your answers on a scale of 0 to 10, where 0 means 'I would make no effort to prepare' and 10 means 'I would make every effort to prepare for the exam.' The values on the scale between 0 and 10 are intended to let you deliver a nuanced opinion that may lie between the two extremes."[3]

3.4. The fieldwork and participants

The fieldwork lasted for 56 days between December 8th, 2021 and February 14th, 2022. Most of the students answered the survey on the first day of the fieldwork (58%), and 95% of the answers were given within the first ten days of the fieldwork. During the entire period of fieldwork, one reminder e-mail was sent (on December 16th) to those students who had not filled in the survey.

Eighteen percent of all students at the university ($n = 3516$) participated in the survey. Comparing SZTE students who did participate in the survey to those who did not, survey-participant students had higher last-semester GPA, were younger, were more likely to be female, and their last-semester GPA was more likely to be missing[4] (see Table A1 in the Appendix). The mean differences are substantial between those who participated in the survey and those who did not. The size of the mean difference is at least 10% of the corresponding variable's standard deviation (concerning GPA, it even reaches 20%). Thus, our sample is not a representative sample of all students at the university. Since being female and having a higher GPA increases students' anticipated effort (see Table A2), our sample contains more motivated students than the average SZTE student. In sum, the non-representative sample limits the

external validity of our results and must be considered when drawing conclusions based on the results.

As Figure A1 in the Appendix suggests, the eight potential vignettes were similarly distributed. The relative share of a particular vignette among the eight possible vignettes does not differ between all sent-out messages ($N = 19,095$) and the sample of responded messages ($N = 3516$). The only exception is Vignette #5 (positive framing, prevention focus, easy exam), which was 2.7 percentage points more likely to be responded to than other vignettes. We do not attach substantive importance to this difference since it is substantially small.[5]

The vignette that students received in the survey did not affect students' participation in the experiment. Table A3 shows that none of the vignette dimensions influenced the response rate.

3.5. Randomization and balance

We randomized at the student level based on a random number. In practice, randomization meant matching students with the specific vignette. We employed the following procedure. We ranked all student IDs available in the university register based on a randomly generated number in ascending order. In the ordered list, beginning from the first student, each of the successive eight students received a different vignette. Therefore, in the ranked list, students 1, 9, and 17 received the same vignette, and students 2, 10, 18 also received the same vignettes.

In the analytical sample, there is a perfect balance between students assigned to different vignettes (treatment arms). As Appendix tables A4-A8 show, there is no statistically significant difference in the baseline variables between the various pairs of vignettes. Therefore, students assigned to different treatment arms (vignettes) are similar.[6]

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[3] The Hungarian-language question that students were asked to answer was the following: *Kérem mondja meg, hogy mekkora erőfeszítéssel készülne a fent leírt vizsgájára? Válaszait az alábbi 0-tól 10-ig terjedő skálán adja meg, ahol a 0 jelentése "semmilyen erőfeszítést nem tenné a felkészülésre" a 10-es jelentése pedig: "a tőlem telhető legnagyobb erőfeszítéssel igyekeznék felkészülni a vizsgára". A skála 0 és 10 közötti értékei azt a célt szolgálják, hogy a két véglet között véleményét árnyalja.*

[4] Because they are younger and more likely to be first-year students, thus having no last-semester GPA.

[5] The difference is statistically significant at the 5% significance level, but the bias is substantially small. For example, Vignette #5 was answered by 62 more students than would have been the case with an equal hypothetical distribution of vignettes in which exactly the same share of students responded to every vignette.

[6] Cells in the tables show the mean difference in the corresponding variable between those assigned to two different vignettes. For example, in the first cell (first column and first row) of Table A4, the figure 0.04 indicates that the difference in the share of female students among those assigned to Vignette #2 compared to Vignette #1 is four percentage points, a difference which is statistically not significant.

