Religion and Motivated Cognition: When Ramadan Meets the College Entrance Exam

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Abstract

This paper reports a field experiment showing that motivated cognition causes people to fail to learn from important objective information. We find that when Chinese Muslim students were scheduled to take the high-stakes College Entrance Exam during the month of Ramadan, they exhibited strong patterns of motivated cognition to underappreciate the cost of fasting on exam performance. When randomly offered explicit exemptions to break the fast, granted by religious leaders, their motivated beliefs were significantly alleviated, which enabled them to more accurately interpret how fasting would affect exam performance, and made them more willing to break the fast during the exam.

Keywords: Ramadan Fasting, Religious Practice, College Entrance Exam, Motivated Cognition

JEL Codes: D91, I21, Z12

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1 Introduction

Classical economic theories generally hold that people correctly update their beliefs in a Bayesian fashion. In reality, it is common and costly that many actually fail to learn from objective information on important issues. For examples, at the macro level, public opinions are polarized on topics such as global warming (Hart and Nisbet, 2012), GMO foods (Priest, 2000), and evolution (Plutzer and Berkman, 2008), despite overwhelmingly one-sided scientific evidence; at the micro level, individuals fail to process red flags of disease risks (Oster et al., 2013), and traders fail to internalize clear signals of housing-market crashes (Cheng et al., 2014).

To rationalize such learning failure, one of the behavioral economic theories is that people have motivated beliefs (Bénabou, 2015; Bénabou and Tirole, 2011, 2016): they attach psychological value to certain beliefs, and can distort their own perceptions toward such preferred beliefs to increase their utility.[1] However, to fully explain the "learning failure" observed in reality, existing empirical evidence on motivated beliefs still falls short on two important dimensions. First, while a series of lab experiments have been conducted to test for motivated beliefs,[2] experimental investigation in the field remains challenging due to the difficulty in exogenously varying people's psychological motivation in a natural setting.[3] Second and most importantly, while existing work has shown that people can distort subjective opinions in their own minds, there is little evidence on the stronger form of motivated beliefs: whether/how people can distort objective evidence that is directly presented in front of their eyes. Such distortion of credible signals is referred to as "reality denial" by Bénabou and Tirole (2016), which is a key implication that distinguishes the theory of motivated beliefs from other theories explaining belief distortion.

Motivated by these gaps in our knowledge, in this paper, we combine a large-scale high-stakes natural experiment with a novel field experiment to provide the first piece of empirical evidence on how people can distort high-stakes information in a real setting. In particular, we focus on a setting where religious practices conflict with secular activities, and reveal a specific underlying mechanism for information distortion: the stringency of religious constraints substantially increases costs of disobedience among religious followers, motivating

[1] This literature also closely relates to an older psychology literature on motivated reasoning, as summarized by Kunda (1990).

[2] For example, Eil and Rao (2011) and Mobius et al. (2011) show that people exhibit asymmetric updating behavior about self-image, and Di Tella et al. (2015) show that beliefs about others' altruism decrease with stakes.

[3] In recent observational works, Oster et al. (2013) show that people are motivated to be overly optimistic about their life expectancy; Huffman et al. (2018) establish the link between biased memory and overconfidence about the future, which is an important prediction generated by models of motivated beliefs.

them to self-rationalize their own religious behaviors to avoid regretting such decisions. This means they tend to distort signals about high costs of their religious behaviors.

Our empirical setting comes from a unique natural experiment in China. In this context, China's College Entrance Exam (CEE), which is the single criterion for college admission for most students and is perceived to be of extremely high stakes (Jia and Li, 2016), is held on June 7th and 8th every year. Between 2016 and 2018, the exam happened to fall in the month of Ramadan, which follows the Islamic (Lunar) Calendar, and shifts 11 days forward every year in the Gregorian Calendar. Using a Difference-in-Differences estimator with administrative data on all students in high school graduation cohorts between 2011 and 2016, we find that taking the exam during Ramadan has a quantitatively important negative impact on the exam performance of Muslim students, as compared to their non-Muslim counterparts.

Given the large negative impacts of fasting on exam performance, and the extremely high stakes associated with the CEE score, it would be natural for the Muslim students who were about to take the CEE during Ramadan in 2018 to consider the possibility of breaking the fast for the exam. However, for those who are practicing Muslims, whether or not they could delay the fast until after the exam depended on obtaining an exemption from a local expert in Islamic jurisprudence (Faqih), explicitly allowing them to break the fast for the CEE. Seeing that there was no clear exemption from fasting made public for the CEE in our setting, we invited two well-respected Muslim religious leaders to explicitly grant exemptions (and present the Quranic reasoning) to some Muslim students. Receiving such an exemption gives a student the flexibility to choose whether or not to fast during the CEE, which therefore is a relaxation of the religious constraint.

We conduct a randomized controlled experiment in a large Muslim high school in the Ningxia Hui Autonomous Region, a Chinese province where 38% of the population is Muslim. By randomly providing the exemptions to some of the Muslim students who were about to take the CEE (during Ramadan) in 2018, we created experimental variation in the stringency of religious practices: some students believed that in light of religious rules, their best choice is to fast during the exam, while other students thought that the fast could be delayed until after the exam. We then showed all students the same graph displaying what we found in the administrative data: taking the exam during Ramadan (fasting) has salient negative impacts on the exam performance of Muslim students. Using a visual-based survey module, we find that students who thought they had to fast during the exam in 2018 (control group) show patterns of motivated cognition: they distort the evidence in the graphs by underestimating the negative impacts of taking the exam during Ramadan, but as much as 50% of such cognitive bias is eliminated among the students who received an exemption

(treatment group).

Our baseline findings suggest that students distort information on the negative consequences of their religious behavior. We conduct a series of additional analyses to better understand the mechanisms. First, we find that the baseline results are mainly driven by extensive margin effects: Muslim students either became particularly accurate in information acquisition after receiving the exemption, or do not adjust their beliefs at all. Perhaps this could be explained by the fact that the incentives to manipulate beliefs arise from one's fasting behavior during the CEE, which is itself a binary decision. Second, we show that the bias in information cognition is most salient among students who always strictly followed the Ramadan fasting requirements during high school, and they are also the ones who respond strongly to our provision of exemptions. This suggests that the baseline findings are indeed driven by motivations associated with fasting attitudes. Third, we conduct a placebo test, and find that the provision of an exemption to delay the fast does not affect the acquisition of information that is unrelated to the Ramadan fasting. Fourth, using a "list experiment" approach, we provide suggestive evidence that alleviating motivated cognition makes students better informed about the costs of Ramadan, and thus more willing to delay the fast until after the CEE.[4]

Our paper speaks to four strands of literature. First and foremost, the paper provides a direct and strong test for the theoretical framework of motivated beliefs/cognition (Bénabou, 2015; Bénabou and Tirole, 2011, 2016). Originating from research on motivated reasoning in psychology,[5] the existence and implications of motivated beliefs/cognition have attracted much scholarly interest in both experimental economics and political science[6]. Recent lab studies have been particularly focused on motivated information acquisition, and have identified a variety of situations in which people are willing to distort beliefs / manipulate information acquisition due to selfish motives (Dana et al., 2007; Di Tella et al., 2015; Exley, 2016). Our study furthers understanding of motivated belief, in particular, motivated information acquisition and cognition, in two important ways. As a field experiment,[7] our setting

[4]A list experiment requires respondents to provide the total number of items on a list to which they answer affirmatively, rather than to answer each item separately, alleviating the bias in eliciting answers to sensitive questions.

[5]See Kunda (1990) for an extensive discussion of the psychology literature.

[6]In economics, Eil and Rao (2011) and Mobius et al. (2011) study the impact of self-image related matters on belief updating. In political science, Redlawsk (2002) study the effects of motivated reasoning on political decision-making; Taber and Lodge (2006) study how people process arguments on important public policy issues with different prior attitudes; Nyhan and Reifler (2010) demonstrate that motivation affects information processing in reading news articles about politicians.

[7]More precisely, according to the classification of field experiments in Harrison and List (2004), our experiment can be defined as a framed field experiment in that the subjects of interest (i.e., students who will face the choice regarding fasting on exam day) constitute precisely the population with whom we are conducting the experiment. Moreover, the intervention we introduce is of critical relevance to their important

shows that motivated beliefs extend to a setting where high-stakes decisions are involved. Moreover, while most lab experiments have been able to show that subjects can either fail to adhere to Bayesian updating (Eil and Rao, 2011; Mobius et al., 2011), selectively acquire information in the presence of substantial cognitive cost (Ambuehl, 2017), or distort memory (Chew et al., 2019; Zimmermann, 2020), our paper shows that learning failure can also happen at the very beginning of the information acquisition process, before information storage (i.e. memory) and belief updating (e.g. Bayesian updating). We find that when clear information is presented right in front of one's eyes, individuals can actively distort the objective signal itself, before even starting to store and interpret it. Bénabou and Tirole (2016) refer to this type of behavior as "reality denial," which is a particularly salient type of bias due to motivated beliefs, yet there has been little empirical evidence examining its prevalence and mechanisms.

Second, our paper builds on a long-standing behavioral economics literature on cognitive limitations (Simon, 1955; Conlisk, 1996). A classic example of cognitive limitation is visual bias, which has been shown to affect information acquisition and could potentially distort economic decisions (Kahneman, 2003). Most of the existing work attributes visual bias to individuals' inherent limits in visual perception. Our paper complements Engelmann et al. (2019) by showing that motivated visual distortion could arise even in a high-stakes field setting. In another related paper, Exley and Kessler (2018) find that people make simple mistakes (e.g., trivial calculation errors) when they are motivated to do so. Our paper and their paper complement each other as they document different types of motivated distortion of outcomes (visual bias vs. computational error).

Third, our paper contributes to the literature on religious participation. Existing literature on this topic mainly follows a "rational choice" approach: the decision to participate in religious activities is based on a cost-benefit analysis (Azzi and Ehrenberg, 1975; Iannaccone, 1992, 1998; Montgomery, 1996; Stark and Finke, 2000; Berman, 2000). The validity of such rational choice frameworks critically relies on the condition that individuals can accurately evaluate the costs and benefits of religious participation. On the benefit side, Augenblick et al. (2016) find that religious followers sincerely attach high pecuniary values to their religious beliefs. However, since valuation of religious beliefs could come from different motives such as salvation, consumption, and peer pressure, it remains challenging to conclude whether such high valuation of religious benefits is "biased."[8] Our paper complements Augenblick et al. (2016) by investigating the cost side of the decision. Since our DiD analysis accurately quantifies the costs of religious participation (taking the exam during

decision in real life.

[8]See Iyer (2016) for a detailed discussion on the different dimensions of religious benefits.

Ramadan), we have the unique opportunity to identify the difference between "perceived cost" and "actual cost" of religious participation, and to analyze the driving force of such a discrepancy. Our results suggest that stringent religious constraints define the action of the followers, motivating them to self-rationalize such action by underestimating its potential costs. These findings imply that religious followers do not realize the full costs of their religious behaviors, which could help rationalize prevalent religious participation and rapid religious expansion in the rational choice framework.

Fourth, this paper also adds to an accumulating body of evidence on the impact of food/liquid deprivation on cognitive function and other economic activities. Documenting the negative impact of fasting on exam performance is important to understanding the non-religious implications of religious behaviors practiced by millions of Muslims (Kuran, 2018). There is a growing literature on the adverse effect of fasting during the prenatal period on children's cognitive skill, health and labor supply (Almond and Mazumder, 2011; Almond et al., 2015; Majid, 2015). It has also been demonstrated by Schofield (2014) that Ramadan fasting has serious impacts on cognitive function, and that people may be naive about the determinants of their health status, such as calories intake. A particularly relevant paper is Oosterbeek and van der Klaauw (2013), which estimates the effect of fasting during the semester on final exam performance in an economics course. Our DiD analysis differs from their paper in two important ways. To start with, the exam we study is of much higher stakes. Moreover, the DiD effect we estimate is purely driven by "fasting on exam day," teasing out any differences in learning before the exam.[9]

The remainder of this paper is organized as follows: in Section 2, we introduce some background information and present the DiD results on the negative consequences of Ramadan; in Section 3, we discuss the details of our experimental design and implementation, and lay out the testable hypotheses which guide the empirical analysis; in Section 5, we present the empirical results and discuss underlying mechanisms; in Section 6, we conclude.

2 Background

In this paper, for both the analysis of administrative data and the survey experiment, we focus on the Ningxia Hui Autonomous Region (henceforce Ningxia), which is a provincial unit with a population of 6.3 million, and has a GDP pc of $7103.

Among the 6.3 million residents in Ningxia, 38% are Hui, a Muslim minority ethnic group

[9]What Oosterbeek and van der Klaauw (2013) identify is a compound effect of these two factors. We can tease out the "learning factor" because in 2016, which is the "treatment period" in our DiD analysis, Ramadan started only one day before the exam.

in China, and the rest are mainly Han, the majority ethnic group in China (non-Muslim).[10] Islam is the dominant religion in Ningxia; there are currently more than 3300 major mosques, and more than 4000 certified Imams; in comparison, there are fewer than 200 religious sites for all the other religions combined, including churches, Buddhist temples, Taoist temples, etc.

Compared with the other major Muslim minority group in China, the Uyghurs, the Hui people are much more similar to the majority Han Chinese: their appearances can hardly be distinguished from the Han people, and their mother tongue is Mandarin.[11] It is generally believed that the Hui have much better relationships with the Chinese government than the Uyghurs, and as a result, the government shows a more lenient attitude towards their religious activities and practices (such as praying and fasting in schools) in the Ningxia Hui Autonomous Region than in the Xinjiang Uyghur Autonomous Region.

