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WHEN INFORMATION CONFLICTS WITH OBLIGATIONS: THE ROLE OF MOTIVATED COGNITION*

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We experimentally test how psychological motivations can impact the processing of purely objective information. We first document that, when the high-stakes College Entrance Exam is held in the month of Ramadan, Chinese Muslim students perform significantly worse. When asked about the impact of fasting, they severely underestimate the cost of taking the exam during Ramadan, even when presented with direct empirical evidence. In the experiment, we randomly offer students reading materials in which well-respected Muslim clerics explain that it is permissible to postpone the fast until after the exam. Consistent with an interpretation of motivated cognition, students who receive the material distort the statistics about the fasting cost significantly less and become more accepting of delaying the fast for the exam.

Do people react differently to the same objective information if it conflicts with, rather than conforms to, their fundamental values? In the presence of such conflicts, numerous observational studies document learning failures that lead to belief polarisation, suggesting a correlation between fundamental values and information acquisition.[1] A causal interpretation of such a correlation comes from the theory of motivated cognition: to gain psychological utility, individuals actively distort, neglect, or deny information that contradicts their fundamental values (Bénabou and Tirole, 2011; Bénabou, 2015). Consequently, people with disparate fundamental values mentally process the same information differently and form different beliefs.

The challenge in testing such a theory is that people with disparate fundamental values typically also differ in other ways, such as their cognitive capacities, and they also tend to get exposed to dissimilar information.[2] Therefore, to causally pin down the existence of motivated cognition, one needs to exogenously vary individuals' fundamental values without altering their information sets, a task seemingly impossible in most ordinary field settings. In this paper, we attempt to circumvent this identification challenge and test the theory of motivated cognition by studying

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[1] For example, despite overwhelming scientific evidence, public opinion is polarised on topics such as GMO foods (Priest, 2000), evolution (Plutzer and Berkman, 2008) and global warming (Hart and Nisbet, 2012).

[2] This could happen for various reasons. For example, people with different values belong to different social groups and organisations, such that the channel through which they acquire information is different (Cinelli *et al.*, 2021).

whether religious norms, a core aspect of fundamental values, causally shape religious followers' acquisition of religion-related information.

We focus on a unique empirical setting, where the month of Ramadan overlapped with China's extremely high-stakes College Entrance Exam (CEE) between 2016 and 2018. In concordance with previous literature (Oosterbeek and Van der Klaauw, 2013), we use comprehensive administrative data to document that taking the exam during Ramadan leads to substantially worse exam performance for Muslim students. Consequently, Muslim students who were about to take the CEE (during Ramadan) in 2018 were facing a stark conflict between the fundamental value that Ramadan fasting is morally desirable and the empirical evidence that the secular cost of such religious practice can be significant. With motivated cognition, Muslim students, when thinking that they are required to fast during the CEE, might distort the undesirable empirical evidence on how Ramadan affects exam performance, in order to avoid feeling upset about this information.

To test this hypothesis, in 2018, we conducted a lab-in-the-field experiment among Muslim students who were about to take the CEE during Ramadan. To create exogenous variation in fundamental values, we randomly offered half of the students reading materials in which well-respected Muslim clerics use Quranic reasoning to explain that it is permissible for students to be exempted from fasting until after the exam. This 'pro-exemption' reading material is expected to change what is perceived by the students to be acceptable fasting behaviour (i.e., fundamental values).

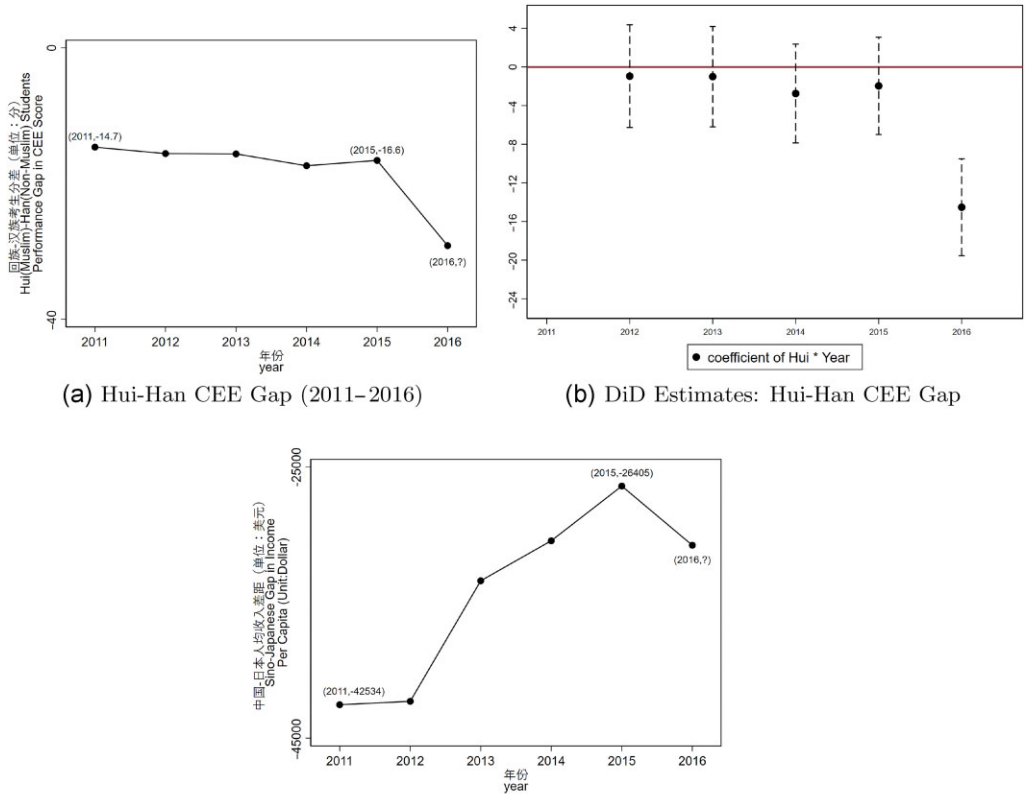
We then present these students with a previously unreleased graph, Figure 1(a), which shows (based on administrative data) that the CEE performance gap between Muslim and non-Muslim students remained stable between 2011 and 2015, but suddenly enlarged substantially in 2016, when the CEE started to fall in the month of Ramadan.[3] We ask the students, in an incentivised manner, to read from this graph the magnitude of the 2016 CEE performance gap between Muslim and non-Muslim students. It is worth noting that graph reading is a question about objective statistics rather than elicitation of subjective beliefs.

We find that the control students who do not receive the pro-exemption reading material systematically misread the objective statistic in Figure 1(a); on average, they underestimate the 2016 CEE score gap between Muslim and non-Muslim students by about 17%. In contrast, among students who have read the pro-exemption article, their reading of the same graph is significantly more accurate; they underestimate the gap by only 9.5%, which is a more than 44% reduction in underestimation compared to the control students. This treatment effect is driven by students who strictly practiced Ramadan fasting in the past, consistent with the intuition that an exemption from fasting should not have salient impacts on students who do not strictly fast anyway. Using a 'list experiment' approach (Miller, 1984), we also provide suggestive evidence that alleviating motivated cognition makes students better informed about the costs of Ramadan, and thus they find it more acceptable to postpone fasting for the CEE.