4. Measures and methods

4.1. Research transparency

We pre-registered our experimental design, hypotheses, and coding decisions before receiving the endline data. We archived a detailed pre-registration plan at the RCT Registry of the American Economic Association, and the original pre-registration is available here: https://www.socialscienceregistry.org/trials/8673. Deviation from pre-registration is indicated.[7] The study's OSF page provides a replication package including the data and the analytical scripts. The package is available at this link: https://osf.io/7cbyx/. The study received approval from the IRB office at the Center for Social Sciences, Budapest on October 14th, 2021 prior to its launch.

4.2. The outcome variable

Our outcome variable is students' anticipated effort to prepare for the exam. The variable is measured on a scale ranging from 0 to 10.

4.3. The treatment

The treatment is the randomly assigned vignette out of the eight possible vignettes.

4.4. Baseline control variables

We pre-registered to deploy baseline variables. The source of student-level baseline control variables is the university register.

1. Students' gender $= 1$ for female students and 0 for male students.
2. Students' age is the difference between the date when they responded to the survey and their date of birth divided by 365.
3. Students' last-semester GPA is their grade-point-average calculated from students' non-missing grades earned in the last semester. First-year students' missing GPAs were replaced by their admission scores. A dummy variable indicates the replacement. Further missing data in GPA was replaced by zero; another dummy variable accounts for that missing status.
4. Fixed effects are used to indicate the study program in which a student is enrolled, through the use of separate dummy variables.

4.5. Empirical strategy

Test of H1

Eq. (1) tests hypothesis H1:

$$Y_{s,p} = \alpha + \beta_1 \times F_{s,p} + \beta_2 \times R_{s,p} + \beta_3 \times E_{s,p} + \beta_4 \times X_{s,p} + \delta_p + \varepsilon_{s,p} \quad (1)$$

Where $Y_{s,p}$ is the effort that student s from the study program p intended to invest in preparing for the hypothetical exam.

The variable F indicates the vignette's framing (positive, i.e., success is communicated [$=0$]; negative, i.e., failure is communicated [$=1$]). R is the regulatory focus (prevention focus [$=0$]; promotion focus [$=1$]). E is the difficulty of the hypothetical exam (easy [$=0$]; difficult [$=1$]). All of these variables (F, R, and E) are randomly assigned; the corresponding

β coefficients have a causal interpretation. The variable X represents students' baseline variables (gender, age, and GPA) and δ stands for study-program-fixed effects. The individual error term is denoted by ε. We cluster standard errors by vignettes.

We evaluate H1 about the effect of framing by examining the sign of β_1. In the case of a significant positive β_1 coefficient, we accept H1, that negative framing motivates students more than the positive framing.

Test of H2A and H2B

To test H2A and H2B, we introduce the interaction between framing [F] and regulatory focus [R] into Eq. (1)., thus estimating Eq. (2).

$$Y_{s,p} = \alpha + \gamma_1 \times F_{s,p} + \gamma_2 \times R_{s,p} + \gamma_3 \times F_{s,p} \times R_{s,p} + \gamma_4 \times E_{s,p} + \gamma_5 \times X_{s,p} + \delta_p + \varepsilon_{s,p}$$

$$(2)$$

We evaluate H2A based on the coefficient of γ_1 which shows the effect of *negative* framing ($F = 1$) in *prevention* focus ($R = 0$). To accept H2A, γ_1 should be positive and statistically significant.

To test H2B, we reverse the coding of framing [F] (positive, i.e., success is communicated [$=1$]; negative, i.e., failure is communicated [$=0$]) and the regulatory focus [R] (prevention [$=1$] and promotion [$=0$]) and rerun the analysis. Due to the new coding, γ_1' shows the effect of *positive* framing ($F = 1$) in *promotion* focus ($R = 0$). To accept H2B, γ_1' should be positive and statistically significant. A negative γ_1' coefficient would indicate the beneficial effect of the negative framing on students' anticipated effort in promotion focus.

The coefficient of γ_3 shows how the framing effect differs between promotion and prevention focus.