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

2.1 The College Entrance Exam in China

The College Entrance Exam (CEE) in China is a closed-book written exam held on June 7th and 8th every year. Students take the exam in their province of residence, within which the exam content is the same for students in the same track (Social Sciences or STEM). All students are tested on Chinese, mathematics, and English, each with a maximum score of 150 regardless of their track. In addition, students in the social sciences track take another exam on history, politics, and geography, while students in the natural sciences track take another exam on physics, chemistry, and biology. This track-specific exam accounts for 300 points. The total score of the CEE is therefore 750 points.

All Chinese colleges admit students based on the students' provincial ranking of the CEE score. For the vast majority of students, conditional on their own stated college preferences, provincial ranking of the CEE score is the sole criterion that determines the admissions outcome.[12] Given the tremendous value placed on education in the east Asian culture (Chen et al., 2017), and the huge return to elite college education (Jia and Li, 2016), it is not

[10] According to the Global Religious Landscape Study, Muslims are the second largest religious group (23%, only next to Christians). There are about 10 million Hui Muslims in China, and about one-fourth reside in Ningxia.

[11] In comparison, the Uyghurs speak a Turkic language written with an Arabic script, and their appearances are distinct from the Han Chinese.

[12] Rare exceptions include winners of international Olympiad contests, students who win sports scholarships, students with exceptional art talents, etc.

surprising that the CEE is considered by nearly all parents and students as a life-changing opportunity, and regarded by many as the most high-stakes event in a lifetime.

College Admission in China follows a centralized system, where each student first learns about his own score, then submits a ranked list of preferred colleges, and then the colleges admit students solely based on the submitted lists and exam scores. Due to the highly competitive nature of this matching market, even a modest improvement in CEE score (say 5 points out of 750, approximately 0.05 standard deviation) would typically allow a student to include better colleges in his ranked list, and could easily lead to more desirable admission outcomes. Even within the same college, popular majors such as economics, finance, and computer science are typically only available to the students with higher CEE scores. Therefore, students at any part of the distribution generally have strong incentives to increase their CEE scores, even by just a small margin.

2.2 The Muslim Ramadan Fasting

Ramadan is the 9th 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 according to Islamic beliefs. Fasting during Ramadan is regarded as one of the "five pillars (fundamental religious duties) of Islam." It requires abstinence from food and liquids (including water) from dawn to sunset, and is obligatory for practicing Muslims. Exemptions to break the fast are typically made for children, the ill, the elderly, travelers, and breastfeeding women.

Many of the conflicts that arise between modern reality and religious practices are not explicitly discussed in the Quran. Under these conditions, practicing Muslims typically rely on a local expert in Islamic jurisprudence (Faqih) to decide whether their cases could be granted an exemption. For instance, the Egyptian national soccer team qualified for the FIFA World Cup in 2018, for the first time in 28 years, 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 his permission to postpone their Ramadan fasting obligations in the days building up to the World Cup. On the contrary, the Tunisian national team faced the same problem, but did not get such an exemption, and as a result, the players kept fasting throughout the month of Ramadan while preparing for the World Cup.

Observing Ramadan has the potential to offer individuals some benefits such as feeling closer to God and learning to exercise greater self-control. However, it has also been well-documented by an extensive medical literature that Ramadan fasting negatively affects

health, through weight loss, metabolic changes, irritability, headaches, dehydration, sleep deprivation, lassitude, etc. (Hallak and Nomani, 1988; Ziaee et al., 2006; Leiper and Molla, 2003; Lancet, 2009). Not surprisingly, these symptoms caused by Ramadan fasting have been shown to be associated with a feeling of tiredness, loss of concentration, and unwillingness to work (Afifi, 1997; Karaagaoglu and Yucecan, 2000). In the economics literature, Campante and Yanagizawa-Drott (2015) show that Ramadan fasting reduces economic output, Schofield (2014) documents that agricultural productivity drops during Ramadan, and Oosterbeek and van der Klaauw (2013) show that students have lower test scores due to Ramadan fasting. Relatedly, outside of the Ramadan context, Figlio and Winicki (2005) show that schools subject to accountability pressure strategically raise the calorie content of meals on test days in an apparent attempt to boost short-term student cognitive performance.

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 publicized locally by the Imams before the start of the month of Ramadan. In some extreme cases, fasting hours could be almost all day long, leaving little time for caloric and water intake.

2.3 Ramadan and Exams

Between 2016 and 2018, the month of Ramadan mainly 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 will likely continue until 2019/20.[13]

Around the world, school leaders and teachers are making efforts to accommodate and support students during Ramadan, including schools in the United States,[14] the United Kingdom,[15] Germany,[16] France,[17] Canada,[18] and the United Arab Emirates,[19] etc. The popular strategies to help students who fast include rescheduling testing or event times, shortening

[13] "Ramadan: Exams and Tests, 2018", visited on Aug 5, 2018

[14] K-12 school example from The Seattle Times; higher education example from USA Today College.

[15] An Op Ed piece at School Week: "How schools can support students during Ramadan?"

[16] An article at World Crunch: "Hungry Students? Postponed Exams? Ramadan in German Schools"

[17] A news report at RT International: "Row over postponing French Muslim students' exams for religious holiday"

[18] A CBC news report: "How are schools accommodating fasting students during Ramadan?"

[19] News report at Gulf News - Education: "Five-hour school days in Dubai during Ramadan"

school days, providing extra and comfortable space, and other accommodations. At the same time, some institutions, such as the Association of School and College Leaders, collected and distributed statements from established Muslim leaders, suggesting that students could delay the fast until after the exam, which is similar in spirit to the exemptions offered in our treatment group.[20]

The problem is particularly serious when students are scheduled to take high-stakes exams and it is not possible to reschedule the exams. For example, Oosterbeek and van der Klaauw (2013) study the effect of Ramadan on final grades of Muslim students in an introductory microeconomics course in the Netherlands, where teaching and exam dates are not adjusted for the fasting period. Using data over five years and a Difference-in-Differences strategy, they find that each additional week of Ramadan fasting reduces the final grades of Muslim students by about 0.1 standard deviations.

Muslim students in China faced even more serious situations. Between 2016 and 2018, the College Entrance Exam in China, which is fixed on June 7th and 8th, fell in the month of Ramadan. When deciding how they observe Ramadan, students need to take into consideration: (1) the great importance of the CEE for their future, (2) the negative impact of fasting on CEE performance, and (3) any flexibility to delay the fast until after CEE. While there is little doubt that most CEE-takers are well aware of the importance of this exam, neither (2) nor (3) are fully clear in the Chinese context: no empirical evidence has been provided regarding the cost of Ramadan on CEE performance, and very little information regarding "whether fast could be delayed until after the exam" could be found on the Chinese internet or other media.[21]

In the following subsection, we first estimate how Ramadan affects exam performance in the absence of any intervention or accommodations, quantifying consideration number (2); in the experimental design to be discussed in Section 3, we describe how we collected explicit exemptions from Chinese religious leaders and randomly distributed those to some Muslim students, creating experimental variation in consideration number (3).

[20]This intervention from the UK ASCL suggests that, while exemptions are potentially available, many Muslim students in the UK are likely unaware of this possibility. This is consistent with our anecdotal observation in China, which motivated our experimental design.

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

2.4 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, and was the criterion used in the college admissions process. This administrative dataset includes 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, school, county of origin, etc.[22]

Exploiting the fact that the CEE fell in the month of Ramadan only in 2016, and the fact that Ramadan is expected to affect the performance of Muslim students only, we identify the causal impact of taking the exam during Ramadan by measuring how the Hui-Han gap in exam score changed in 2016, compared with the gaps between 2011 and 2015. As shown in Figure 1, the Hui-Han gap in exam score was overall stable between 2011 and 2015: on average Hui students score 15 points lower than their Han counterparts.[23] 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.

To formalize the graphical patterns, we estimate a simple Difference-in-Differences model:

$$Score_{isct} = \sum_{t \in \{2012-2016\}} \alpha_t \cdot Hui_i \cdot Year_t + \lambda_{st} + \epsilon_{isct} \tag{1}$$

where $Score_{isct}$ is defined as the CEE score of student i, who chooses track s (STEM vs. Social Sciences), from county c, and takes the exam in year t. Hui_i is a dummy variable that equals 1 if student i is ethnically Hui, and 0 otherwise. $Year_t$ is the Year Fixed Effect, λ_{st} is the Track-by-Year Fixed Effect, and ϵ_{isct} is the error term. Standard errors are clustered at the school level to allow for serial correlation within the same high school.

Since the CEE fell in the month of Ramadan only in 2016, we expect the Hui-Han gap in exam scores to be stable between 2011 and 2015. Therefore, for $t \in \{2012-2015\}$, α_t should be statistically indistinguishable from zero. Because the Hui students took the exam during Ramadan in 2016, we expect to see a drop in their relative performance, and therefore a negative and significant α_{2016}.

As can be seen in Figure 2, the regression results are highly consistent with our expectations: α_t is always a precisely estimated zero between 2012 and 2015, prior to the overlap

[22] Since we only have data for urban CEE-takers to conduct the DiD analysis, for consistency, the field experiment is also carried out in an urban Muslim high school.

[23] The enlarged gap in 2014 was driven by the fact that more Hui students chose the social sciences track rather than the STEM track, and the social sciences track exam was relatively difficult in 2014. This fluctuation disappears once we control for a Track-by-Year Fixed Effect in the regression analysis.

between the CEE and the month of Ramadan, which suggests that the Hui and Han students have parallel trends in exam performance before 2016. In 2016, when Hui students took the exam during Ramadan, their performance dropped significantly relative to their Han peers, by a magnitude of more than 13 points, out of the average score of 383. In contrast with Figure 1, the pre-trend is flatter since we have controlled for the idiosyncratic fluctuations at the track-year level. The regression results are quantified in Table 1, where we also show that the results are robust to the inclusion of gender and county fixed effects, and also robust to collapsing all the pre-treatment data into one control group.

In this context, a score loss of 13 points is a huge burden for the students, and would very likely lead to admission by a lower-ranked college, or at least a " less desirable" major within the same college.[24] It is also worth pointing out 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 than 13 points.[25]

3 Experimental Design and Implementation

For Muslim students who were about to take the exam during Ramadan in 2018, the huge negative impact of Ramadan on CEE scores in 2016 (as documented in Section 2) would likely be perceived as undesirable information. However, correctly understanding this information could potentially be highly beneficial to them, for at least three reasons. First, knowing the cost of Ramadan fasting for exam performance would help them make better decisions about whether or not to delay the fast until after the CEE. Second, knowing this information in advance could help them decide the optimal efforts to put into studying for the CEE. Third, this information could help them predict their own exam performance, which could help them make better college choices.[26]

However, if we simply presented our DiD findings to those Muslim students who were about to take the CEE during Ramadan in 2018, the stringent requirements of Ramadan

[24] To put the magnitude in context, in Ningxia, winning in the highly prestigious National Mathematics Olympiad Competition or an international athletics competition would only be rewarded with 5 bonus points on the CEE.

[25] As shown in Table 3, in our representative experimental sample, around 54% of high school students never broke a fast, which suggests that the TOT effects could be as large as 24 points (0.24 standard deviations).

[26] While the college choices are only made after the announcement of the CEE scores, students need to learn about potentially relevant colleges in advance, based on their expected CEE score. It has been shown that finding a "suitable" shortlist of schools is central to realizing a satisfactory admissions outcome (Wang et al., 2020).

fasting in the Islamic religion could give them psychological motives to discount this undesirable information, and underestimate the cost of Ramadan on exam performance. Motivated by this intuition, we designed and implemented a field experiment in Ningxia in May 2018, which formally tests how the stringency of religious practice (Ramadan fasting requirement) generates motivated cognition regarding the cost of religious behavior (impact of Ramadan on exam performance).

With the assistance of the China Center for Education and Human Resources Research at Peking University, we partnered with a large urban Muslim high school in Ningxia to conduct a survey experiment. The high school is the second largest in its prefecture city, with 24 classes in its senior cohort (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 behaviors such as fasting and praying generally observable to other students.

Our survey experiment took place on May 4th, 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 to participate constitute our population for this study. The students were informed by their classroom head teachers before the study that this was a survey conducted by Peking University, which is our partner institution and the top university in China. Students were also informed that completing the questionnaire could lead to as much as a 20 Yuan cash reward.[27] Given the reputation of Peking University among high school students in China, the questionnaires were answered carefully by the vast majority of our subjects, as can be reflected by the fact that most students correctly answered our multiple choice questions based on a 1000-word reading material.

As summarized in Table 2, our survey experiment has a 2-by-2 design. Randomly, half of the students read material containing the exemption to delay the fast for the CEE (*Exemption*); the other half read an article on art and philosophy (*No Exemption*). In the meantime, we cross-randomized the information received by students: half of the students were incentivized to read a graph about the Hui-Han CEE score gap (*Information*), while the other half were incentivized to read a graph about the Sino-Janpanese income gap (*No Information*). The 533 Muslim students participating in the study were randomized into one of these four arms, which they were unaware of during the survey experiment. A flow chart summarizing the survey experiment, translated versions of all survey questions, and translated versions of the treatment and control reading materials can be found in Appendix B.

[27] Students on average spend about 10 Yuan on meals every day. 20 Yuan is thus a substantial payment to a high school student.