There are two main confounding stories for our main intervention (pro-exemption reading material). First, the pro-exemption reading material might make students upwardly adjust their priors about the cost of taking the exam during Ramadan, which could in turn be reflected in their reading of Figure 1(a).[4] Second, the pro-exemption reading material might occupy substantial mental bandwidth, which could make students read any graph less accurately. To investigate these alternative possibilities, in our experiment, we randomly select half of the Muslim students

[3] As will be explained in Section 1, the Muslim group is Hui people, and the non-Muslim group is Han people.

[4] This could happen either because the material contains information that is suggestive of the high cost of Ramadan, or because it generates an experimenter demand effect.



(a) Hui-Han CEE Gap (2011–2016)

(b) DiD Estimates: Hui-Han CEE Gap

(c) Sino-Japanese Income Gap (2011–2016)

Fig. 1. *Graphical Information.*
Notes: Panel (a) displays the Hui–Han CEE score gap between 2011 and 2016. Panel (b) displays the DiD coefficients of the Hui–Han CEE gap (controlling for track-by-year fixed effects (FE)), with 95% confidence intervals. Panel (c) displays the Sino-Japanese income gap between 2011 and 2016. Panels (a) and (c) are the graphs presented to students in our survey experiment, with English translations of the Chinese labels.

to not read Figure 1(a), and instead just elicit their priors on the cost of taking the CEE during Ramadan. We find that these students do not update their priors after reading the pro-exemption reading material, which is inconsistent with the first confounding channel. Moreover, we also ask these students to read a placebo graph that is unrelated to Ramadan fasting, see Figure 1(c), and find the reading accuracy to be unaffected by the pro-exemption reading material, which is at odds with the second alternative interpretation.

This paper speaks to two strands of literature. First, it provides a direct experimental test for motivated cognition in a field setting with potentially high-stakes information. Our paper complements existing laboratory studies that have established the existence of motivated cognition[5] and adds to the real-world evidence on motivated beliefs by addressing the identification

[5] For example, see Eil and Rao (2011), Di Tella *et al.* (2015) and Exley and Kessler (2018).

challenge with a randomised experiment.[6] We find that motivated cognition can take place at the very beginning of the decision-making process, before belief updating (Mobius *et al.*, 2011) and information storage (Chew *et al.*, 2020; Zimmermann, 2020). The findings add to the relatively scarce evidence on 'reality denial', a strong and distinct prediction generated by the theory of motivated cognition (Bénabou and Tirole, 2016).

Our findings also shed light on the costs and benefits of religious participation. In addition to confirming the costs of Ramadan fasting (Almond and Mazumder, 2011; Oosterbeek and Van der Klaauw, 2013; Schofield, 2014; Almond *et al.*, 2015; Majid, 2015), we also show that such significant costs are severely underappreciated by practicing Muslims, which is consistent with conjectures in the literature (Kuran, 2018).[7] More broadly, such underappreciation of the costs of religious activities, when combined with a 'rational choice' framework of religious behaviours,[8] could help explain the prevalence of religious participation.

1. Background

In this paper, for both the analysis of administrative data and the randomised experiment, we focus on the Ningxia Hui Autonomous Region (henceforth Ningxia), a provincial unit in the northwest of China with a population of 6.3 million and a GDP per capita of around $9,000.

Among the 6.3 million residents in Ningxia, 38% are Hui, a Muslim minority ethnic group in China, and the rest are mainly Han, the majority ethnic group in China, who are non-Muslim. Due to the large presence of Hui people, Islam is the dominant religion in Ningxia. There are currently more than 3,300 major mosques and more than 4,000 certified Imams in Ningxia. In comparison, there are fewer than 200 religious sites for all the other religions combined, including churches, Buddhist temples, Taoist temples, etc.

In this section, we introduce the background of our empirical setting: the College Entrance Exam in China, Muslim Ramadan fasting, and how the overlap between Ramadan and the exam affected the performance of Muslim students in Ningxia.

1.1. *Muslim Ramadan Fasting*

Ramadan is the ninth month in the Islamic calendar, and is observed by Muslims around the world as the holy month of fasting (*sawm*) to commemorate the first revelation of the Quran to Muhammad. Fasting during Ramadan is regarded as one of the 'five pillars of Islam'. It requires abstinence from food and liquids (including water) from dawn to sunset, and is obligatory for practicing Muslims.

The Quran specifies certain subjects for whom exemptions from the fast can be granted, which include children, the ill, the elderly, travellers, and breastfeeding women. However, many other conflicts between secular activities and religious practices are not explicitly discussed in the

[6] For observational studies that relate to motivated beliefs, see Di Tella *et al.* (2007), Oster *et al.* (2013), Huffman *et al.* (2019) and Schwardmann *et al.* (2019).

[7] On the benefit side of the equation, Augenblick *et al.* (2016) find that religious followers sincerely attach high pecuniary values to their religious beliefs, and Campante and Yanagizawa-Drott (2015) find that Ramadan fasting increases happiness. Our paper complements these papers by investigating the cost side of the equation.

[8] For example, Azzi and Ehrenberg (1975), Iannaccone (1992, 1998), Montgomery (1996), Berman (2000) and Stark and Finke (2000).

Quran and, under these conditions, practicing Muslims typically rely on a local expert in Islamic jurisprudence (Faqih) to decide whether they may be exempted from fasting.[9]

Due to the difference between the Islamic (lunar) calendar and the commonly used Gregorian calendar, Ramadan shifts 11 days forward every year and has a 33-year cycle. The detailed fasting schedule changes every year and is different across regions based on each location's latitude, which is publicised locally by the Imams before the start of the month of Ramadan.

1.2. *Ramadan and Exams*

Between 2016 and 2018, the month of Ramadan fell in May and June, which are popular times for final exams and high school and college entrance exams around the world. As a result, millions of Muslim students worldwide faced a dilemma between practicing the Ramadan fasting and excelling in academic exams. For example, as described in an information paper by the Association of School and College Leaders, 2016 was the first time Ramadan had clashed with major exams and tests in the UK since the 1980s, and this overlap would continue until 2019/20.[10] Existing evidence suggests that taking exams during Ramadan has significant negative impacts on the performance of Muslim students (Oosterbeek and Van der Klaauw, 2013).

The problem was particularly severe for Chinese Muslim students: between 2016 and 2018, the extremely high-stakes College Entrance Exam in China, which is fixed on 7 and 8 June for all students, fell in the month of Ramadan. When deciding how they observe Ramadan, students need to take into consideration: (1) the importance of the CEE for their future; (2) the potential negative impact of fasting on CEE performance; and (3) any religious flexibility to postpone the fast until after the CEE. While there is little doubt that most CEE-takers are well aware of the importance of this exam, neither (2) nor (3) is fully clear in the Chinese context: no empirical evidence existed regarding the cost of Ramadan on CEE performance, and little information regarding 'whether the fast could be delayed until after the exam' could be found on the Chinese internet or other media outlets.[11] Such unawareness was also prevalent among interviewed students in our focus groups.