Throughout the hypothesis testing, we use the false discovery rate (FDR) of Benjamini and Hochberg (1995) to account for multiple hypotheses testing (BH correction) .[8]

5. Results

5.1. Descriptives

Fig. 2 shows students' anticipated effort concerning each of the eight vignettes. The mean values of the dependent variable (shown in the figure) are higher in promotion-focus vignettes than in prevention-focus vignettes. In prevention/promotion focus, respectively, students reported stronger effort if the vignette has a negative and not a positive framing. Students indicated more effort concerning difficult exams than easy ones, according to a specific regulatory focus and framing.

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[7] We deviate from the pre-registered hypotheses in the following respects. We realized that self-worth theory (Covington, 1984), which motivated the pre-registered H4, is more complex and cannot be tested by simply analyzing the differences between easy and difficult exams. Therefore, we implemented the corresponding pre-registered analysis (Table 2, Model 1), but did not interpret the results in the light of the theory. The results indicate that students invest more effort into a difficult exam ($\beta_3 = 0.405$). The coefficient remains significant after multiple the correction for multiple hypothesis testing (p $= 0.033$).

[8] This correction method considers the p-values of all tests that we run and controls the FDR—the probability that we falsely declare a coefficient to be nonzero even though it is in fact zero.We pre-registered four hypotheses in our pre-registration plan and the significance level of 0.05. Therefore, the critical p-value would be 0.0125 for the coefficient with the lowest p-value ($\alpha_{r:1}^{BH} = 0.05 * 1/4 = 0.0125$), which is the same as the Bonferroni correction. For the coefficient with the second-lowest p-value, the critical p-value will be $\alpha_{r:2}^{BH} = 0.025$ (0.05*2/4). For the coefficient with the third-lowest p-value, the critical p-value will be $\alpha_{r:3}^{BH} = 0.0375$ (0.05*3/4). For the coefficient with the highest p-value, the critical p-value will be $\alpha_{r:4}^{BH} = 0.05$ (0.05*4/4).The BH correction method determines the corrected significance level using the following procedure. Among the ranked four observed p-values, we identify the largest p-value, which is smaller than the corresponding pre-registered α_r^{BH} significance level. We then use that BH-corrected α_r^{BH} significance level as the critical p-value in all pre-registered hypothesis testing instead of the conventionally used 0.05 significance level.In this particular case, the BH-corrected critical p-value was 0.05 since even the fourth-ranked observed p-value (0.0498) was smaller than $\alpha_4^{BH} = 0.05$. Specifically, the four observed p-values were the following in ranked order: 0.00036, 0.009, 0.033, and 0.0498. All of these figures were smaller than the pre-registered corresponding critical value, respectively: $\alpha_{r:1}^{BH} = 0.0125$; $\alpha_{r:2}^{BH} = 0.025$; $\alpha_{r:3}^{BH} = 0.0325$; $\alpha_{r:4}^{BH} = 0.05$.
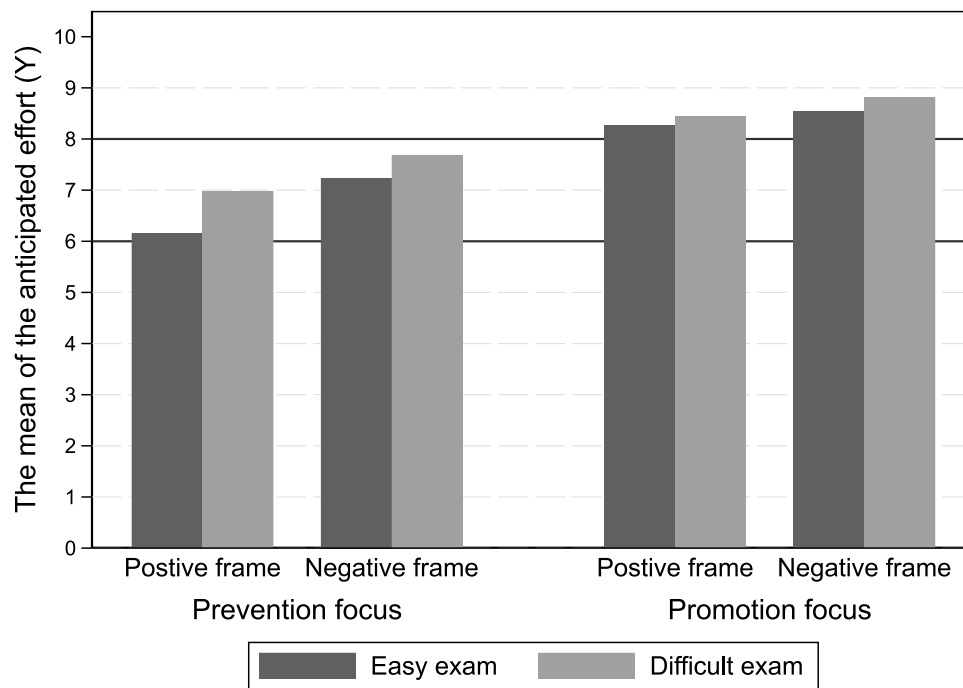
Fig. 2. The mean of students' anticipated effort according to regulatory focus (prevention/promotion), framing (positive/negative), and exam difficulty (easy/difficult exam).