In our treatment reading material, we collected statements from well-respected Chinese Muslim leaders, which directly gave exemptions to students to delay the fast until after the CEE, and combined them as an article of about 1000 Chinese words. Specifically, we interviewed an established Muslim scholar, the Imam of an historic mosque, who explicitly said that "Muslim students should 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 was told that "we should interpret the Quran in the modern context and allow the CEE participants to delay their fast." The two Imams also gave the Quranic reasoning behind their arguments. We also collected similar exemptions given in Egypt and France to further support the case. For the control reading material, we edited an article from a famous Chinese writer, Xiaobo Wang, 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 monetary rewards if they answered the questions correctly.

Our main outcome of interest is whether a student could accurately acquire the information regarding the costs of taking the CEE during Ramadan. To measure such cognitive accuracy, we presented half the students (randomly selected) in each group (treatment and control) with Figure 1, which documented how the Hui-Han gap in CEE score was stable between 2011 and 2015, but enlarged abruptly in 2016. The scale of Figure 1 was intentionally labeled 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 estimate the enlarged Hui-Han gap in 2016.

We explicitly told the 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 the Hui-Han gap in 2016 from the graph.*" In order to incentivize careful reading of the gap, we offered cash rewards to students whose estimates were in the top 50% in terms of accuracy. The main hypothesis is that if students think they have to fast during the CEE, they would be motivated to underestimate the cost of fasting, therefore students would tend to have downward biases when reading the gap from the graph. On the contrary, when granted the exemption, students would think that they do not have to fast during the CEE, and would thus be able to absorb the information with less influence from psychological motivations, and therefore get more precise estimates from the same graph.

Both our anecdotal knowledge and the recent literature suggest that Muslim students

might not be fully aware of the negative impacts of fasting (Kuran, 2018). To verify whether this is true in our context, for the other half of the students in each group, we did not show them the "Hui-Han CEE gap" graph (Figure 1). Instead, we just told them "*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,*" and then we asked the students to guess the 2016 Hui-Han CEE gap, in an incentivized way.[28] By doing so, we could elicit students' priors regarding the Hui-Han CEE gap, in the absence of any interventions.

For the students who did not read the "Hui-Han CEE gap" graph, we conducted a placebo test, where we asked them to read a graph on the Sino-Japanese income gap, as illustrated in Figure 3. Since exemptions to delay the fast should not affect motivations to distort beliefs about the Sino-Japanese income gap, we expect no difference in reading the gap in this graph.

For students in all four arms, in addition to the randomized contents (religious vs. placebo reading; Hui-Han vs. Sino-Japanese information), we also asked them a common set of questions on basic individual characteristics, including age, gender, parental education, access to computer, access to internet, academic track, whether boarding at school, whether the student prays daily, whether the student ever broke a fast during high school, etc. We compared the answers to the administrative information maintained by the school to ensure the authenticity of the data.

At the end of the questionnaire, after the students completed all the common questions, the reading materials, and score gap estimation specific to their assigned arm, we also conducted a common "List Experiment" for every student, where we provided five statements about the CEE, four of which were subjective and 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 how many of the five statements they agree with, without having to specify which statements in particular. By comparing the number of statements agreed with in each arm, we could estimate the direct effect of relaxing the religious constraint on fasting behavior, as well as the indirect effect of better learning about the cost of religious behavior on fasting attitudes.

[28] If the accuracy of one's guess was above the median student, he received a cash reward of 3 RMB. We adopted this simple payment scheme (acknowledging its potential shortcomings) instead of more rigorous ones such as Hossain and Okui (2013), because in our pilot studies the latter schemes appeared too complicated for subjects in our setting and caused substantial confusion.

Given the 2-by-2 design, we prepared four different types of questionnaires: *No Exemption*No Information*, *Exemption*No Information*, *No Exemption*Information*, *Exemption*Information*. All questionnaires have an identical cover letter explaining that this is a survey conducted by Peking University, and the data is confidential and will be used for purely academic purposes. We pre-randomized 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. We hired 24 surveyors, each covering one classroom throughout the survey experiment, to make sure that students answered their questionnaires individually, and did not communicate with each other throughout the process. Given that the cover letters were identical and the students did not communicate during the survey, it is most likely that the vast majority of students did not realize that they were assigned differentiated questionnaires until the end of the survey experiment.

To check the quality of randomization, in Table 3, we present results from the ANOVA test across the four different arms, for all the baseline characteristics that we collected. As can be seen, the four arms are overall very well balanced with each other, suggesting that the randomization is well-executed. There exists only one case where the ANOVA test is marginally significant (perceived value of college). As will be shown in the tables forthcoming, none of our main results would be affected in any substantial way if we included all these covariates in the regressions.

In addition to checking for balance, Table 3 also provides some useful information about our context: less than 5% of students have a parent who graduated from college, consistent with the fact that Ningxia is one of the poorest provinces in China; 85% of the students board at school, which means that whether or not a student keeps fasting is largely observable to his peers; 59% of the students pray every day; and 54% of the students never broke a fast throughout high school, suggesting that there exists substantial variation in the religiosity of students.

4 Testable Hypotheses

To rationalize the experimental design and guide the empirical analysis, we propose a simple conceptual framework based on the theory of motivated beliefs. In this model, a subject jointly chooses two parameters: (1) his belief about the average cost of Ramadan on CEE performance; and (2) whether or not to break the fast during the CEE. By doing so, he maximizes his own utility, which consists of three components: (a) anticipatory utility of exam results; (b) benefits from sticking to the religious practice; and (c) the cognitive cost of manipulating his own beliefs.

The details of the model, including its setup, mathematical proofs, and formal propositions, are elaborated in Appendix A. In this section, we simply lay out in words the main testable hypotheses derived from the model, and briefly explain the associated intuitions.

Hypothesis 1 *When reading the 2016 Hui-Han CEE score gap from Figure 1, in the absence of the exemption to delay the fast until after the CEE, Muslim students would underestimate the true gap.*

This hypothesis is the core implication of motivated cognition: students who stick to fasting due to religious constraints are motivated to underestimate the cost of fasting. The intuition in our conceptual framework is clear: students face a trade-off between the bad anticipatory utility on exam results due to fasting and the cognitive cost of suppressing the truth in order to be overly optimistic.

Hypothesis 2 *When reading the 2016 Hui-Han CEE score gap from Figure 1, students who received the exemption to delay the fast would on average get more precise estimates, as compared to those who did not get the exemption.*

This is the main test of our paper. Receiving the exemption relaxes the religious constraint, which should alleviate the motivation to underestimate the cost of Ramadan on exam performance, and lead to more accurate reading of Figure 1. Note that this is a particularly strong test, as Muslim students were presented with the exact same objective information right in front of their eyes, and they were asked to read the "objective information itself," rather than "how they update their own priors based on such information." Therefore, any difference in graph-reading caused by the exemption should be interpreted as the magnitude of "objective information manipulation," which was motivated by the stringency of religious constraints.

Hypothesis 3 *When given the exemption, students adjust at the extensive margin. Either they do not debias at all (non-compliers), or they read the Hui-Han CEE gap highly accurately (compliers).*

Muslim students are jointly choosing "whether to fast during the CEE" and "the belief to hold on the cost of Ramadan." Since the fasting decision is binary, our model implies that the choice on belief manipulation would also be polarized. This means that in this model adjustment in accuracy happens only at the extensive margin: when receiving the exemption, some students do not comply, and remain highly biased in graph-reading; other students comply, and become highly accurate in graph reading. Admittedly this is a bit surprising from an ex ante point of view. We discuss the relative contribution of extensive and intensive adjustment in our empirical section.

Hypothesis 4 *On average, students who kept fasting in the past would exhibit more severe bias when reading the 2016 Hui-Han CEE score gap from Figure 1, but they would also respond more strongly to the exemption and reduce their bias more.*

It is important to point out that we abstract from the potentially differential treatment effects across students with different fasting history. In our model, the value of fasting decreases to 0 if an exemption is granted, regardless of the level of original utility from adherence to religious practice. Under this premise, for students who never broke a fast throughout high school, the religious constraint is likely to be more stringent, which means they would have stronger motivation to underestimate the cost of Ramadan on CEE performance, in order to gain psychological relief. Therefore, students who always fasted should have stronger baseline bias in reading the Hui-Han CEE graph. Meanwhile, these "always-fasting students" also had more binding religious constraints, which means that the exemption to delay the fast for the CEE would have a stronger debiasing effect on them, rather than on those students who did not always fast.

Hypothesis 5 *Students with higher valuation for college education would exhibit more severe bias when reading the 2016 Hui-Han CEE score gap from Figure 1, but they would also respond more strongly to the exemption and reduce their bias more*[29].

This follows a similar logic to Hypothesis 4. When students value college education more, the higher stakes give them more motivation to underestimate the cost of Ramadan on CEE performance, to gain psychological relief. But in the presence of an exemption, since the information on the "cost of fasting" is more valuable to them,[30] they would respond to the exemptions more strongly and debias more.

Hypothesis 6 *When reading the Sino-Japanese income gap from Figrue 3, whether or not a student received the exemption would not affect the accuracy of the estimate.*

This is the main placebo test of our paper. Since the Sino-Japanese income gap is unrelated to either Ramadan or the CEE, any motivated beliefs associated with reading Figrue 3 would not be alleviated by the exemptions.

Hypothesis 7 *Both the exemption and the information could help Muslim students adopt a more flexible schedule in Ramadan fasting. Importantly, these two interventions are complementary: providing exemption and information at the same time could most effectively persuade Muslim students to delay the fast until after the CEE.*

[29] In our model, consistent with the stringency of religious practice, the value of Ramadan practice without exemption is assumed to be much larger than the cost of fasting.

[30] The information could help them maximize their performance in the CEE, which they value highly.

This hypothesis links our interventions to students' willingness to delay their fasts. Exemptions mechanically make students more willing to delay the fast, as they are told to be allowed to do so. Information on the Hui-Han CEE gap (Figure 1) could also make students more willing to delay the fast, as they become more aware of the potential costs. Our model predicts that these two interventions are complementary to each other: receiving the exemption relaxes the religious constraint, which alleviates motivated cognition, helping the students better absorb the undesirable information on the negative impact of taking the CEE during Ramadan. Therefore, when we combine the exemption with information in one intervention, it should have the strongest effect in terms of persuading students to delay their fasts.

5 Results

In this Section, we analyze the experimental data, and test each of the hypotheses discussed in Section 4 respectively.

5.1 Students' Priors on the Cost of Ramadan

We first elicit students' priors on the impacts of taking the CEE during the month of Ramadan. In our 2-by-2 experimental design, there exists an arm where Muslim students receive neither the religious reading (exemption) nor the Hui-Han CEE gap information, which we refer to as "*No Exemption*No Information*." Within this group, students do not get any experimental intervention, so they should maintain their original priors regarding the cost of taking the CEE during Ramadan. Therefore, incentivizing them to guess the enlarged 2016 Hui-Han CEE score gap would elicit their priors on the cost of the Ramadan fast, which is representative for our population due to random assignment.

To help students get a sense of the performance gap in the absence of Ramadan fasting, we informed students about the benchmark: the average Hui-Han gap between 2011 and 2015 is -16.4. Then we incentivized each student to make a guess on the 2016 Hui-Han CEE gap, as accurately as possible. For the 128 students in "*No Exemption*No Information*," the answer we get is -17.9, as compared to the true value of -29.4. This suggests that Muslim students held highly biased priors, and believed that taking the exam during Ramadan has minimal impact on performance.[31]

[31] A T-test suggests that the average guess in this arm is not different from -16.4 in any statistically meaningful way.

5.2 Existence of Motivated Cognition and Effects of Exemption

Hypothesis 1 asserts that Muslim students distort their own beliefs when learning about the cost of taking the exam during Ramadan, which leads to an underestimation of the true cost. Hypothesis 2 claims that the relaxation of the religious constraint (*Exemption*) would reduce such cognitive bias.

To test these two main hypotheses of our paper, we compare the accuracy of graph-reading between Muslim students in "*No Exemption*Information*" and "*Exemption*Information.*" We re-estimate equation 2 for students who were asked to read the enlarged 2016 Hui-Han CEE gap from Figure 1. Again, we define an alternative outcome variable $Deviation_i$, which directly measures how far each student's reading deviates from the true value (-29.4).

As shown in Table 4, for those without exemptions, the average estimated gap is -24.4, which understates the true gap by about 5 points.[32] When randomly assigned an exemption, the estimated gap enlarged by 2 to 2.2 points, eliminating roughly 40% of the baseline cognitive bias. From column 1 to column 3, it is obvious that the coefficient of interest remains highly robust as we control for class fixed effects and the full set of individual controls, again confirming that the randomization was well-executed. We also get similar results using "Deviation" as the outcome variable: the baseline bias is about 5.8 points, more than 30% of which could be eliminated by the religious intervention.[33]

These empirical patterns confirm the main hypothesis of this paper: the stringency of religious practices leads to motivated cognition regarding the cost of religious behaviors, and the relaxation of religious practice could help alleviate such cognitive bias.

5.3 Mechanisms

In this subsection, we investigate the underlying mechanisms behind our baseline findings.

5.3.1 Direct Impacts of Exemption

A potential concern is that, in addition to alleviating the students' religious constraints, the exemption itself might also 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. In princi-

[32] Compared to the control mean in Table 5 (-17.9), the control mean here is -24.4, suggesting that the Muslim students could partially absorb the information from the figure, consistent with our model assumption that belief distortion is not costless.

[33] The difference between using the two outcome variables arises mainly from the fact that a small proportion of students overestimate the 2016 Hui-Han gap, which gets canceled out in the first but not the second definition.

ple, this interpretation should not confound our main findings, because our main test focuses entirely on the students' reading of the information presented in Figure 1, and whether or not they find such information credible should be of no relevance.