1.3. *The Costs of Taking the CEE During Ramadan*

To identify the causal impact of taking the CEE during Ramadan on students' academic performance, we obtained administrative data on the exam performance of every urban student in Ningxia who took the CEE between 2011 and 2016. This information is maintained by the Ningxia Educational Examination Institute. The exam score is the predominant criterion of college admission. This administrative dataset contains the exam score of every urban CEE-taker in Ningxia during the six-year period, as well as their basic background information, such as ethnicity, gender, age, etc.

[9] For instance, the Egyptian national soccer team qualified for the FIFA World Cup in 2018, but the game was scheduled to start right after the end of the month of Ramadan. Seeing this potential conflict, the Grand Mufti of Egypt, Shawki Allam, granted the Egyptian national squad permission to postpone their Ramadan fasting obligations. On the contrary, the Tunisian national team faced the same problem, but did not get such an exemption, and the players kept fasting while preparing for the World Cup.

[10] 'Ramadan: Exams and Tests, 2018' (last accessed: 5 August 2018). https://www.ascl.org.uk/help-and-advice/help-and-advice.ramadan-exams-and-tests-2018.html.

[11] Two pieces of relevant information could be found through online search engines: an article written by an Imam arguing that students should keep fasting during the CEE, and a translated piece based on the statement of the Egyptian Grand Mufti, suggesting students could delay their fast under certain circumstances.

Exploiting the fact that the CEE began falling in the month of Ramadan in 2016, and the fact that Ramadan is expected to mostly affect the performance of Muslim students, we illustrate the impact of taking the exam during Ramadan by measuring how the Hui–Han gap in exam scores changed in 2016, relative to the pre-existing gaps between 2011 and 2015. As shown in Figure 1(a), the Hui–Han gap in exam scores was stable between 2011 and 2015; on average, Hui students score 16.4 points (0.16 SD) lower than their Han counterparts.[12] However, the Hui–Han gap almost doubled in 2016, suggesting that taking the exam during Ramadan had salient negative impacts on the relative performance of Muslim students.

We formalise these graphical patterns in Figure 1(b) and Appendix A, Table A1, in which we estimate the event study and difference-in-differences (DiD) specifications controlling for a demanding set of fixed effects. Our results suggest that the empirical patterns documented in Figure 1(a) are highly robust. Quantitatively, taking the exam during Ramadan lowered Hui students' exam performance relative to their Han counterparts by 12.8 points (0.13 SD).

In this context, a score loss of roughly 13 points is a huge burden for the Muslim students, and would very likely lead to admission by a lower-ranked college, or at least a less desirable major within the same college. It is also worth noting that our DiD model estimates an 'Intention to Treat (ITT)' effect, rather than a 'Treatment on the Treated (TOT)' effect, given the fact that not all Hui students are practicing Muslims, and some of them might not fast during the exam. Therefore, the real impact of fasting during the exam would be even larger.[13]

2. Experimental Design

In this section, we explain the design and implementation of our experiment, and lay out the main hypotheses that will guide the empirical analyses.

We partnered with a large urban Hui Muslim high school in Ningxia to conduct a survey experiment.[14] The high school is the second largest in its prefecture city, with 24 classes in its senior cohort (students who were about to take the CEE in June 2018). The majority of students are Hui Muslim, and the average CEE score in the school is comparable to the provincial average. More than 80% of the students board at school on the weekdays, making a student's religious compliance generally observable to his peers.

Our survey experiment took place on 4 May 2018 (about one month before the CEE in 2018), during a 40-minute afternoon class on Friday, simultaneously for the entire senior cohort. The 533 Hui students who were present constitute our population for this study. Our survey questions were answered carefully by the majority of students, as reflected by the fact that most of them correctly answered our multiple choice questions based on a 1,000-word reading material.

[12] The enlarged gap in 2014 was driven by the fact that more Hui students chose the humanities track rather than the STEM track, and the humanities track exam was relatively difficult in 2014. This fluctuation disappears once we control for a track-by-year fixed effect in the regression analysis.

[13] As shown in Appendix A, Table A2, in our experimental sample, around 54% of high school students never broke a fast. If the sample is representative of Ningxia, this would suggest that the TOT effects could be nearly twice as large as the ITT estimates.

[14] 'Hui Muslim high schools' are public schools set up by the government in regions with high concentrations of Hui population, which provide accommodations for the dietary and other religious needs of the Hui students. We recognise that in our context, Han students can serve as an ideal placebo group in the empirical test of motivated cognition. However, due to the lack of Han students in our partner school, we are unable to conduct such a test.

2.1. *Main Experimental Design*

The structure of the experimental design is presented in Figure B1. The primary randomisation in our experiment is the exposure to pro-exemption reading material. Roughly half of the students are assigned to read this material (Treatment), whereas the other half are assigned to read a placebo article of similar length on art and philosophy (Control). The students were unaware of this randomisation during the survey experiment. Translated versions of all survey questions, as well as translated versions of the treatment and control reading materials, can be found in Appendix A.

In the pro-exemption reading material, we summarised statements from well-respected Chinese Muslim leaders as an article of about 1,000 words, which clearly explained that, if students feel that fasting might affect their ability to perform well on the CEE, it would be permissible to delay the fast until after the exam. Specifically, we interviewed an established Muslim scholar, the Imam of an historic mosque, who explicitly said that '*Muslim students may delay their fast until after the CEE is finished*'. We also interviewed a famous religious leader, who is the vice president of the provincial Islamic Association, and were told that '*we should interpret the Quran in the modern context and allow the CEE participants to delay their fast*'. The two Imams also explained the Quranic reasoning behind their arguments in detail. We also collected similar exemptions given in Egypt and France to further demonstrate the case.

For the control group's reading material, we edited an article from a famous Chinese writer, which is about different perspectives in appreciating art, and has roughly the same length as the religious reading. For both treatment and control readings, to ensure that students understood the materials correctly, we asked three multiple choice reading comprehension questions after the main texts, and students got CNY 2 for each correct answer.

In addition to randomising the pro-exemption reading material, we also cross-randomise the outcome variables elicited. Our main outcome of interest is whether students could accurately acquire the information regarding the cost of taking the CEE during Ramadan. To measure such learning accuracy, for a random half of the students (across both the treatment and control groups), we asked them to read Figure 1(a), which documents how the Hui–Han gap in CEE score was stable between 2011 and 2015, but enlarged abruptly in 2016. The scale of Figure 1(a) was intentionally labelled in a coarse way, where we only showed the max (0) and min (−40) values, but omitted all the intermediate scales, so that the students had to read carefully to accurately report the enlarged Hui–Han gap in 2016.

We explicitly told these students that 'between 2011 and 2015, the CEE did not overlap with Ramadan, and the Hui–Han CEE gap was relatively stable (−14.7 in 2011, and −16.6 in 2015); however, in 2016, the CEE fell in the month of Ramadan, and the Hui–Han CEE gap enlarged in this year. Please read and report the Hui–Han gap in 2016 from the graph'. In order to incentivise careful reading of the gap, we offered CNY 3 to students whose estimates were in the top 50% in terms of accuracy.[15]

To address potential confounders, we elicit two placebo outcomes exclusively from the students who were *not* selected to read Figure 1(a). For the first placebo outcome, we told these students 'between 2011 and 2015, the CEE did not fall in the month of Ramadan, and the average Hui–Han CEE gap was −16.4; however, in 2016, the CEE fell in the month of Ramadan'. We then asked

[15] In this context, CNY 3 was about the cost of a regular breakfast in the school café. We adopted this simple incentive scheme because our focus group study revealed that theoretically optimal designs, such as the binary scoring rule (Hossain and Okui, 2013), appeared to be much too complicated for the students in our sample and could cause substantial confusion if used in a survey experiment.

them to guess (without seeing any graphical information) the 2016 Hui–Han CEE gap, and told them that they would receive a cash reward of CNY 3 if their accuracy was above median. For the second placebo outcome, we asked these students to read a graph about the Sino-Japanese income gap, as illustrated in Figure 1(c), with the cash incentive the same as that used for the main outcome. Given that exemptions to delay the fast should not affect motivations to distort beliefs about the Sino-Japanese income gap, if the exemption indeed affects the reading of Figure 1(a) exclusively by alleviating motivated cognition, we expect it to have no impact on the reading of Figure 1(c).