Table 2
Testing H1: The effect of a negatively framed information nudge on students' anticipated effort—unstandardized OLS regression coefficients.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Negative frame (ref: *Positive* frame) [β_1]	0.606**	0.556			0.602*		0.561
	(0.170)	(0.622)			(0.233)		(0.595)
Promotion focus (ref: *Prevention focus*) [β_2]	1.508***		1.500**		1.518***	1.490**	
	(0.153)		(0.309)		(0.210)	(0.277)	
Difficult exam (ref: *Easy exam*) [β_3]	0.405*			0.435	0.399	0.441	
	(0.153)			(0.610)	(0.271)	(0.581)	
Constant	5.594***	6.507***	6.149***	6.646***	5.776***	5.972***	6.303***
	(0.433)	(0.673)	(0.415)	(0.688)	(0.479)	(0.442)	(0.829)
Observations	3516	3516	3516	3516	3516	3516	3516
R-squared	0.277	0.147	0.249	0.141	0.268	0.257	0.157

Column 1 test H1.
Columns 2–7 show various combinations of the causal effect of framing, regulatory focus, and exam difficulty on students' anticipated effort.
Control variables in all models: Female, Age, GPA, Study-program-fixed effects.
Standard errors are clustered by vignette.
Robust standard errors (clustered at vignette level) are in parentheses.
We pre-registered to use the false discovery rate of Benjamini and Hochberg (1995) to account for multiple hypotheses testing (BH correction). In Table 1 (Column 1), the coefficient of interest (β_1) is significant at $p = 0.009$ level, and it remains significant after the BH correction.
*** $p<0.001$
** $p<0.01$
* $p<0.05$

Below, we analyze the differences behind the descriptive results with the pre-registered models.

5.2. Testing prospect theory (H1)

The first row in Column 1 in Table 2 shows how the negative framing affects students' anticipated effort. The corresponding coefficient of β_1 is 0.606 ($p = 0.009$), signaling that the negative framing increases students' anticipated effort. The coefficient β_1 remains significant after correcting for multiple testing. Therefore, we accept H1, which posits that students' anticipated effort is stronger under negative framing. This result is in concordance with the prediction of prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981) and its extension of the goal-framing effect (Levin et al., 1998).

We note that the message's framing only influences students' anticipated effort if the regulatory focus is controlled for (Column 5). Without controlling for regulatory focus, the framing has no average effect on students' effort (Columns 2 and 7), suggesting potential treatment heterogeneity.

5.3. Testing regulatory focus theory (H2A and H2B)

The first row in Table 3 shows the difference in students' anticipated effort when they are in prevention focus and the vignette is negatively (rather than positively) framed. According to regulatory focus theory, the joint condition of prevention focus and negative framing is a state in which students experience regulatory fit (Cesario et al., 2008; Higgins, 2000). Here students' goal orientation (preparing for an exam in a

Table 3

Testing H2A: The effect of a negatively framed information nudge on students' anticipated effort in prevention focus and the interaction between negative framing and regulatory focus—unstandardized OLS regression coefficients.