Nevertheless, our experimental design allows us to directly investigate whether the exemption itself affects the students' priors about the cost of Ramadan on exam performance, by comparing the elicited guesses on the enlarged 2016 Hui-Han gap between "*No Exemption*No Information*" and "*Exemption*No Information.*" Specifically, for all the Muslim students who did not read the Hui-Han CEE gap figure (*No Information*), we estimate:

$$Gap_i = \alpha \cdot Exemption_i + X_i^{'} \cdot \beta + \epsilon_i \tag{2}$$

where Gap_i is student i's elicited prior of the Hui-Han CEE gap in 2016. $Exemption_i$ is a dummy variable, which equals 1 if student i received the exemption, and 0 otherwise. X_i is a vector of individual characteristics, and ϵ_i is the error term. We also define an alternative outcome variable $Deviation_i$, which directly measures how far each student's guess deviates from the true value (-29.4).

Table 5 shows that the treatment effect is a precisely estimated zero, suggesting that providing the exemption alone does not change the students' priors on the 2016 Hui-Han gap.

5.3.2 Extensive Margin Adjustment

In the environment of our model, when students face a binary choice for the religious practice (to fast or not during the CEE), their choice regarding the extent of belief manipulation is also binary; therefore, the cognition is either highly accurate or much off (Hypothesis 3). The intuition for such polarized equilibria is as follows: if one chooses to keep fasting during the CEE, then it is optimal for him to self-rationalize this behavior by distorting the undesirable information; on the contrary, if one decides to delay the fast until after the CEE, it would be optimal to accurately read the graph, as information distortion is costly.

To visualize whether this prediction is true, in Figure 4, we plot the distribution of "Deviation" by groups (*Exemption* vs. *No Exemption*). As can be seen, the treatment group with exemptions tends to have fewer "highly biased" students in the right tail, while having more "highly accurate" students in the left, as compared to the group without exemptions. While this is obviously consistent with our hypothesis that the exemption shifts compliers at the extensive margin, there is also an alternative explanation: students only adjusted at the intensive margin, so students with deviation in the range "6 - 15" shifted to the bin "3 - 6,"

and students in the bin "3 - 6" shifted to the bin"0 - 3."[34] To rule out this alternative explanation, we conduct a simple balance test: if the "extensive adjustment" hypothesis is true, then the composition of students in the "3 - 6" bin should remain the same with or without the exemption, which should not be the case if the "intensive adjustment" explanation is true. Our balance test finds that, in the "3 - 6" deviation bin, all the baseline covariates are orthogonal to exemption, which provides suggestive evidence supporting Hypothesis 3.[35]

The fact that students with exemptions become highly accurate in graph-reading can be quantified using regression analysis. For students required to read the 2016 enlarged Hui-Han gap in CEE score, we define a dummy indicator for the accuracy of their estimation: $Accuracy = 1$, if the estimation is within two points of the true value, and 0 otherwise. We estimate equation 2 using $Accuracy$ as the outcome variable, and the results are shown in Table 6. It is obvious that students who randomly received an exemption are 15 percentage points more likely to get highly accurate estimations, which is consistent with the patterns in Figure 4. The coefficient is robust to the inclusion of class fixed effects and the full set of individual characteristics.

5.3.3 Motivation Driven by Fasting History

Hypothesis 4 indicates that those who strictly followed Ramadan fasting in the previous years tend to be more religious, and therefore they should have stronger incentives to manipulate their beliefs to underestimate the cost of Ramadan, and in the meantime should also be more responsive to the exemptions.

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. To explore the heterogeneity associated with previous fasting behavior and test Hypothesis 4, we estimate the following modified version of Equation 2:

$$Gap_i = \alpha \cdot Fasted_i + \beta \cdot Exemption_i + \gamma \cdot Fasted_i \cdot Exemption_i + X_i^{'} \cdot \delta + \epsilon_i \qquad (3)$$

where $Fasted_i$ equals 1 if student i strictly practiced Ramadan fasting during high school, and 0 otherwise. Under this specification, α measures the extra baseline bias of the students who strictly practiced fasting, β identifies the treatment effect of the exemption on students

[34]It is also worth noting that a 15-point deviation suggests blatant reality denial: despite the huge drop in Hui-Han gap shown in figure 1, the students give up potential monetary rewards and insist that the trend remains flat!

[35]Some covariates, such as "access to computers" and "whether always kept fasting," are good predictors of "Deviation." These variables do not show up significantly in our balance test.

who did not strictly practice fasting, and γ identifies the additional treatment effect of the exemption on students who strictly practiced fasting. According to Hypothesis 4, we expect that $\alpha > 0$, $\gamma < 0$, and $\beta + \gamma < 0$.

As shown in Table 7, the negative and significant α indicates that students who strictly practiced fasting had larger downward biases than their non-fasting counterparts. The statistical insignificance and small magnitude of β implies that receiving the religious intervention does not have any statistically meaningful impacts on students who did not strictly practice fasting during high school. The large, negative and significant γ implies substantial heterogeneity in treatment effects across those who strictly fasted and those who did not. Estimates of "$\beta+\gamma$" remain highly significant and robust across different specifications, suggesting that our treatment effect is concentrated among those who strictly practiced Ramadan fasting. Therefore, the empirical results are highly consistent with our theoretical predictions, further suggesting that the stringency of religious practices, rather than confounding factors, are driving the motivated cognition observed in this context.

5.3.4 Motivation Driven by Valuation for College

Hypothesis 5 states that students who value college education highly would have stronger motivated beliefs, but when provided with exemptions, they would also respond more strongly and debias more. The intuition is that these students care more about the CEE scores, so in the absence of exemptions, they can avoid more utility loss by choosing to believe that fasting is not bad for CEE performance; however, when given exemptions, their higher valuation for the CEE makes them more likely to choose to delay the fast, which leads to more accurate readings of the Hui-Han CEE gap.

To test this hypothesis, we estimate a modified version of Equation 3, where we replace the "*Fasted*" dummy with a "*High Stake*" dummy, which measures whether the student self-reports having high valuation for college education. As reported in Table 8, in the absence of exemptions, students who report high valuation for college education also have 35 percent (1.7 points) extra baseline bias in reading the Hui-Han CEE gap; but in the presence of exemptions, these high-stakes students respond more strongly by fully eliminating the extra baseline bias.

5.3.5 Placebo Test

As stated in Hypothesis 6, receiving the exemption to delay fasting should not affect the cognitive accuracy regarding topics unrelated to either the CEE or Ramadan fasting, such as the Sino-Japanese income gap (Figure 3).

Therefore, to further rule out alternative mechanisms, we conduct a placebo test, where some students read the religious article (exemption) and were required to estimate the Sino-Japanese income gap (*Exemption*No Information*), and others read the placebo article (about art) and were required to estimate the same Sino-Japanese income gap (*No Exemption*No Information*). Estimating Equation 2 for students who estimated the Sino-Japanese income gap from Figure 3 would therefore estimate the "placebo effect of exemption on cognitive accuracy." Note that, being Chinese, these students could very well have their own motivated beliefs regarding the Sino-Japanese gap, but what we focus on here is that such motivated beliefs should not be affected by religious exemptions.

As can be seen in Table 9, students in general tend to underestimate the Sino-Japanese income gap.[36] But, importantly, reading about the religious exemption has no statistically meaningful effect on the accuracy of reading the Sino-Japanese income gap, suggesting that our findings are indeed driven by religion-motivated learning, rather than alternative mechanisms.

5.3.6 Active Information Distortion

Another interpretation of our result is that maybe the religious reading (*Exemption*) did not relax the religious constraint, but simply triggered students' interest/curiosity in the topic of Ramadan, so that they gave more attention to the Hui-Han figure, which led to more accurate readings.

This interpretation is inconsistent with the previous findings, which showed that the baseline bias is driven by fasting history and valuation for college, unless students who never broke a fast and students who valued college more highly were also those with no interest/curiosity in Ramadan in the absence of the religious reading.

To further address this concern, we propose another test, where we compare the accuracy of graph-reading across all four arms. Since 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 1000-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 1000 dollars; and zero otherwise.

Following this definition, we are able to compare the accuracy of graph-reading across the 4 different arms. Since 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 attention (curiosity/interest), we should expect *No Exemption*Info* to be more accurate than *No*

[36] The true gap is 30771.29, while the students in the control group on average read -28433.92.

*Exemption*No Info* and *Exemption*No Info*. However, as shown in Figure 10, 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 suggests that the motivated bias in the baseline was driven by active information distortion rather than lack of attention, which supports our framework and rules out the alternative interpretation.

5.4 Fasting Decisions

We have demonstrated that our treatments have substantially changed students' beliefs about the impact of Ramadan fasting on exam performance. As predicted by Hypothesis 7, changes in beliefs would also lead to changes in fasting decisions, which we test empirically in this subsection.

The main challenge here is that the fasting decision is essentially unobservable, and direct elicitation of fasting attitudes in the survey may raise social image concerns, and therefore lead to biased answers. To circumvent these problems, we use a "list experiment" approach to elicit students' attitudes on whether it is acceptable to stop fasting during the CEE. The list experiment is different from direct elicitation in that it asks students "among the following five statements, how many do you agree with?" Among the five statements, one is about fasting attitudes, which we are interested in, and the other four statements are related to the CEE but irrelevant to students' religion. Students only have to tell us *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 willingness to break Ramadan fasting.[37] Under these procedures, students should be free to state their attitudes in a roundabout way.[38]

As asserted by Hypothesis 7, when students are generally unaware of the harm of fasting during the exam, both "accurate information" and "exemption" may be helpful in changing fasting attitudes: the former increases the cost of fasting, while the latter reduces the return. While the model does not specify which type of intervention is more effective, it does predict that their combination will be most effective in changing fasting attitudes. This is driven by an interaction effect between the exemption and the information: relaxing the stringency of religious norms could lead to better acquisition of undesirable information (regarding the cost of religious activities), which further changes religious behavior.

[37] To minimize the potential social pressure, we also reassure the students that their responses will not be released.

[38] The proportion of students who agree/disagree with all 5 statements is extremely low (below 2%), which guarantees the effectiveness of the list experiment in "hiding" the fasting attitude of an individual student.

To test these predictions, we first compare the average number of statements that students agree with in each of the four arms (Figure 5). It can be seen from Figure 5 that both "information alone (*No Exemption*Information*)" and "exemption alone (*Exemption*No Information*)" are helpful in changing students' fasting attitudes, and religious reading appears to be more effective. Importantly, the combination of both exemption and information persuades the most people not to fast during the CEE, which is consistent with the prediction of our theoretical framework. To quantify these findings, we estimate the following equation:

$$List_i = \gamma_1 + \gamma_2 Exemp \cdot No\ Info + \gamma_3 No\ Exemp \cdot Info + \gamma_4 Exemp \cdot Info + X_i'\beta + \epsilon_i \quad (4)$$

where $List_i$ is the number of statements that student i agrees to in the list experiment. γ_1 is a constant representing the average of *list* for students in group "$No\ Exemp * No\ Info$," while γ_2, γ_3, and γ_4 represent the point estimates of different treatment effects relative to the control group. It follows from Table 11 that the statistical evidence we find is consistent with the visual representation, and robust across different specifications. The positive and significant γ_2 represents the mechanical effect of allowing students to delay fasting; the positive yet insignificantγ_3 suggests that information treatment alone is not as effective as the exemption; whereas the large and significant γ_4 suggests that combining both information and exemption will create the strongest effect in persuading students to stop fasting during the CEE.

The fact that the magnitude of γ_4 is larger than the coefficients for γ_2 and γ_3 combined suggests that, in addition to the direct effects of relaxing religious constraints and receiving information on religious behavior, there is also a more subtle interaction effect, where the relaxation of religious constraints leads to better understanding of the information, which further affects religious behavior. The T-test for this additional interaction effect, however, lacks statistical power due to sample size limitations.

Ideally, we would like to also investigate the subsequent impacts of our interventions on the actual fasting behaviors and CEE exam performance of these students. However, per the request of the partner high school, all students were informed about the "exemption" after our survey experiment ended. As a result, we no longer have any experimental variation to identify the impacts on fasting behaviors and exam outcomes.

6 Conclusion

In this paper, we first document that taking the CEE during Ramadan in 2016 had a significant negative impact on the performance of Muslim students in China. We then col-

lected explicit exemptions from well-respected Chinese Muslim religious leaders encouraging students to delay the fast until after the CEE, which we randomly distributed to Muslim students who were about to take the CEE during Ramadan in 2018, creating experimental variation in the stringency of religious practice. After that, we presented all students with the same information regarding the cost of taking the CEE during Ramadan, and find that students who thought they were required to fast during the exam were more likely to distort this undesirable signal, by underestimating the negative impacts of Ramadan on the CEE score of Muslim students; but for those students who were randomly selected to receive exemptions to delay the Ramadan fasting, more than half of such cognitive bias could be eliminated.

Further analysis suggests that the baseline treatment effects are driven by adjustment at the extensive margin (students persuaded by the exemptions interpreted the signal highly accurately), and the baseline bias and treatment effects are both particularly strong for students who strictly practiced Ramadan fasting throughout high school and for students who had higher valuations for college. Reassuringly, our placebo test confirms that religious exemption only affects the cognition of religious information (Hui-Han CEE gap), but not the cognition of non-religious information (Sino-Japanese Gap). Our analysis also suggests that while providing either information or exemption alone could potentially change students' fasting behavior, they are most effective when combined, due to the existence of an interaction effect: the exemption could help students better interpret the information on the cost of Ramadan, leading to more informed fasting decisions (increased willingness to delay the fast for the CEE).