2.2. *Other Survey Features and Survey Execution*

In addition to the aforementioned randomisations, for all students, we also asked them a common set of questions on basic individual characteristics, including age, gender, parental education, access to computer/internet, academic track, whether boarding at school, whether the student prays daily, whether the student ever broke a fast during high school, etc.

At the end of the questionnaire, we also conducted a 'List Experiment' for every student, where we provided five subjective statements about the CEE, four of which were unrelated to religion, including '(1) learning alone is more effective than learning in groups, (2) we should care about what we have actually learned more than the CEE score itself, (3) playing sports is good for exam preparation, (4) the CEE mainly tests on familiarity with the material rather than actual intelligence'; and one statement was about Ramadan fasting, '(5) delaying the fast until after the CEE is acceptable'. We asked each student with *how many* of the five statements they agree, without having to specify which statements in particular. By comparing the number of statements agreed with in each experimental arm, we could estimate the impacts of our experimental interventions on fasting attitudes.[16]

Given our design, based on whether a student received the pro-exemption material (*Exempt*) and whether he read the Hui–Han CEE score graph (*Info*), we prepared four different versions of questionnaires: '*No Exempt*×*No Info*', '*No Exempt*×*Info*', '*Exempt*×*No Info*', '*Exempt*×*Info*'. A flow chart that contains the key elements both treatment and control groups of the experiment is presented in Figure B2. All questionnaires had an identical covering letter explaining that the survey data is confidential and will be used for purely academic purposes. We pre-randomised the order of the questionnaires before distributing them in each classroom. As a result, the 533 Muslim students were randomly assigned one of the four types of questionnaires. Given that the covering letters were identical and the students were not able to communicate with each other during the survey, the students did not realise that they were assigned differentiated questionnaires until the end of the survey experiment.

In Appendix A, Table A2, we conduct balance tests on all the baseline characteristics of the students who took one of the four versions of the survey. The samples for all versions are well balanced with each other, suggesting that the randomisation was well executed.

[16] The list experiment is a popular method in political science to (indirectly) elicit truthful answers to sensitive questions. As long as the entire list does not apply, the respondent can be assured that the researcher does not know their answer to the sensitive question, which encourages them to provide truthful answers to sensitive questions. For more details on this approach, see Blair and Imai (2012), Glynn (2013), Jamison *et al.* (2013), Coffman *et al.* (2017), Brownback and Novotny (2018) and Blair *et al.* (2020).

2.3. *Main Hypotheses*

To guide the empirical analysis, in this section, we briefly discuss the two key hypotheses derived from the theory of motivated cognition.

The first prediction of motivated cognition is that students in the '*Exempt*' arm will read Figure 1(a) more accurately than those who are in the '*No Exempt*' arm. Given that the exemption relaxes the students' religious constraint, it alleviates their motivation to underestimate the cost of Ramadan on exam performance and leads to graph reading with greater precision.

The second prediction is that students in '*Exempt*×*Info*' will be more likely to believe that it is acceptable to postpone the fast until after the exam, as compared to their peers in '*No Exempt*×*Info*'. There are two effects that jointly contribute to this prediction. First, receiving the pro-exemption reading material directly enables students to consider delaying the fast. Second, the exemption treatment, by alleviating motivated beliefs about the cost of fasting on exam performance, will also make students better appreciate such cost from the graphical information. Both effects would result in increased willingness to recognise that it is acceptable to delay the fast.

3. Results

In this section, we analyse the experimental data to test the two key predictions of motivated cognition as discussed in Section 2, and discuss whether alternative explanations could rationalise our findings.

3.1. *Main Outcome: Reading Score Gap*

As discussed in Section 2, motivated cognition might cause students to misread the graphical evidence on the cost of taking the CEE during Ramadan, but receiving the pro-exemption reading material should alleviate motivated cognition and thus reduce the bias in reading the same graphical information.

To test this prediction, we examine the accuracy of reading the graph on the exam score gap in '*No Exempt*×*Info*' and in '*Exempt*×*Info*'. Specifically, for all the students who were asked to read the Hui–Han CEE gap from Figure 1(a), we estimate:

$$Gap_i = \alpha \cdot Exemption_i + X_i' \cdot \beta + \gamma + \epsilon_i,$$

where Gap_i is student i's estimate of the Hui–Han CEE gap in 2016 based on reading Figure 1(a). $Exemption_i$ is a dummy variable, which equals 1 if student i received the pro-exemption reading material and 0 otherwise. X_i is a vector of individual characteristics, γ is a constant that reflects students' estimation of the gap in the absence of any exemption, and ϵ_i is the error term. The key coefficient of interest is α, which captures how the exemption treatment changes students' reading of Figure 1(a).

As shown in Table 1, for those who did not receive the 'pro-exemption' reading material, the average estimated gap is −24.4, understating the gap by about 5 points (17%, statistically significant). When randomly assigned the pro-exemption reading material, the students' reading of the 2016 Hui–Han CEE gap enlarged by more than 2 points, increasing the reading of score gap by around 9% relative to the '*No Exempt*×*Info*' arm, representing a more than 40% de-biasing effect. In columns 1 and 2, the coefficient of interest remains robust as we control for class

Table 1. *Motivated Cognition in Reading the Graph on Exam Performance Gap.*

	(1)	(2)	(3)	(4)
	Perceived Hui–Han CEE Score Gap in 2016			
Exemption	−1.9032**	−2.1985***	−0.5822	−0.8654
	(0.7387)	(0.7451)	(1.0672)	(1.0935)
Fast			2.5805**	2.9742***
			(1.0425)	(1.0753)
Exemption × Fast			−2.6181*	−2.5483*
			(1.4617)	(1.5348)
Constant	−24.3954***		−25.6952***	
	(0.5289)		(0.7399)	
Mean of control	−24.395	−24.395	−24.395	−24.395
Class FE	No	Yes	No	Yes
Control variables	No	Yes	No	Yes
Number of observations	277	274	277	274
R^2	0.024	0.233	0.045	0.242

Notes: Columns 1 and 2 present the effects of receiving an exemption to delay fasting on the accuracy of reading the 2016 enlarged Hui–Han gap in CEE performance. Columns 3 and 4 present heterogeneous treatment effects of exemption based on fasting history. Robust standard errors are in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

fixed effects and a rich set of individual controls. These empirical patterns support the prediction of motivated cognition: the stringency of religious practices leads to cognitive distortion of the secular cost of religious behaviours, and the relaxation of religious norms could help alleviate such distortion.