	(1) Full sample
Negative frame (ref: *Positive* frame) [γ_1]	0.938**
	(0.146)
Promotion focus (ref: *Prevention* focus) [γ_2]	1.843*
	(0.162)
Negative frame × Promotion focus [γ_3]	−0.663*
	(0.169)
Difficult exam (ref: *Easy* exam) [γ_4]	0.409*
	(0.092)
Constant	5.426**
	(0.397)
Observations	3516
R-squared	0.282
Cohen's d effect size (Negative frame)	0.453

Control variables in all models: Female, Age, GPA, Study-program-fixed effects.
Standard errors are clustered by vignettes.
Robust standard errors (clustered at vignette level) are in parentheses.
We pre-registered to use the false discovery rate of Benjamini and Hochberg (1995) to account for multiple hypotheses testing (BH correction). In Table 3, the coefficient of interest (γ_1) is significant at $p = 0.00036$ level, and it remains significant after the BH correction.
** $p<0.001$
* $p<0.05$

subject they are obliged to pass to obtain a diploma) fits the strategic means that orient them toward a negatively framed outcome (the exam's past fail rate). Therefore, H2A assumes that a negatively (and not positively) framed vignette will increase students' anticipated effort in prevention focus.

In concordance with the theory, in prevention focus, the negatively framed nudge (instead of a positively framed nudge) increased students' anticipated effort—it had a positive effect ($\gamma_1 = 0.983$; $p = 0.00036$). Since γ_1 remains significant after correcting for multiple testing, we accept H2A. The corresponding Cohen's d effect size shows a middle-sized effect (0.453).

Furthermore, H2B assumes that a positively (and not negatively) framed vignette will increase students' anticipated effort in promotion focus. According to regulatory focus theory, the coincidence of promotion focus and positive framing is another state in which students experience regulatory fit. In this case, students' goal orientation (preparing for an exam in a subject they enjoy learning) fits the strategic means that orient them toward a positively framed outcome (the exam's past pass rate).

Contrary to the theory, in promotion focus, the positively framed nudge *de*creased (and did not increase) students' anticipated effort—it had a negative (and not a positive) effect ($\gamma_1' = -0.275$; $p = 0.0498$).[9] The corresponding Cohen's d effect size is small-sized (−0.133). Since the negative γ_1' remains significant after correcting for multiple testing, we reject H2B, which posits a positive relationship. The adverse effect of the positive framing in promotion focus means that regardless of students' induced regulatory focus, the anticipated effort can be induced by a negatively framed nudge. In sum, we have mixed evidence for the two parallel predictions of regulatory focus theory since only one (not both)

of the fit conditions increased students' anticipated effort.

Nevertheless, Table 3 shows that the advantageous boosting effect of the negative framing is smaller in the promotion focus than in the prevention focus. The corresponding γ_3 has a negative sign ($\gamma_3 = -0.663$; $p = 0.006$). Therefore, at best, it can be said that negative framing has a smaller (but still positive) effect on students' anticipated effort. In short, one can conclude that regulatory focus moderates the framing effect but not according to the pattern predicted by the theory.

Fig. 3 shows students' predicted anticipated effort using Eq. (2). Negative framing increases students' anticipated effort in prevention and promotion foci. Consequently, Fig. 3 shows that regardless of regulatory focus, the black bars are higher than the white bars, signaling a positive γ_1 coefficient, or – using the reversed coding – a negative γ_1' coefficient. However, the relative difference between positive and negative framing is smaller in promotion focus (the right two bars) than in prevention focus (the left two bars), signaling a negative γ_3 coefficient.