In addition to contributing to the growing strands of literature on motivated beliefs, visual bias, religious participation, and Ramadan fasting, the results in this paper have essential policy implications. Specifically, our findings imply that the dissemination of accurate information and the relaxation of religious constraints work as strong complements when people appear to be ignorant about the adverse impacts of certain religious practices. Therefore, in order to minimize the cost due to conflicts between religion and and other aspects of life, if accommodating to the religious schedule is unfeasible, a natural second-best solution is to combine "relaxation of religious constraint" with "powerful reminders of the real-life costs of religious behaviors" as a compound policy instrument. More generally, our findings also suggest that, to reduce polarization in important policy discussions, in addition to providing convincing scientific evidence and objective information, it is also important to identify and tackle the psychological motives that could potentially prevent one from acquiring accurate information.

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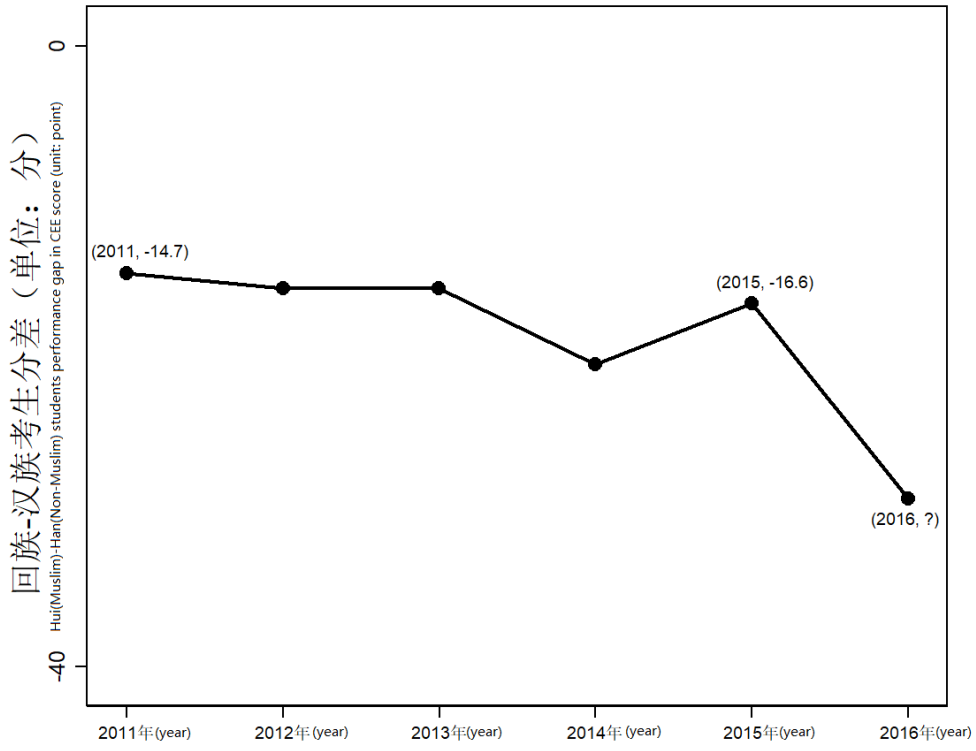
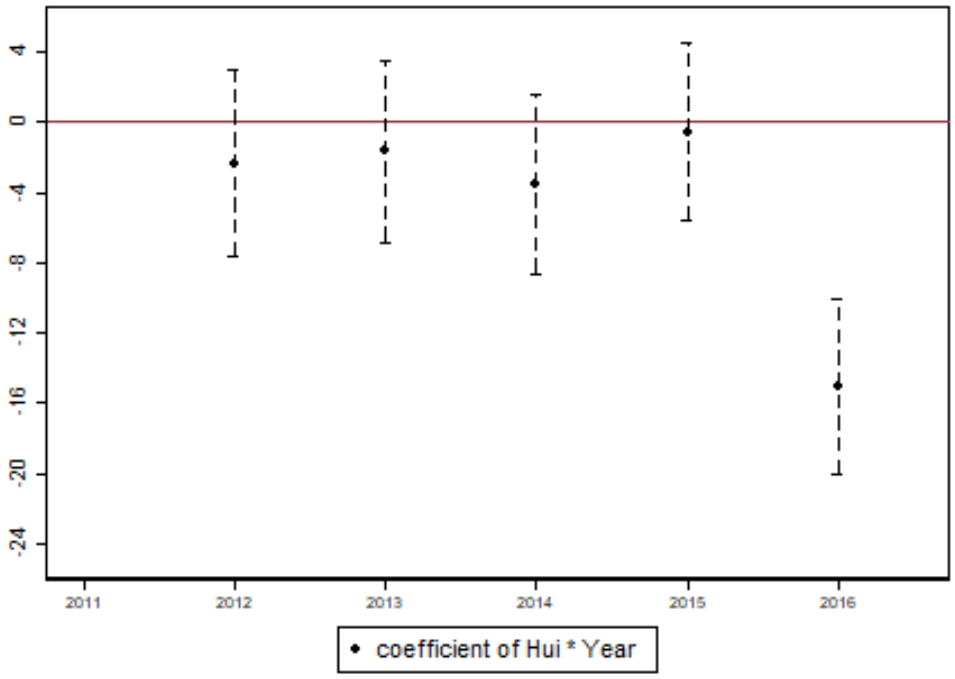
Figure 1: Hui-Han CEE Gap (2011-2016)



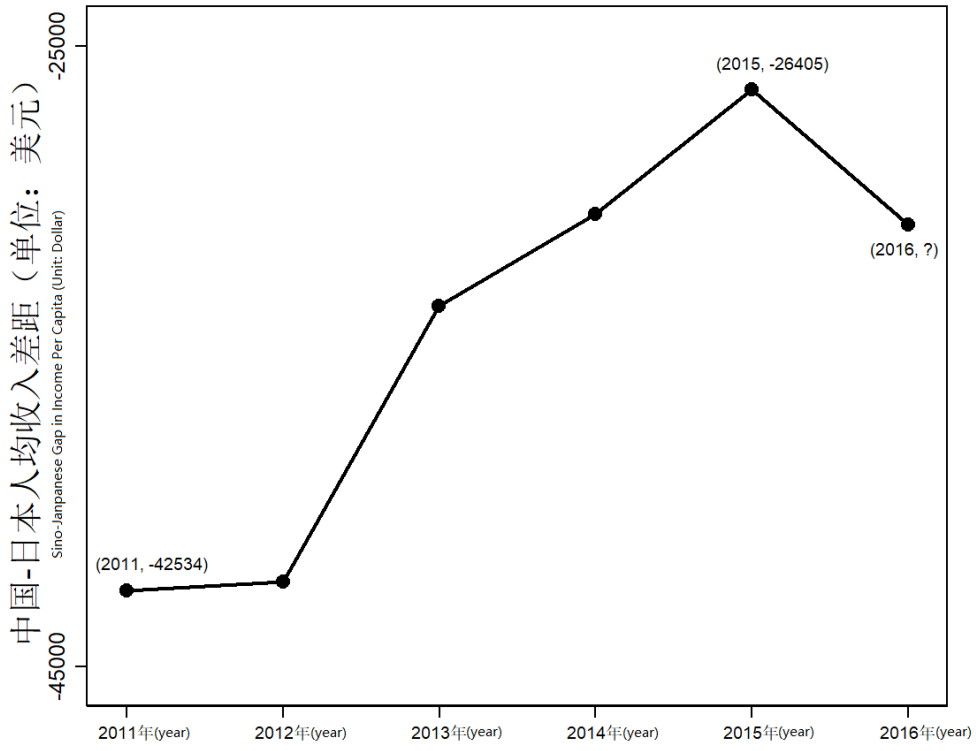
Note: This figure displays the Hui-Han average CEE score gap for all urban students in Ningxia between 2011 and 2016. This is the same figure that was presented to the students in our experimental sample (with Chinese labels). The first dimension of the coordinates marked beside a data point is year (horizontal axis) and the second dimension of the coordinates (vertical axis) is the magnitude of the gap.

Figure 2: Event Study: Hui-Han CEE Gap



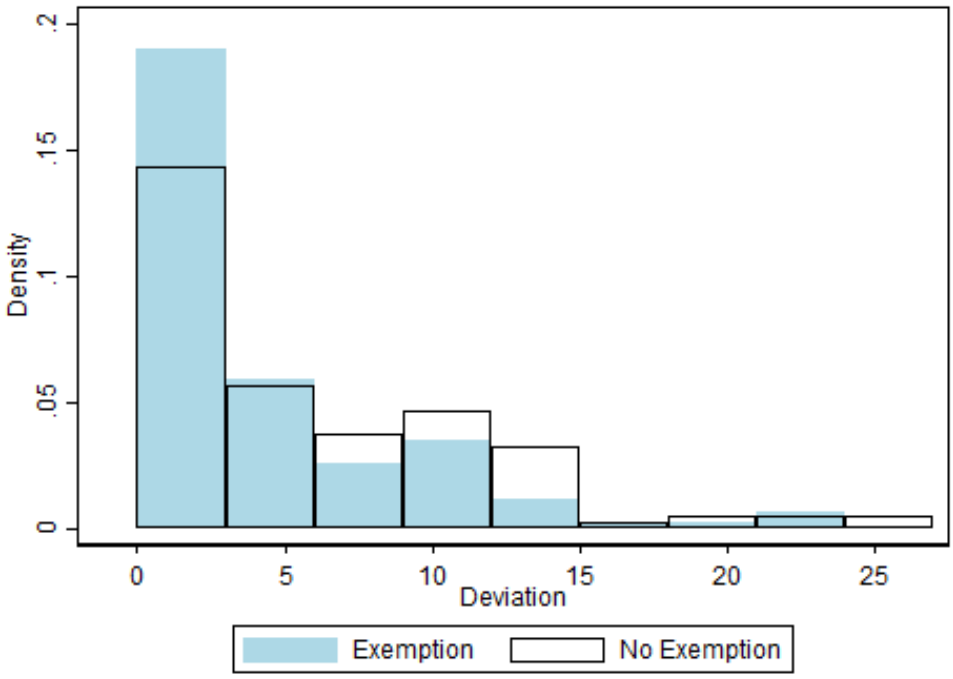
Note: This figure presents the event study estimates of the dynamics of the Hui-Han CEE score gap, with 5% confidence intervals plotted around each coefficient. As can be seen, the Hui-Han gap remained highly flat during 2011-2015, but enlarged significantly in 2016.

Figure 3: Sino-Japanese Income Gap (2011-2016)



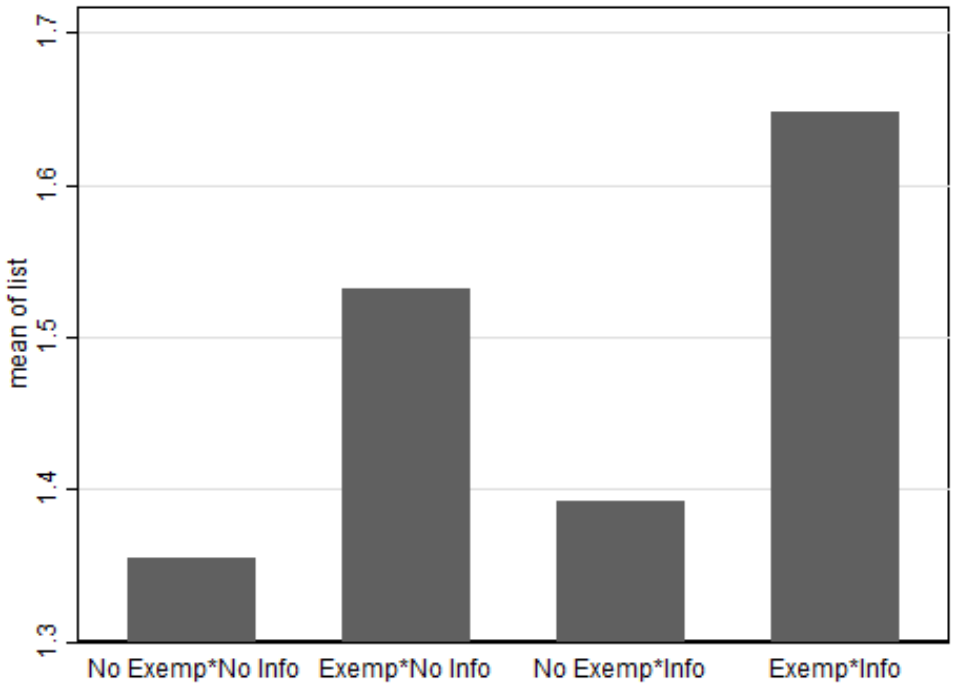
Note: This figure displays the gap between GDP pc of China and that of Japan during 2011-2016. This is the same figure that was presented to the students in our experimental sample (with Chinese labels).The first dimension of the coordinates marked beside a data point is year (horizontal axis) and the second dimension of the coordinates is the magnitude of gap.

Figure 4: Distribution of Guesses of 2016 Enlarged Hui-Han CEE Gap



Note: This figure depicts the distribution of the guess accuracy for treatment $T_{info} * T_{religion}$ (the green bins) and treatment $T_{info} * C_{religion}$ (the white bins). Each bin covers a 3-point interval. The vertical axis is the density of distribution. The horizontal axis describes how much students' guess is off the accurate information we provide about the gap.

Figure 5: Mean of Number of Agreed Response for List Experiment Across Treatments



Note: This graph plots the mean of number of statements that students agree with for each treatment the list experiment. Among 5 statements in the list experiment, students can choose to agree with 0-5 of them without specifying which statements exactly they agree with.