The theory of motivated cognition also implies that our intervention will have heterogeneous treatment effects: students who strictly followed Ramadan fasting in the past would likely attach higher fundamental values to this religious norm, which means they have stronger incentives to manipulate their beliefs to underestimate the cost of Ramadan. At the same time, they should also be more responsive to the provision of pro-exemption reading materials.

In the survey, we asked each student 'whether you strictly practiced Ramadan fasting (never broke a fast) throughout high school'. Roughly 54% of the students answered 'Yes' to this question, and the ratio is balanced across the four arms due to random assignment. In columns 3 and 4 of Table 1, we interact 'whether a student strictly followed Ramadan fasting in the past' with 'whether the student received the pro-exemption reading material'. Consistent with our hypothesis, the baseline findings of the initial cognitive bias among Muslim students and the subsequent de-biasing effect of providing pro-exemption reading materials are both stronger among the more religious students, with the caveat that the de-biasing effect is only marginally significant.[17]

3.2. *Willingness to Delay Fasting*

Our second prediction is that the level of acceptability of delaying fasting will be higher in '*Exempt*×*Info*' than in '*No Exempt*×*Info*'.

Two channels jointly contribute to this prediction. The first channel is that, independent of (beliefs about) fasting cost, the exemption mechanically reduces the students' mental cost of fasting postponement by changing the perceived acceptability of non-adherence. This channel is

[17] As shown in Appendix A, Table A3, an alternative outcome variable that measures how far each student's reading deviates from the true value (−29.4) yields qualitatively similar results.

Table 2. *Fasting Attitudes Revealed in List Experiment.*

	(1)	(2)	(3)
		Agreed Statements in List Experiment	
Exemp*No Info	0.1769*	0.1924*	0.2168*
	(0.1065)	(0.1085)	(0.1107)
No Exemp*Info	0.0383	0.0540	0.0485
	(0.1051)	(0.1074)	(0.1089)
Exemp*Info	0.2936***	0.2988***	0.3216***
	(0.1038)	(0.1063)	(0.1075)
Constant	1.3543***		
	(0.0754)		
Mean of control	1.354	1.354	1.354
Test: Exempt×Info = No Exempt×Info	0.013	0.019	0.010
Class FE	No	Yes	Yes
Control variables	No	No	Yes
Number of observations	532	531	528
R^2	0.019	0.053	0.088

Notes: This table presents the effects of the graph, the pro-exemption reading material, and their interaction on the number of statements one agreed with in the list experiment. Robust standard errors are in parentheses. * significant at 10%, *** significant at 1%.

valid regardless of whether the students are asked to read the score performance gap. The second channel works exclusively among students who are asked to read the score gap figure, where the pro-exemption article, by alleviating motivated cognition, also helps them better appreciate the cost of fasting on CEE performance, which should further increase their willingness to delay the fast.

As explained in Section 2, directly eliciting students' willingness to postpone the fast might be deemed 'sensitive' and lead to misreporting. To circumvent this issue, we follow the literature to conduct a 'list experiment', in which we present students with five statements related to the CEE, one of which says 'delaying the fast until after the CEE is acceptable' and the other four are unrelated to students' religious beliefs. Students only need to report *how many* of the statements they agree with, and do not need to indicate specifically *which* statements they agree with, which alleviates the social image concerns related to directly admitting to one's willingness to postpone the fast.

In this list experiment, if, on average, students in a certain experimental arm agree with more statements than students in other arms do, we can infer that the corresponding intervention causally increased students' willingness to postpone the fast for the CEE. As shown in Table 2, relative to the control group (*No Exempt×No Info*), just showing students the Hui–Han CEE gap alone (*No Exemp∗Info*) barely changes students' acceptance of delaying fasting, while just providing students with the pro-exemption reading (*Exemp∗No Info*) makes them more acceptable of delaying the fast (consistent with the first channel of our prediction). Importantly, across all arms, the combination of both exemption and graphical information persuades the most students to accept postponing the fast for the CEE. This demonstrates the importance of the second channel of our prediction, namely, the exemption article and the score gap graph serve as strong complements, as the exemption helps students better appreciate the graphical information about fasting cost.

Ideally, it would be interesting to also investigate the subsequent impacts of our interventions on the actual fasting behaviours and CEE performance of these students. However, to ensure that our interventions could potentially benefit more students, upon finishing the survey, we provided

all students access to the 'pro-exemption reading material' and the 'Hui–Han CEE gap graph'. As a result, beyond the survey experiment, we no longer have any experimental variation to identify the eventual impacts on fasting behaviours and exam outcomes.

3.3. *Mechanisms*

In this section, we discuss how our experimental design can help distinguish between motivated cognition and alternative interpretations.

3.3.1. *Exemption directly shifting students' beliefs?*

A potential concern is that, in addition to alleviating the students' religious constraints, the pro-exemption reading material itself might carry some information on the cost of Ramadan; for example, students might infer from the Imam's statements that fasting could hurt exam performance, which makes the information presented in the Hui–Han CEE figure more credible.[18] In principle, this interpretation should not confound our main findings, because our main test focuses entirely on the students' reading of the objective information presented in Figure 1(a), and neither the students' priors nor the perceived credibility of the information should be relevant.

To directly investigate this confounding interpretation, for a random half of the students, we did not show them the graph on the Hui–Han score gap, and instead elicited their priors on this gap. Specifically, in the survey, we first informed them about the benchmark Hui–Han CEE gap between 2011 and 2015, and then asked them, in an incentivised manner, to make their most accurate guess on the 2016 Hui–Han CEE gap when the exam happened during Ramadan.[19]

By comparing the elicited guesses on the enlarged 2016 Hui–Han gap between '*No Exempt*×*No Info*' and '*Exempt*×*No Info*', we can test whether the exemption itself affects the students' priors about the cost of Ramadan on exam performance. As shown in Panel A of Table 3, in the absence of the pro-exemption reading material, students guess that the 2016 Hui–Han CEE gap was −17.9, which is statistically indistinguishable from the average gap between 2011 and 2015 (−16.4). This is consistent with conjectures in the literature that many practicing Muslims are not fully aware of the cost of their religious activities (Kuran, 2018).[20] Most importantly, when students receive the pro-exemption reading material, their elicited guess of the 2016 Hui–Han CEE gap barely changes at all, confirming that providing the exemption alone does not change the students' priors on the cost of taking the exam during Ramadan.

3.3.2. *Exemption affecting students' mental bandwidth?*

Because motivated cognition is generated by the fundamental values attached to Ramadan fasting, receiving an exemption to delay the fast should not affect the graph reading accuracy regarding topics unrelated to either the CEE or Ramadan fasting. However, if the pro-exemption reading material occupies substantial mental bandwidth, the treated students might become less accurate in reading any graph, which is not specific to the Hui–Han information.

[18] Relatedly, there may also be experimenter demand effects, where students infer that the experiment aims to convince them of the cost of Ramadan and cater to such objectives in graph reading.

[19] We told the students 'Between 2011 and 2015, the CEE was held outside of the month of Ramadan, and the average score gap between Hui and Han students was −16.4 points. In 2016, the CEE was held in the month of Ramadan. Please give us your most accurate guess: what was the average Hui–Han CEE score gap in 2016?'