6. Discussion and conclusion

This research addressed the question of how to frame a nudging message to best motivate students' exam preparation. To answer our pragmatic research question, we tested the predictions of various social theories of psychology and behavioral economics. First, guided by the prospect theory of behavioral economics (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981), we tested how negative/positive framing or the prospect of failure/success influences students' anticipated effort. Second, influenced by the regulatory focus theory of psychology (Crowe & Higgins, 1997; Higgins, 1997) and the corresponding regulatory fit conditions (Cesario et al., 2004, 2008; Higgins, 2000), we investigated how students' regulatory focus (their goal orientation) moderates the framing effect.

We conducted a large-scale survey experiment involving more than 3500 students—nearly one-fifth of the entire student population at Hungary's second-largest university: the University of Szeged (SZTE).

Our results have theoretical and practical implications. The theoretical implications are twofold. First, we found confirmatory evidence that the prospect of failure—communicating to students the failure rate of the exam (instead of the success rate)—increased students' anticipated effort. This result is in line with the predictions of prospect theory (Kahneman & Tversky, 1979; Levin et al., 1998; Tversky & Kahneman, 1981). Thus, our results confirmed this theory concerning university students' anticipated efforts.

Second, our large-scale experiment could not confirm the two parallel predictions of regulatory focus theory. On the one hand, in concordance with the theory, we found that in prevention focus (in the case of an exam for which students are obliged to learn), a negatively framed nudge that fits students' regulatory focus (by orienting students on possible loss and communicating the exam's failure rate) increased students' anticipated effort relative to a positively framed nudge, which did not fit students' regulatory focus. On the other hand, in discordance with the theory, we found that in promotion focus (in the case of an exam for which students like to learn), a positively framed nudge that fits students' regulatory focus (by orienting students on gain and communicating the exam's pass rate) did *not* increase (but decrease!) students' anticipated effort relative to a negatively framed nudge, which did not fit the regulatory focus. In sum, the negative framing spurred students' anticipated effort independently of their regulatory focus. However, we also found that negative framing boosted students' anticipated effort more in prevention than in promotion focus.

There are four potential explanations for why our results did not support the predictions of regulatory focus theory. First, most prior experiments have measured regulatory focus as a trait using validated survey instruments (Study 2 in Cesario et al., 2004; Latimer et al., 2008; Shah et al., 1998). By contrast, the regulatory focus in our design was a

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[9] Since the estimation of Eq. (2). with reversely coded framing [F] and regulatory focus [R] variable produces different coefficients only for γ_1 (framing) and γ_2 (regulatory focus), while the estimated coefficients for γ_3 (framing × regulatory focus) and γ_4 (exam difficulty) are the same, we do not show the full regression results in a separate table. Therefore, concerning the test of H2B, we just show γ_1' in the text but not in the tables. However, using the provided figures in Table 3, one can calculate γ_1' since $\gamma_1' = \gamma_1 + \gamma_3$.
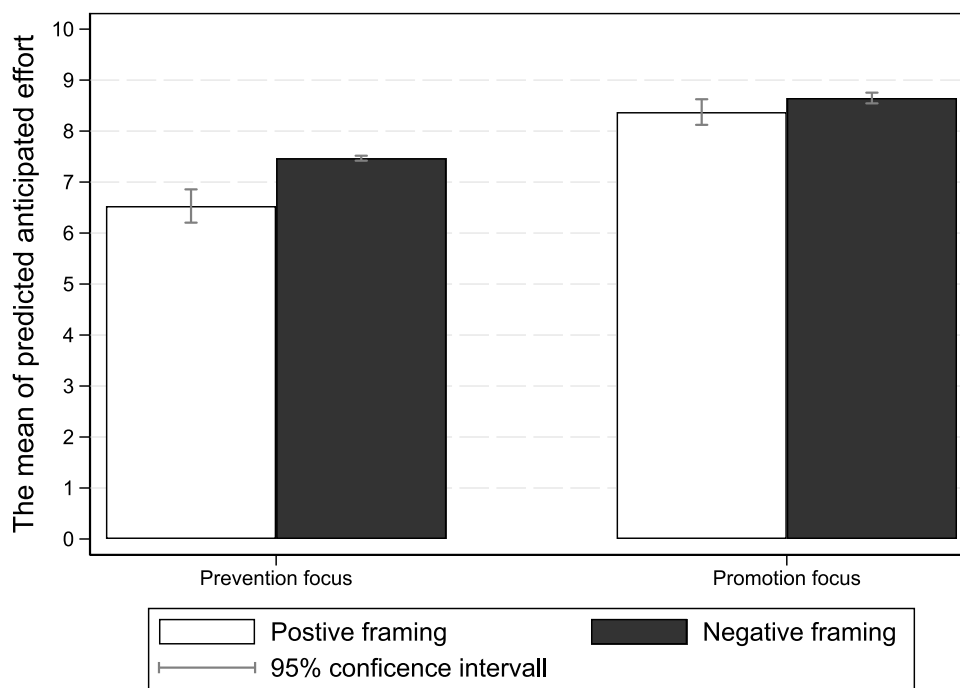
Fig. 3. Students' predicted anticipated effort using Eq. 2.