Table 1: 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***	-15.5981***	-15.5981***
	(1.9194)	(1.9183)	(0.8138)	(0.8138)
Hui*Ramadan			-12.8275***	-12.8275***
			(1.8799)	(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	124369	124369	124369	124369
R squared	0.022	0.025	0.025	0.025

Note: 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, and see an abrupt increase the Hui-Han gap in 2016, the year that Ramadan overlaps with the CEE. In columns 3 and 4, we collapse the pre-treatment years into a larger control group, and get quantitatively similar results. 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 10%, ** significant at 5%, *** significant at 1%.

Table 2: 2*2 Experimental Design

Information / Religion	Read the gap in CEE score between Muslim and Non-Muslim students	Read the Sino-Japanese Gap in GDP pc
Exemption to delay fast for the CEE	Exemp*Info	Exemp*No Info
No Exemption	No Exemp*Info	No Exemp*No Info

Note: This table summarizes the 2*2 design of our survey experiment. Randomly, half of the Muslim students get exemptions to delay fast until after the CEE, while the other half of students do not get such exemptions. Then we cross-randomize between these two groups, such that half of them are required to read a graph on "Hui-Han CEE gap," while the other half of them required to read a graph on "Sino-Japanese income gap."

Table 3: Balance Test

	All		No Exp*No Info	Exp*No Info	No Exp*Info	Exp*Info	Anova Test	
Variables	Mean	Std.Dev	Mean	Mean	Mean	Mean	F-stat	p-value
Geneder: 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	0.390	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
Honors 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		

Note: 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 randomization was well-implemented. "Risk loving" and "Perceived value of college" are measured using a five-point Likert scale. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 4: The Effect of Exemption on Graph Reading (Hui-Han Gap)

	(1) Gap	(2) Gap	(3) Gap	(4) Deviation	(5) Deviation	(6) Deviation
Exemption	-1.9032**	-1.9881***	-2.1985***	-1.6436***	-1.6625***	-1.8617***
	(0.7387)	(0.7387)	(0.7451)	(0.6295)	(0.6346)	(0.6396)
Constant	-24.3954***			5.8576***		
	(0.5289)			(0.4507)		
Mean of Control	-24.395	-24.395	-24.395	5.858	5.858	5.858
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 squared	0.024	0.151	0.233	0.024	0.144	0.227

Note: This table presents the effects of receiving exemption to delay fast on the accuracy of reading the 2016 enlarged Hui-Han gap in CEE performance. As shown in columns 1-3, the average gap read by students is -25.4, 4 points smaller than the true value of -29.4; receiving an exemption would make the guess 2 points closer to the true value. As shown in columns 4-6, using the "absolute deviation from true value" as outcome variable produces similar results. Robust standard errors are in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 5: The Effect of Exemption Under Unawareness

	(1) Gap	(2) Gap	(3) Gap	(4) Deviation	(5) Deviation	(6) Deviation
Exemption	-0.0699	-0.2167	-0.1481	-0.1610	-0.3070	-0.4357
	(0.9995)	(1.0141)	(1.0586)	(0.7726)	(0.7718)	(0.8188)
Constant	-17.9325***			12.3602***		
	(0.7082)			(0.5474)		
Mean of Control	-17.933	-17.933	-17.933	12.360	12.360	12.360
Class FE	No	Yes	Yes	No	Yes	Yes
Control Variables	No	No	Yes	No	No	Yes
Number of Observations	247	247	246	247	247	246
R squared	0.000	0.116	0.218	0.000	0.143	0.217

Note: This table presents the effects of religious intervention alone on updating prior. As shown in the table, the mean of the elicited 2016 Hui-Han gap is -17.97, close to the -16.4 gap between 2011 and 2015, much smaller than the true value of -29.4, indicating that Muslim students have acute downward bias in their priors. Receiving the exemption does not update this prior in any substantial way. As shown in columns 4-6, using the "absolute deviation from true value" as outcome variable produces similar results. Robust standard errors are in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 6: Extensive Margin Adjustment

	(1) Accuracy	(2) Accuracy	(3) Accuracy
Exemption	0.1152*	0.1312**	0.1573**
	(0.0594)	(0.0618)	(0.0630)
Constant	0.3778***		
	(0.0426)		
Mean of Control	0.378	0.378	0.378
Class FE	No	Yes	Yes
Control Variables	No	No	Yes
Number of Observations	277	276	274
R squared	0.013	0.077	0.151

Note: This table presents the effect of receiving an exemption on the likelihood of reading the 2016 Hui-Han CEE gap highly accurately. "Accuracy" is a dummy variable indicating whether the deviation from true value (-29.4) is within two points. As shown, students with exemptions are 16 percentage points more likely to make such accurate guesses. Robust standard errors are in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 7: Heterogeneity Based on Fasting History

	(1) Gap	(2) Gap	(3) Gap	(4) Deviation	(5) Deviation	(6) Deviation
Exemption	-0.5822	-0.9368	-0.8654	-0.2870	-0.5661	-0.5823
	(1.0672)	(1.0734)	(1.0935)	(0.9092)	(0.9238)	(0.9372)
Fast	2.5805**	2.8892***	2.9742***	2.1833**	2.3905***	2.4848***
	(1.0425)	(1.0518)	(1.0753)	(0.8881)	(0.9052)	(0.9216)
Exemption*Fast	-2.6181*	-2.2005	-2.5483*	-2.6392**	-2.2253*	-2.4455*
	(1.4617)	(1.4859)	(1.5348)	(1.2453)	(1.2788)	(1.3154)
Constant	-25.6952***			4.7579***		
	(0.7399)			(0.6303)		
Mean of Control	-24.395	-24.395	-24.395	5.858	5.858	5.858
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 squared	0.045	0.177	0.242	0.046	0.167	0.238

Note: This table presents heterogeneous treatment effects of exemption based on fasting history. As shown, students who strictly followed the Ramadan fasting during high school had larger downward bias to start with, and responded to the religious intervention by eliminating such cognitive bias. On the contrary, students who did not strictly follow Ramadan fasting were not responsive to the exemption. Robust standard errors are in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 8: Heterogeneity Based on Valuation for College

	(1) Gap	(2) Gap	(3) Gap	(4) Deviation	(5) Deviation	(6) Deviation
Exemp	-0.6302	-0.8284	-1.5129	-0.1375	-0.2705	-0.7869
	(1.1463)	(1.0363)	(1.1299)	(1.0021)	(0.8102)	(0.9496)
High Stake	1.6253	1.8244*	1.4605	1.7088*	1.9717**	1.5580*
	(0.9799)	(0.9927)	(1.0089)	(0.8758)	(0.8203)	(0.8946)
Exemp*High Stake	-1.9577	-1.6064	-1.0526	-2.2478*	-1.9938*	-1.6693
	(1.2178)	(1.1791)	(1.2647)	(1.1994)	(1.0543)	(1.0971)
Constant	-25.4623***			4.6856***		
	(0.9796)			(0.8127)		
Mean of Control	-25.371	-25.371	-25.371	5.015	5.015	5.015
Class FE	No	Yes	Yes	No	Yes	Yes
Control Variables	No	No	Yes	No	No	Yes
Number of Observations	274	274	274	274	274	274
R squared	0.032	0.166	0.232	0.036	0.162	0.230

Note: This table presents heterogeneous treatment effects of exemption based on perceived valuation of college education. As shown, students who reported higher valuation for college had larger downward bias to start with, and responded to the religious intervention by eliminating such cognitive bias. On the contrary, students who did not value college education were not responsive to the exemption. Robust standard errors are in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 9: Effect of Exemption on Graph Reading (GDP Per Capita)

	(1) GDP gap	(2) GDP gap	(3) GDP gap	(4) Deviation	(5) Deviation	(6) Deviation
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***			6140.187***		
	(760.942)			(959.323)		
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
Number of Observations	229	229	228	229	229	228
R squared	0.002	0.061	0.161	0.001	0.149	0.216

Note: This table presents the placebo effect of receiving an exemption on the accuracy of reading the 2016 Sino-Japanese income gap. As can be seen, the religious intervention has no meaningful impacts on reading the income gap. As shown in columns 4-6, using the "absolute deviation from true value" as outcome variable produces similar results. Robust standard errors are in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 10: Active Information Distortion

	(1) Accuracy	(2) Accuracy	(3) Accuracy
Exemp*No Info	-0.0313	-0.0356	-0.0367
	(0.0622)	(0.0624)	(0.0632)
No Exemp*Info	-0.1769***	-0.1837***	-0.1674***
	(0.0613)	(0.0618)	(0.0622)
Exemp*Info	-0.0617	-0.0573	-0.0440
	(0.0606)	(0.0611)	(0.0615)
Constant	0.5547***		
	(0.0439)		
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 squared	0.018	0.079	0.126

Note: This table compares the accuracy of graph-reading across the four arms. Outcome variable is "accuracy," which is defined as deviating within 2 points if reading the Hui-Han CEE gap, or deviating within $1000 when reading the Sino-Japanese income gap. As shown in the table, students are least accurate when asked to read Hui-Han CEE gap without exemptions. Robust standard errors are in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 11: Fasting Attitudes

	(1) Agreed Statements	(2) Agreed Statements	(3) Agreed Statements
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
Class FE	No	Yes	Yes
Control Variables	No	No	Yes
Number of Observations	532	531	528
R squared	0.019	0.053	0.088

Note: This table presents the effects of the information treatment, the religious treatment, and their interaction on the number of statements one agreed with in the list experiment. The results suggest that receiving the exemption alone makes one more willing to delay fast, receiving the information does not have any significant impact, and receiving both the religious and information interventions have the most powerful persuasion effects. Robust standard errors are in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Appendix

A Setup of the Model

There are two periods, period 0 and period 1. Student i derives payoff v_i from fasting in each normal Ramadan period. Denote her vulnerability to hunger and thirsty by $\rho_i \in \{0, 1\}$, which she cannot observe directly in period 1. However, she has a prior about this vulnerability which can be fully characterized by $\hat{\rho} \equiv P\{\rho_i = 1\}$.[39] Denote her fasting behavior in periods 0 and 1 by f_0 and f_1 respectively.

Period 0 describes students' fasting behavior during a normal Ramadan period, when Ramadan does not overlap with the CEE. In this period, fasting only affects students' performance in CEE via negatively affecting the effectiveness of learning during Ramadan but not their health status during the exam. The quantity of this effect is expressed as κh, where h is the full effect had she fasted during the CEE and $\kappa < 1$ captures the relatively minor impact on CEE due to inefficient learning during previous Ramadan months. $\omega_i > 0$ represents the importance students i attach to the final outcome of the college entrance exam. For simplicity, we assume that students know their ρ_i due to repeated fasting experience in middle school. They choose f_0 to maximize:

$$f_0 v_i + (1 - f_0)(\kappa \omega_i h \rho_i + \epsilon_{i0}) \tag{5}$$

where ϵ_{i0} is a random disturbance governed by distribution $F_0(\epsilon_{i0})$. Put it in another way, students will either fast ($f_0 = 1$), in which case they derive utility v_i by committing to religious practice, or not to fast ($f_0 = 0$), in which case they enjoy enhanced learning effectiveness. Note that we arrange the utility in this form to highlight the tradeoff between fasting ($f_0 = 1$) and not fasting ($f_0 = 0$).

In period 1, students have answered the survey we distributed, and were expecting the

[39] Here we binarize the impact of fasting to be either "negative" or "nonexistent," this is without much loss of generality because no more than 3% of the students in any treatments have beliefs that Ramadan will help boost their performance in the CEE.

CEE in a month. They decide to fast or not in the exam, get anticipatory utility about her performance in the exam and derive utility from fasting behavior, denoted by f_1. In this period, they can no longer remember ρ_i but instead, they form a posterior about ρ_i based on prior $\hat{\rho}$ and previous fasting behavior f_0 as a Bayesian. This is due to either forgetfulness or that they lack knowledge about the impact of fasting on test performance (remember in period 0 that they only experienced fasting when no formal exams like CEE happened). In this period students jointly choose $(\hat{\rho}, f_1)$ to maximize:

$$f_1 \cdot (v_i r - \omega_i E[\rho_i|\hat{\rho}, f_0]h - C(\rho_0 - \hat{\rho})) + (1 - f_1)(-C(\rho_0 - \hat{\rho}) + \epsilon_{i1}) \tag{6}$$

where ϵ_{i1} is governed by distribution $F_1(\epsilon_{i1})$. Denote the joint distribution of (ϵ_{i1}, v_i) and the marginal distribution of v_i by $F(\epsilon_{i1}, v_i)$ and $G(v_i)$ respectively. Note that v_i has to be non-negative, which is the only restriction for distribution $F(\epsilon_{i1}, v_i)$ and $G(v_i)$. r is the special return for this special Ramadan period (i.e. fasting during CEE). For simplicity, $r \equiv r_C = 1$ if students regard this fasting period the same and the rest; $r \equiv r_T$ with $0 < r_T < 1$ if students are persuaded by religious leaders, and believe that fasting may not be necessary during the particular exam days. Therefore $v_i r$ captures the payoff from fasting during CEE. $-E[\rho_i|\hat{\rho}, f_0]h$ is the expected cost of fasting during CEE, and $-C(\rho_0 - \hat{\rho})$ is the cognitive cost of manipulating her prior away from her original prior ρ_0 had motivated beliefs been not at play. We assume that $C(.)$ is twice continuously differentiable, minimized at 0. We also assume ρ_0 and $\hat{\rho}$ to be a real number between 0 and 1. Note that we arrange the utility in this form to highlight the utility derived from both fasting ($f_1 = 1$) and not fasting ($f_1 = 0$) respectively.