[20] Theoretically, anticipatory utility about future exam performance could motivate students to exaggerate the cost of Ramadan on exam performance. By lowering their expectations now, the students could experience positive news in the future and gain psychological utility. However, the results in Sections 3.1 and 3.3.1 do not support this hypothesis.

Table 3. *Effect of Exemption on Placebo Outcomes.*

	(1)	(2)	(3)	(4)	(5)	(6)
	Gap: Answer—Truth			Deviation: |Answer—Truth|		
Panel A: Placebo Outcome—Prior						
Exemption	−0.0699	−0.2167	−0.1481	−0.1444	−0.2859	−0.4120
	(0.9995)	(1.0141)	(1.0586)	(0.7789)	(0.7786)	(0.8270)
Constant	−17.9325***	−17.8588***	−17.8847***	12.5114***	12.5824***	12.6589***
	(0.7082)	(0.7092)	(0.7219)	(0.5518)	(0.5445)	(0.5640)
Mean of control	−17.933	−17.933	−17.933	12.511	12.511	12.511
Class FE	No	Yes	Yes	No	Yes	Yes
Control variables	No	No	Yes	No	No	Yes
No. observations	247	247	246	247	247	246
R^2	0.000	0.116	0.218	0.000	0.142	0.214
Panel B: Placebo Outcome—GDP						
Exemption	−712.084	−876.285	−1126.323	799.783	1011.386	628.583
	(1088.079)	(1146.520)	(1202.963)	(1371.746)	(1375.892)	(1464.607)
Constant	−28433.923***	−28353.615***	−28219.183***	6140.187***	6036.695***	6250.212***
	(760.942)	(790.069)	(809.704)	(959.323)	(948.129)	(985.815)
Mean of control	−28433.923	−28433.923	−28433.923	6140.187	6140.187	6140.187
Class FE	No	Yes	Yes	No	Yes	Yes
Control variables	No	No	Yes	No	No	Yes
No. observations	229	229	228	229	229	228
R^2	0.002	0.061	0.161	0.001	0.149	0.216

Notes: This table presents the effects of religious intervention on placebo outcome variables. Panel A presents the effects of religious intervention on the prior about the score gap. Panel B presents the effect of receiving an exemption on the accuracy of reading the 2016 Sino-Japanese income gap. Columns 1–3 use the reading of the score gap (Panel A) and GDP gap (Panel B). Columns 4–6 adopt an alternative measure, 'absolute deviation from true value' as outcome variable produces similar results. Columns 1 and 4 add no additional controls. Columns 2 and 5 control for class fixed effect. Columns 3 and 6 additionally control for the rich set of control variables we collect from background information. Robust standard errors are in parentheses. *** significant at 1%.

To examine this confounding story, we conduct a placebo test, where students who did not read Figure 1(a) ('*No Info*') were asked to instead read the Sino-Japanese income gap from Figure 1(c). As can be seen in Panel B of Table 3, students in general tend to underestimate the Sino-Japanese income gap.[21] But, importantly, reading about the religious exemption has no statistically meaningful impact on the accuracy of reading the Sino-Japanese income gap, suggesting that our findings are indeed driven by religion-induced motivated cognition, rather than alternative mechanisms.

3.3.3. *Inattention versus motivated cognition*

Another confounding story is that, when students think the information would not be valuable to them (since they have to fast anyway), and if they do not care about the modest monetary incentives provided for accurate reading of the graph, then it is indeed possible that they would pay little attention to the Hui–Han score gap graph, and thus give inaccurate readings. In the paper, two important pieces of evidence help distinguish between our motivated cognition interpretation and this alternative 'inattention' interpretation.

First, motivated cognition predicts that people will systematically underestimate the performance gap (to avoid feeling upset about this inconvenient information). In contrast, if the inaccuracy in reading the Hui–Han gap is simply driven by inattention, then we should expect biases to exist both ways (i.e., both over- and underestimations of the Hui–Han gap in the figure). Our

[21] The true gap is −30771, while the students in the '*No Exempt*×*No Info*' arm on average read −28434.

experimental data, as illustrated in Appendix B, Figure B3, suggests systematic underestimation, which is consistent with motivated cognition rather than inattention.

Second, to further address this concern, we propose another test where we compare the accuracy of graph reading across all four arms. Given that the Hui–Han figure ranges from 0 to −40, and the Sino-Japanese figure ranges from −25000 to −45000, a 2-point deviation in the former is equivalent in scale to a 1,000-dollar deviation in the latter. Therefore, we can extend the definition of 'accuracy' to every student in any of the four arms: it equals one if the student either read the Hui–Han gap and made an error within 2 points, or read the Sino-Japanese gap and made an error within 1,000 dollars; and zero otherwise.

Following this definition, we are able to compare the accuracy of graph reading across the four different arms. Given that the Hui–Han information is more relevant for those Muslim students about to take the CEE during Ramadan, if the results are indeed driven by changes in attention (curiosity/interest), we should expect *No Exemption∗Info* to be more accurate than *No Exemption∗No Info* and *Exemption∗No Info*. However, as shown in Appendix A, Table A4, the students are least accurate when reading the Hui–Han figure without an exemption, even less accurate than when reading the Sino-Japanese gap.

This finding corroborates that the cognitive bias in the baseline was driven by active information distortion rather than lack of attention, which supports the motivated cognition interpretation over the inattention one.

4. Conclusion

In this paper, we find that, when information conflicts with one's fundamental values, an individual may exhibit strong patterns of motivated cognition by significantly distorting the 'undesirable' information in his learning process, even if the information is objective and potentially of very high stakes. These findings suggest that, in order to effectively disseminate important information on polarised issues (e.g., climate change, vaccination, etc.), it is crucial to first identify and intervene against the underlying fundamental values that might prevent individuals' accurate digestion of the high-stakes information.

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Additional Supporting Information may be found in the online version of this article:

Online Appendix
Replication Package

Appendix A

Table A1. *Impacts of Ramadan on CEE Score.*

	(1) Score	(2) Score	(3) Score	(4) Score
Hui × Year_2012	−0.9527	−2.3302		
	(2.7122)	(2.7103)		
Hui × Year_2013	−1.0004	−1.6581		
	(2.6467)	(2.6448)		
Hui × Year_2014	−2.7471	−3.5299		
	(2.6090)	(2.6067)		
Hui × Year_2015	−1.9583	−3.1176		
	(2.5705)	(2.5686)		
Hui × Year_2016	−14.5265***	−15.0378***		
	(2.5613)	(2.5596)		
Hui	−14.6394***	−13.3878***	−16.0395***	−15.5981***
	(1.9194)	(1.9183)	(0.8145)	(0.8138)
Hui × Ramadan			−13.1264***	−12.8275***
			(1.8813)	(1.8799)
Mean of dep. variable	383.218	383.218	383.218	383.218
Year FE	Yes	No	Yes	No
STEM–year FE	No	Yes	No	Yes
Number of observations	124,369	124,369	124,369	124,369
R^2	0.022	0.025	0.022	0.025

Notes: This table presents the effects of taking the CEE during Ramadan on the relative performance of Muslim students. In columns 1 and 2, we interact Muslim dummy with year dummies. In columns 3 and 4, we collapse the pre-treatment years into a larger control group. In columns 1 and 3, we control for year FE; in columns 2 and 4, we control for STEM-by-year FE. Standard errors in parentheses are clustered at the high school level. *** significant at 1%.