randomly assigned characteristic of the vignette, similar to Study 1 in Cesario et al. (2004). Therefore, we measured people's induced regulatory focus as a state. It could be that people's predominant trait regulatory focus modifies the framing effect differently than the situationally induced regulatory focus.

Second, students may generally think of exams as mandatory tasks (prevention focus); it is possible that exposing students to a vignette that described the subject of the exam as something they enjoyed learning was a weak exposure. It might only dampen students' predominant understanding of the exam situation and qualify the exam as less burdensome, but it could not successfully induce the state of promotion focus.

Third, our results could be specific to our analytical sample, which consists of students who are more motivated and high-performing than the average student at the university. It might be that due to a not-yet-known mechanism, participating students generally react more sensitively to the negative framing.

Fourth, prior evidence has been established on small samples. Thus, the small-sample bias could drive prior research's findings in terms of showing empirical evidence that corroborates the predictions of regulatory focus theory (Kühberger et al., 2014).

The practical consequences of our results might be considered by educational practitioners and policy for various reasons. First, negative framing increased students' anticipated effort by 5.5–6 percentage points—a sizable effect. Second, communicating statistics to students before specific exams about the proportion of those who failed that exam the prior semester is an easily scalable, light-touch, and easy-to-implement nudge. By contrast, one cannot easily change students' regulatory focus or the difficulty of exams—factors that also affect students' effort but are outside of the scope of light-touch nudging.

The results presented in this study are insufficient to determine how the treatment would affect students' actual (instead of anticipated) effort and their potential impact on exam grades. New experiments should be conducted to answer these questions. However, it is important to caution against a narrow focus on this issue in upcoming experiments. Increasing students' actual effort is an important policy goal in itself, as it can contribute to their engagement with academic life (Appleton et al., 2008; Christenson et al., 2012). Therefore, future research should also

consider students' actual effort as a potential outcome variable in addition to examining how the (framing of) nudges affect grades or drop-out rates (Keller & Szakál, 2021).

We should also note some key aspects of our experiment that might limit generalization. We measure the difference in the impact of negative framing by making a comparison with positive framing. This is a side-effect of how we developed the nudge. Specifically, communicating statistics about past exams using a language that avoids framing (pass or failure rate) is impossible. This means that there is no neutral option in our experiment, similar to the vast majority of similar prior studies (Cesario et al., 2004; Ganzach & Karsahi, 1995; Latimer et al., 2008; Shah et al., 1998). Nevertheless, such a design can only reveal the relative difference between positive and negative framing. By contrast, it is logically feasible that both positive and negative framing motivates students more than a (non-existent) neutral framing. Our design is unable to explore this scenario.

We conclude that easy-to-implement nudging messages are capable of motivating students' anticipated effort in relation to preparing for an exam. The framing of these messages should be negative, involving the failure rate of an exam. Future field experiments should test more thoroughly whether these negatively framed nudging messages can induce real behavioral changes in students' exam preparation.

Data availability

A replication package and the pre-analysis plan are available on the study's OSF page: https://osf.io/7cbyx/.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.socec.2023.102012 on the study's OSF page: https://osf.io/7cbyx/.

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