The major difference between our model and the previous studies is the focus on the manipulable prior $\hat{\rho}$, which merits further discussions. Aside from the mechanical explanation above, another interpretation of ρ_0 is that this prior is subconscious, and the subject's cognition process manipulates her prior away from the subconscious one to maximize her anticipated utility. The modeling of $\hat{\rho}$ is similar in spirit to Augenblick et al. (2016), where

students manipulate their beliefs about the probability of dooms day above their original beliefs had a religious concern not been present. Importantly, this subconscious belief need not be accurate. While Augenblick et al. are agnostic about the formation and implications of differential ρ_0 in their paper as this is not their focus, we directly test the additional implication of a wrong ρ_0 and confirms the validity of our model.

Our model is also different from previous studies on motivated beliefs in that the anticipatory utility merely comes from students' expectation about their own performance in the exam. Arguably, as an once-in-lifetime high-stakes exam, for which students have been preparing for years, the effect of anticipatory utility should be particularly strong. We do not specifically model the utility of religious beliefs, such as utility carried by h itself, which may reflect people's belief on how omnipotent their religion is. The primary reason of this omission is that the incorporation of this utility does not qualitatively change our results, and our empirical results do not support this possibility either.

This model has a number of predictions about students' response in beliefs and fasting attitudes. We categorize them into three groups to highlight the relationship between these propositions and the results presented in the next section. Specifically, Proposition 1 predicts response in beliefs under unawareness of fasting impact; Proposition 2, 3, 4 predicts response in beliefs under awareness of fasting impact; Proposition 5 discusses the relationship between the beliefs and the perceived importance of the College Entrance Exam; Proposition 6 and 7 presents our model's prediction on fasting attitudes.

Proposition 1 When $\rho_0 = 0$, $\hat{\rho} = 0$ irrespective of the value of f_0, f_1, r and v_i.

This proposition discusses how students might react when their subconscious beliefs are wrong. Since anecdotal evidence suggests that students may not be aware of the negative impact of fasting at all, our proposition focus on the prediction in this case. The framework predicts that the students do not have to incur any cost to create illusion, but just happily take the view that fasting does not do even cause the slightest harm. As a result they sincerely do not believe that on average, fasting is significantly detrimental to their cognitive

function regardless of whether religious leader try to persuade them to fast or not during CEE. This prediction of this proposition, in our context, is elaborated by Hypothesis 1 in the main text.

Proposition 2 In case of $\rho_0 > 0$ and for almost any given (ϵ_{i1}, f_0), $\hat{\rho} < \rho_0$ if $f_1 = 1$ for any positive r and v_i.

As one of the most basic results of this model, this proposition says that for people who choose to fast, they have the incentive to distort their prior as long as they become partially aware of the fact that fasting is harmful to their exam performance, irrespective of its magnitude. In our experiment, we use "belief about the average impact of taking the CEE during Ramadan" as a proxy for the parameter ρ_0. This prediction of this proposition, in our context, is elaborated by Hypothesis 2 in the main text.

As r change, students have different incentives to fast, hence to distort their beliefs about the impact of fasting, as illustrated in the following proposition:

Proposition 3 In case of $\rho_0 > 0$, for any given (ϵ_{i1}, f_0), $\hat{\rho}$ is weakly decreasing as r increases: for small r such that students opt not to fast, their belief $\hat{\rho} = \rho_0$. Students do not bias belief downwards until r is large enough such that $f_1 = 1$, and the extent of distortion is constant for $f_1 = 1$.

Put it in another way, this proposition says that given the awareness of the negative impact of fasting on exam, students are more likely to form the right belief and not to fast if the religious leader successfully persuade them not to do so by lowering their r. Moreover, as students face two options for f_1 (to fast or not), their choice regarding the extent of manipulation is also binarized: either they do not manipulate at all and do not fast, or they manipulate to a constant extent and and stick to the religious practice regardless of how valuable/harmful it is. Students' adjustment on their prior is therefore entirely on the extensive margin. This prediction of this proposition, in our context, is elaborated by Hypothesis 3 and 4 in the main text.

For simplicity, we additionally assume that κ is small in the discussion of last proposition.

This assumption says that the impact of Ramadan fasting during pre-exam period (say fasting one year or two years ahead of the CEE) is minor to fasting on CEE exam. We argue that this is a reasonable assumption for the following two reasons: first, the length of Ramadan fasting is merely one month for every year in Islamic calendar, which is relatively short compared to years of exam preparation; second, even if students' learning activity are affected during fasting, they can still make up for it by studying harder before/after the fasting month.

This proposition concerns the heterogeneity of the treatment effects with respective to past fasting behavior f_0. While the prediction of model in general may not be entirely clear given different κ, f_0, $C(.)$ and the joint distribution of v_i and ρ_i, with assumption on κ, we can derive the following results.

Proposition 4 When κ is sufficiently small, the distribution of v_i given $f_0 = 1$ stochastically dominates that given $f_0 = 0$. Hence given the same ρ_0, $E[\hat{\rho}|f_0 = 1] < E[\hat{\rho}|f_0 = 0]$

This proposition discuss the case where fasting in the past can barely affect the CEE outcome. In this case, students can only extract information about v_i from f_0. For those who did not fast in the past, then have lower v_i, hence less incentive to manipulate their beliefs. We view this assumption as plausible because as we have discussed in institutional details, past fasting rarely affects the exam outcome because students have three years to prepare for the exam, hence they can have plenty time and opportunities to make up had they, by any chance, fallen behind during the fasting period. Moreover, the results are fairly robust even when κ is large [40] This prediction of this proposition, in our context, is elaborated by Hypothesis 5 in the main text.

Proposition 5 Holding other parameters constant and $f_1 = 1$, $\hat{\rho}$ is weakly decreasing as ω_i increases.

The intuition of this proposition is clear: the motivation of distortion is determined by

[40] When κ is large, f_0 is affected by both ρ_i and v_i. We need to consider the joint distribution of these two variables. However, even in this case, with moderate assumptions on cognitive cost, we will be able to get the result that the optimal probabilistic beliefs for those who choose f_1 to be 1 is smaller for students who fast in the past.

the value of anticipatory utility. If the individual in question attaches more importance to the exam, she naturally cares more about the value of her anticipatory utility. Hence, given that she decide to fast, the presence of motivated beliefs generates more biases when the stake is even higher, which runs against the argument that economic importance may mitigates distortion in this particular case. This prediction of this proposition, in our context, is elaborated by Hypothesis 6 in the main text.

The last two propositions concerns treatment effects on fasting attitudes.

Proposition 6 In case of $\rho_0 > 0$, for almost any given $(\epsilon_{i1}, f_0, v_i, r)$, as long as $h > 0$, $f_1 = 0$ if and only if $\hat{\rho} = \rho_0$

This proposition provides us with a tight link between the elicited beliefs $\hat{\rho}$ and fasting behavior f_1 during CEE: when students are aware of the harm of Ramadan fasting (i.e. their subconscious belief ρ_0 is positive), those who hold the right beliefs will not fast and vice versa. While the implication that we can precisely identify those who do not fast must express the right belief is not robust to alteration such as incorporating people's utility from the omnipotence of their religion (i.e. utility as a function of h), it is indeed robust that given a correct ρ_0, as beliefs become more accurate, students are less likely to fast during the CEE across different treatment groups. This proposition provides a way to proxy fasting behavior: if we want to focus on the group of people who fast (say, examine the impact of perceived stake on biases conditional on fasting), we can restrict our attention to subsample where people don't read the graph accurately.

While people will not adjust their beliefs given the initial unawareness of the harm of fasting, the persuasion from religious leaders do decrease r, which decreases the gap of utility between fasting and not fasting in period 1. If there are any independent disturbance of fasting preferences as illustrated by ϵ_{i1} in the model, the rate of fasting will also be decreased by authorization from religious leaders.

The next proposition discusses the effectiveness of information treatments in terms of changing fasting attitudes. We can easily deduce from Equation 6 that religious leader

persuasion alone is sufficient to shift the fasting decisions of some people. In addition to that direct channel, there is also an additional role of information dissemination on changing fasting attitudes:

Proposition 7 For any given ϵ_{i1}, Denote the minimum level of v_i needed to choose fast for treatments "*No Exemp*No Info*," "*Exemp*No Info*," "*No Exemp*Info*," "*Exemp*Info*" by $\bar{v}_1$, $\bar{v}_2$, $\bar{v}_3$, $\bar{v}_4$, respectively. If, say, any non-negative v_i is enough for fast in treatment "*No Exemp*No Info*," then $\bar{v}_1 = 0$. We have: (i) $\bar{v}_1 < \bar{v}_2$, $\bar{v}_1 < \bar{v}_3$;(ii) $\bar{v}_4 - \bar{v}_2 > \bar{v}_3 - \bar{v}_1$.

This proposition use a specific set measures, $\bar{v}_1$, $\bar{v}_2$, $\bar{v}_3$, $\bar{v}_4$, to measure people's preference to choose fasting in the end. The higher the threshold is, to the less extent people would prefer fasting. (i) says that the threshold for merely providing information $\bar{v}_3$ and threshold for merely providing religious exemption $\bar{v}_2$ both move up relative to control threshold $\bar{v}_1$, indicating that both treatment works in the same direction, whereas the relative effectiveness of them is an empirical question. (ii) says that the information treatment and religious exemption may serve as compliments: when religious exemption is granted, the effectiveness of providing information in terms of the movement of the threshold, $\bar{v}_4 - \bar{v}_2$, is larger than $\bar{v}_3 - \bar{v}_1$, in which case no exemption is granted. Of course, the results still hold when we regard these threshold as a function of ϵ_{i1}, and integrate over it to compare the expected level of thresholds. This prediction of this proposition, in our context, is elaborated by Hypothesis 8 in the main text.

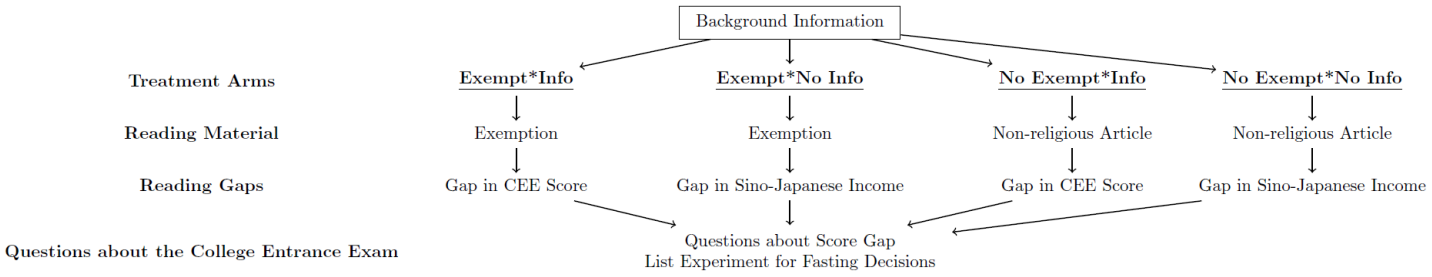
B Translated Survey Questions and Reading Materials

Section A: Background Information

Section B: Reading Material (treatment and control reading materials randomly assigned to students)

Section C: Reading Gaps (treatment and control graphs randomly assigned to students)

Section D: Questions about the College Entrance Exam



Section A: Background Information

Name and Student ID

1. Your gender: A. Male B. Female

2. Your ethnic group: A. Han B. Hui C. Other

3. The highest education level among your parents:

A. Primary school or below
B. Middle school
C. Occupational high school
D. Regular high school
E. Community college
F. Regular college
G. Graduate degrees

4. Do you have access to computer and internet at home?

A. Access to neither
B. Access to computer but not internet
C. Access to internet but not computer
D. Access to both

5. Do you board at school?

A. Yes B. No

6. Which of the following hobbies do you have?

A. Video games on PC
B. Video games on smart phone
C. Foreign sports matches
D. Japanese and Korean TV shows
E. American and British TV shows
F. Foreign popular music
G. None of the above

7. What is your risk attitude in making high-stakes life decisions?

Please evaluate on a scale of 1 to 5: 1=very cautious, 2=relatively cautious, 3=neutral, 4=relatively adventurous, 5=very adventurous)

8. Do you think higher education can lead to a better life?

Please evaluate on a scale of 1 to 5: 1=completely disagree, 2=generally disagree, 3=neutral, 4= generally agree, 5= completely agree)

9. Do you pray everyday?

A. Yes B. No C. Not applicable because I am not Muslim

10. Did you ever break a fast during Ramadan in the past three years?

A. Yes B. No C. Not applicable because I am not Muslim

Section B: Reading Material

(treatment and control reading materials randomly assigned to students)

Please read the following article and answer three reading comprehension questions. (For each correct answer, you will receive 2 RMB in rewards.)

(Treatment reading material)

Between 2016 and 2018, the Muslim holy month of Ramadan coincided with the college entrance examination. Therefore, for many Muslim students, ``whether they can break the fast and make it up later after the college entrance exam" has become an important issue that cannot be ignored.

In order to understand whether ``Ramadan fasting can be postponed during the college entrance examination," we consulted Guo Haihui, a well-known scholar who graduated from the Royal Religious University of Malaysia and the current Imam of the century-old temple ``Xiangfang Mosque." He said:

``The acts of worship of Islam has three goals: to express faith to Allah, exercise good words and deeds and sublimate souls. The Prophet (PBUH) said: `Allah does not look at your appearance and your goods. He looks only at your heart and your deeds.' The good intention for any deed is the key to get good results. The college entrance examination has become a major concern for the whole society, let alone for the students. It is no exaggeration to describe it as the turning point for the students. Because the examination is both mentally and physically exhausting and no easier than any other work, both parents and students need to make great efforts to prepare for it. Therefore, it is necessary to appropriately reduce their burden. To temporarily postpone the fasting during the college entrance examination will neither anger Allah, nor will it weaken your beliefs."