Table A2. *Balance Test.*

	All		No Exp&No Info	Exp&No Info	No Exp&Info	Exp&Info	Anova Test	
Variables	Mean	SD	Mean	Mean	Mean	Mean	*F*-stat	*p*-value
Gender: male	0.405	0.491	0.445	0.398	0.393	0.387	0.38	0.765
Parents with college education	0.045	0.208	0.016	0.047	0.044	0.070	1.57	0.195
Access to computer at home	0.390	0.488	0.391	0.375	0.400	0.394	0.06	0.980
Access to Internet at home	0.814	0.389	0.859	0.758	0.837	0.803	1.67	0.172
Boarding at school	0.831	0.375	0.852	0.82	0.859	0.796	0.84	0.475
Risk loving	2.461	2.125	2.480	2.438	2.652	2.282	0.71	0.548
Perceived value of college	3.692	1.186	3.543	3.680	3.919	3.620	2.51	0.058*
STEM track	0.610	0.488	0.609	0.625	0.630	0.577	0.32	0.810
Honours class	0.334	0.472	0.320	0.336	0.385	0.296	0.88	0.454
Pray everyday	0.589	0.492	0.641	0.555	0.607	0.556	0.95	0.418
Never broke a fast	0.535	0.499	0.602	0.469	0.504	0.563	1.85	0.137
Mock exam score	365.856	62.899	371.006	368.126	366.081	358.953	0.91	0.435
Observations	533		128	128	135	142		

Notes: These two panels present the balance tests across the four different arms in the 2×2 experimental design. As can be seen, most variables are well balanced, indicating that the randomisation was well implemented. 'Risk loving' and 'Perceived value of college' are measured using a five-point Likert scale. * significant at 10%.

Table A3. *Motivated Cognition in Graph Reading: Alternative Outcome Variable.*

	(1) Deviation	(2) Deviation	(3) Deviation	(4) Deviation	(5) Deviation	(6) Deviation
Exempt	−1.6726***	−1.6957***	−1.9021***	−0.2880	−0.5790	−0.5945
	(0.6404)	(0.6457)	(0.6502)	(0.9245)	(0.9394)	(0.9526)
Fast				2.2770**	2.4863***	2.5825***
				(0.9031)	(0.9205)	(0.9368)
Exemption×Fast				−2.6987**	−2.2722*	−2.4995*
				(1.2663)	(1.3004)	(1.3371)
Constant	5.9317***			4.7848***		
	(0.4585)			(0.6409)		
Mean of control	5.932	5.932	5.932	5.932	5.932	5.932
Class FE	No	Yes	Yes	No	Yes	Yes
Control variables	No	No	Yes	No	No	Yes
Number of observations	277	276	274	277	276	274
R^2	0.024	0.143	0.228	0.047	0.168	0.239

Notes: This table presents the effects of receiving exemption to delay fast on the accuracy of reading the graph about the 2016 enlarged Hui–Han gap in CEE performance, as well as heterogeneous treatment effects of exemption based on fasting history. We use the 'absolute deviation from true value' as outcome variable instead of the gap read by students. Robust standard errors are in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table A4. *Share of Very Accurate Response: Placebo Outcome Versus Main Outcome.*

	(1) Accuracy	(2) Accuracy	(3) Accuracy
Exempt×No Info	−0.0312	−0.0369	−0.0345
	(0.0621)	(0.0624)	(0.0633)
No Exempt×Info	−0.1843***	−0.1902***	−0.1734***
	(0.0613)	(0.0618)	(0.0624)
Exempt×Info	−0.0688	−0.0667	−0.0528
	(0.0605)	(0.0611)	(0.0616)
Benchmark	Control—Placebo	Control—Placebo	Control—Placebo
Mean of control	0.555	0.555	0.555
Class FE	No	Yes	Yes
Control variables	No	No	Yes
Number of observations	533	532	529
R^2	0.019	0.076	0.122

Notes: This table compares the share of very accurate response across all four arms: '*No Exempt* × *No Info*', '*Exempt* × *No Info*', '*No Exempt* × *Info*', '*Exempt* × *Info*' by pooling both the main and placebo outcome on graph reading. Columns 1–3 use exactly the same specification where we include the placebo outcome (students' beliefs about the score gap) and use it benchmark for the regression. The only difference across the columns is the threshold below which a response is counted as accurate response. Robust standard errors are in parentheses. *** significant at 1%.

Table A5. *Difference-in-Differences Estimate of Effect of Exemption Article on the Reading of Exam Performance Gap.*

	(1) Gap	(2) Gap	(3) Gap	(4) Deviation	(5) Deviation	(6) Deviation
Exempt×Info	−1.9173*	−1.9529**	−1.7041*	−1.5410**	−1.6221**	−1.6807**
	(0.9892)	(0.9114)	(0.9728)	(0.7290)	(0.6791)	(0.6959)
Class FE	No	Yes	Yes	No	Yes	Yes
Control variables	No	No	Yes	No	No	Yes
Number of observations	523	523	520	523	523	520
R^2	0.226	0.285	0.321	0.300	0.364	0.390

Notes: This table presents the difference-in-differences estimates of the effect of the exemption article on the reading of the exam performance gap, by incorporating students from whom placebo outcomes (the beliefs about the performance gap in 2016) were elicited. The regression we run is similar to those in the main text: Score Gap $= \alpha$Exempt $+ \beta$Info $+ \gamma$Exemption×Info + List of Controls in the Table. where 'Exemption' takes the value of 1 if students are presented with the exemption reading materials, and 0 if not. 'Info' takes the value of 1 if students are assigned to read the performance gap in exam score (i.e., main outcome), and 0 if students do not see the score gap graph, and instead give their guess (not reading) about the performance gap in 2016 (i.e., placebo outcome). Columns 1–3 use the reading of the GDP gap directly. Columns 4–6 adopt an alternative measure, 'absolute deviation from true value' as outcome variable produces similar results. Columns 1 and 4 add no additional controls. Columns 2 and 5 control for class fixed effect. Columns 3 and 6 additionally control for the rich set of control variables we collect from background information. Robust standard errors are in parentheses. * significant at 10%, ** significant at 5%.