We also consulted the famous scholar Liu Xueqiang, who is also the vice president of the Provincial Islamic Association and the Imam of the famous Xigong Mosque. His suggestion was consistent with that of Guo Haihui:

``The purpose of Islamic law is to create convenience for people, not to create difficulties. The implementation of Islamic law can be flexible in the actual process and it should not be interpreted rigidly. Allah never asks people to do things beyond their ability. Therefore, if the candidate thinks that fasting will affect his or her test scores, it is acceptable to break the fast, and make up afterwards. It poses no problem in the Islamic law."

This situation is not unique to China: as the college entrance examination is held in June in many countries, the jurists in these countries also give corresponding doctrinal orders for the examination and fasting. Through summarizing, we find that many authoritative religious scholars and institutions

abroad share similar views on this issue with imams in China. For example, when being asked if ``students can break the fast during the college entrance examination," Grand Mufti Shawki Allam of the Egyptian Shariah Committee replied:

``If fasting affects the students' ability to revise and study for the exam, resulting in symptoms like reduced concentration, unresponsiveness, dizziness, etc., and the exam time stipulated by the education system cannot be adjusted to the end of Ramadan, students should break the fast and make it up after the exam, so that their previous efforts will not be wasted."

Experts of the French Muslim Religious Committee also conducted in-depth researches on this issue and finally issued a notice: ``It is recommended that candidates break the fast, especially those who need to take the exam in the afternoon. However, they need to make it up after Ramadan."

11. According to Mr. Guo Haihui, one is allowed to delay the fast for the CEE, because Allah cares the most about:

A. Your appearance and your goods
B. Your heart and your deeds
C. Both A and B are correct
D. Both A and B are incorrect

12. What is the opinion of Mr. Liu Xueqiang on Ramadan fasting:

A. The implementation of Islamic law can be flexible, and students should be allowed to delay their fast for the CEE
B. Ramadan fasting is an outdated tradition that does not fit modern societies
C. Both A and B are correct
D. Both A and B are incorrect

13. According to Mr. Shawki Allam, what are the conditions that warrant an exemption to delay the fast for an exam:

A. Ramadan fasting would hurt exam performance
B. The exam cannot be rescheduled
C. Both A and B are needed to delay the fast
D. Neither A nor B is needed to delay the fast

Please read the following article and answer three reading comprehension questions. (For each correct answer, you will receive 2 RMB in rewards.)

(Control reading material) :

There is a US diplomat who spent ten years in Moscow in the 1920s and 1930s. He wrote in his memoir that he has watched the ``Swan Lake'' performance for 300 times. Even for a classic ballet as famous as the ``Swan Lake,'' 300 times is too much. But for a diplomat, some social engagements are inevitable, and he had no choice but to watch this play again and again until it was a bit overwhelming.

I guess, for the first few dozen times to watch the "Swan Lake" performance, what the American heard was the beautiful music of Tchaikovsky and what he saw was the beautiful performance of the artists of the former Soviet Union. He appreciated it wholeheartedly and applauded ardently from time to time. After having watched it for 100 times, the impression became different. At that time, he could only hear some instruments ringing and see some people running on the stage and he became slow-witted as well. Then, after 200 times, the impression changed again. The music was on and the curtain was up, but there was only the white void in front of him - he was caught in the nightmare of this play. At this point, his eyes were blank, his face was smirking, like a hibernating crocodile whose loose muscles could not support the chin, or a landing boat rushing to the beach, and his mouth was opening, with big drops rolling down from the corner of his mouth and falling on his knees. It was so intoxicating that not until the curtain was down and someone switched off the light did he realize that it was over. He quickly slapped himself awake and went home. Later, when he got the order to leave the Soviet Union, he said with relief: well, finally, no more "Swan Lake."

As you know, the scene above is just my guess - to be honest, no one will ever include this in one's memoirs - but I think anyone repeatedly appreciating a piece of work will encounter these three phases. In the first phase, you hear the music and see the dance - in short, you are enjoying art. In the second phase, you hear some sounds and see some objects moving, and you are aware of a familiar physical process. In the third phase, you have gained a philosophical perspective and finally realized that the ballet, just like everything else in the world, is a form of material existence. From art to science and then to philosophy, it is a process of returning to the original nature.

Normally, people's appreciation always stays in the first phase, but some people can reach the second phase. For example, in the movie "Farewell My Concubine," the tyrant played by Ge You blamed an actor: The Conqueror played by other people took six steps, why did you take four steps? In the lab, a physicist would also ask an object in confusion: how can your acceleration be two Gs while others is a G when falling in a vacuum? In the laboratory, a physical process must be reproducible, or otherwise it will not be scientific.

Therefore, no object falls with two Gs' acceleration. The classic works of art should also be reproducible. Take "Swan Lake" for example, the content of this ballet cannot be changed in order to

let future generations appreciate the best things created by the predecessors. It can only be played over and over again.

Classic works are good and worth watching, but not too many times. Otherwise, the art cannot be appreciated - just like tea drinking in the "Dream of Red Mansions": one cup is for tasting, two cups are for the thirst, and three cups are drinking like a fish. Of course, whether it is tea-tasting or drinking like a fish, it is just a way of material existence. In this respect, there is no difference between them...

11. According to the author, what are the three phases in the repeated appreciation of art?

A. Science-Philosophy-Art
B. Philosophy-Art-Science
C. Art-Science-Philosophy
D. Art-Philosophy-Science

12. What is the author's opinion regarding the "reproducibility**" of art**:

A. Physics should be reproducible, art should not be reproducible
B. Physics should not be reproducible, art should be reproducible
C. Both should be reproducible
D. Neither should be reproducible

13. What is the author's opinion regarding the appreciation of art:

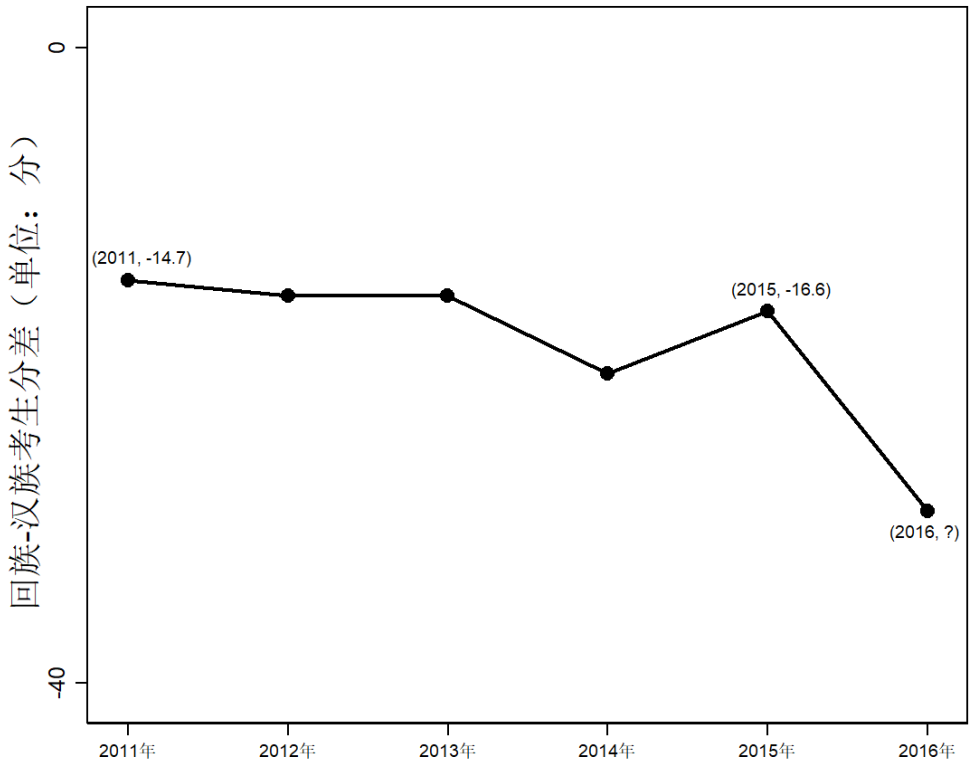
A. One should appreciate the same work repeatedly
B. One should not appreciate the same work repeatedly
C. Both statements above are wrong
D. No clear opinion expressed by the author

Section C: Reading Gaps

(treatment and control graphs randomly assigned to students)

Hui-Han gap figure:

Based on the administrative information provided by the Ningxia Provincial Bureau of Examination, we plot the gap in the College Entrance Exam (CEE) score between Hui (Muslim) and Han (non-Muslim) students in Ningxia from 2011 to 2016. The trend of this Hui-Han gap is shown in the figure below.



(Note: The y-axis label is "College Entrance Exam score gap between Muslim (Hui) and non-Muslim (Han) students (unit: point)")

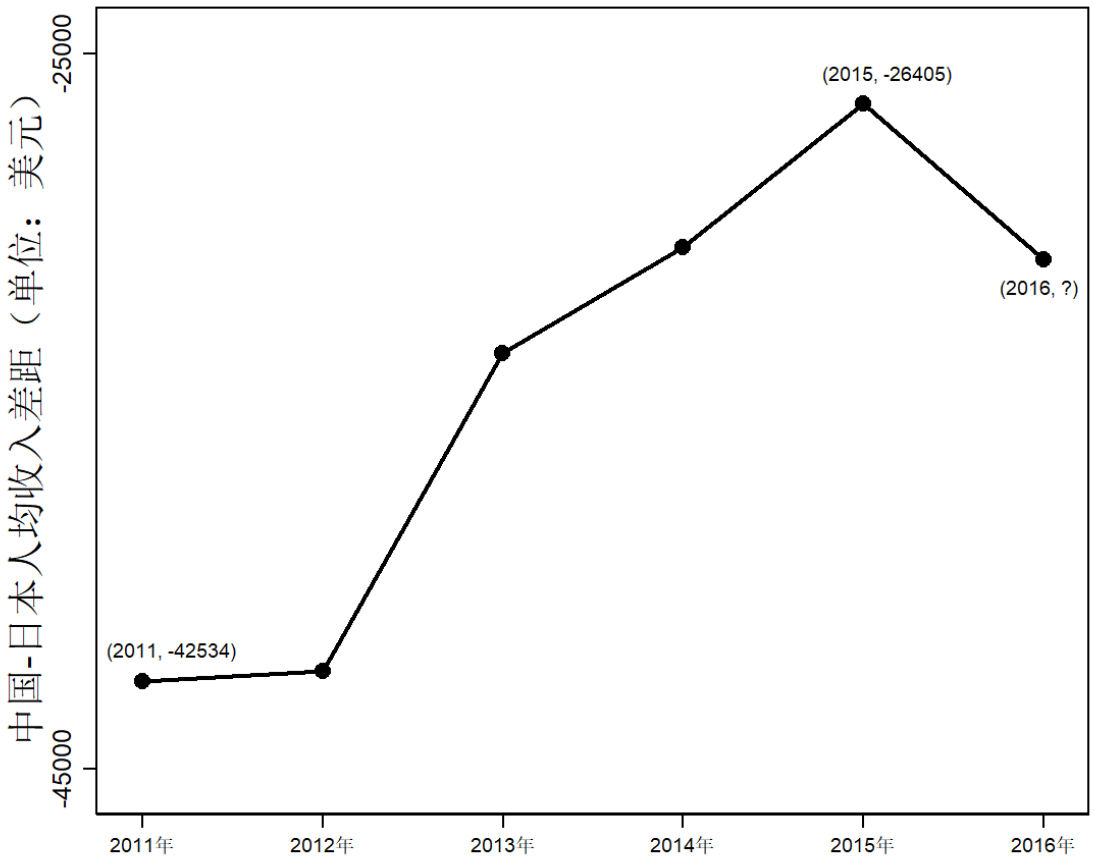
In 2011, the average CEE score of Hui students was 366.9, the average score of Han students was 381.6, so the average Hui-Han gap was -14.7 points. In 2015, this gap was -16.6 points.

14. In 2016, the CEE happens during Ramadan. Please read from this figure: what was the CEE score gap between Muslim and non-Muslim students in 2016? (If the accuracy of your answer is above the median in your class, you will receive a cash reward of 3 RMB.)

Answer: _____ points

Sino-Japanese gap figure:

Based on data published by the World Bank, we plot the gap in average annual income between China and Japan from 2011 to 2016. The trend of this Sino-Japanese gap is shown in the figure below.



(Note: The y-axis label is "Per-capita income gap between China and Japan (unit: U.S. dollar)")

In 2011, the average annual income was 5634 USD in China, while 48168 USD in Japan, so the average Sino-Japanese gap was -42534 USD. In 2015, this gap was -26405 USD.

14. Please read from this figure: what was the annual income gap between China and Japan in 2016? (If the accuracy of your answer is above the median in your class, you will receive a cash reward of 3 RMB.)

Answer: _____ USD

Section D: Questions on the CEE

15. Your total score in the "second mock exam": _____

16. Among the five statements listed below, how many do you agree with?

In this question, you do not need to specify which exact statements you agree with, you just need to tell us the number of statements that you agree with (0-5).

(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) Delaying Ramadan fast until after the CEE is acceptable.
(4) Playing sports is good for exam preparation.
(5) The CEE mainly tests on one's familiarity with the material rather than actual intelligence.