Appendix B

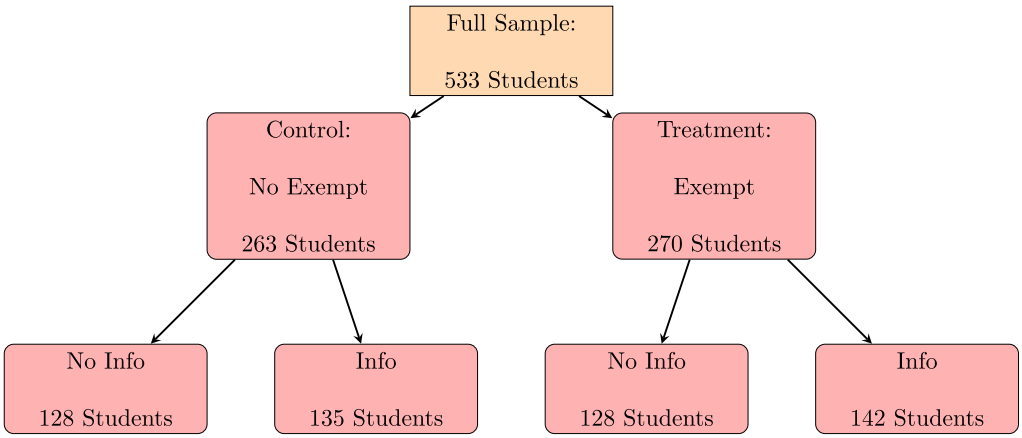

Fig. B1. *Experimental Design. This picture depicts the structure of the experimental design. The most important experimental variation is whether the exemption reading material is presented to the students. Randomly half of the students (263 Students) are assigned to 'No Exempt' where they do not read the exemption materials. The other half of the students (270 Students) are assigned to 'Exempt' where the materials are presented during the experiment. Within each group of the students, some students are presented with the graphical information about the score gap between Hui and Han students, whose group is labelled as 'Info', whereas other students are not presented with such information, whose group is labelled as 'No Info'. Therefore, there are in total four groups: No Exempt×No Info (128 Students), No Exempt×Info (135 Students), Exempt×No Info (128 Students), Exempt×Info (142 Students).*

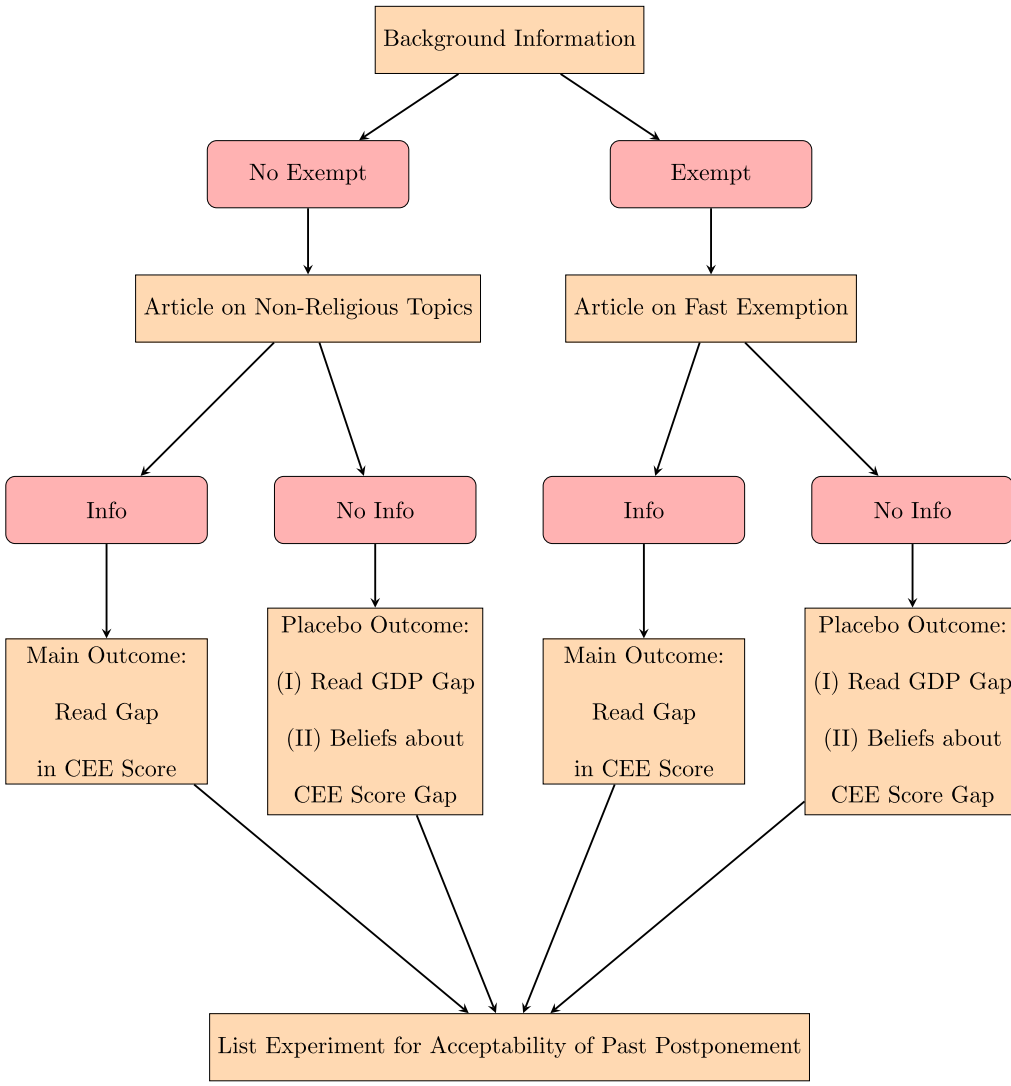

Fig. B2. *Flow Chart for Details of the Experiment. This picture depicts the sequence in which each component of the survey is displayed for the four versions of the survey, which differ on (I) whether students read the exemption material ('Exempt') or the placebo material ('No Exempt'); (II) whether students read the score gap graph ('Info') or the Sino-Japanese GDP graph ('No Info'). The four versions are therefore 'No Exempt×No Info', 'Exempt×No Info', 'No Exempt×Info', 'Exempt×Info' respectively.*

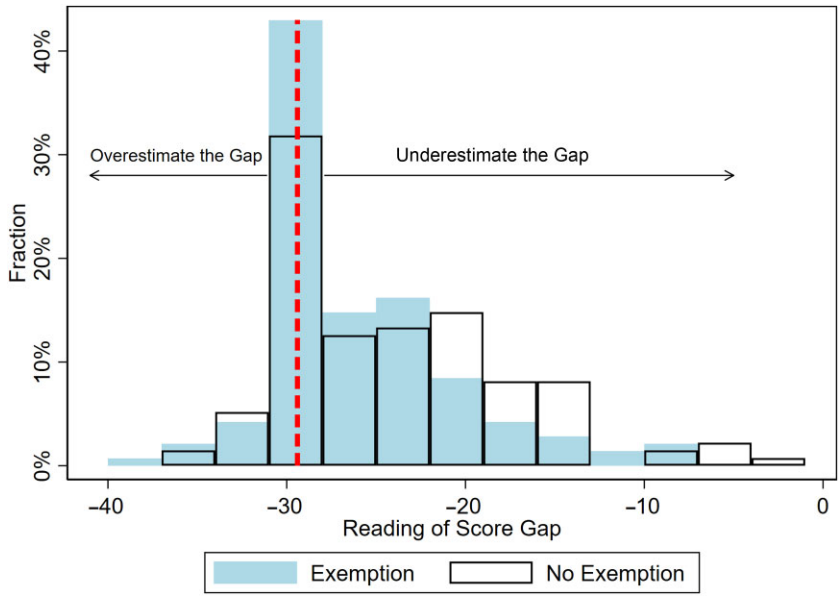

Fig. B3. *Distribution of Students' Reading of the Score Gap. This figure plots the distribution of the main outcomes elicited, namely, students' reading of the score gap, for students who read the exemption article ('Exemption') and who did not read the exemption article ('No Exemption'). The dash line correspond to the correct answer (−29.4).*

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