

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

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Preliminary Version§

## Abstract

China's high-stakes College Entrance Exam (CEE) is held on June 7th and 8th annually, which happened to fall in the Muslim Ramadan month between 2016 and 2018. With a Difference-in-Differences design, we first document that taking the exam during Ramadan strongly worsened the academic performance of Muslim students. We then conduct a field experiment with Muslim students who were about to take the exam (during Ramadan) in 2018. We invited well-respected Chinese Muslim leaders to grant explicit exemptions to delay the fast until after the exam, which we randomly provided to some Muslim students, creating experimental variation in the stringency of religious practices. We then showed all Muslim students the same information on the cost of taking the exam during Ramadan. We find that when students did not receive the exemption, they exhibited strong patterns of motivated cognition by underestimating the cost of fasting on exam performance; but for those that received the exemption, such bias in learning was alleviated, which made them more willing to delay the fast for the CEE. Our results provide new evidence on how people could distort high-stakes objective information and under-appreciate the cost of religious activities.

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

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# 1 Introduction

It is costly yet ubiquitous that people fail to learn from objective information on important issues. 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 explain such learning failure, one of the theories proposed by behavioral economists is that people have motivated beliefs (Bénabou, 2015; Bénabou and Tirole, 2011, 2016): they attach psychological values to certain beliefs, and could distort their own beliefs toward such preferred beliefs to increase utility.<sup>1</sup> In recent years, there has been a growing empirical literature attempting to test motivated beliefs using laboratory experiments, generally showing that people could distort their subjective opinions.<sup>2</sup> However, to fully explain the “learning failure” in reality, existing evidence still falls short on two important dimensions. First, outside of the labs, we do not have any field experimental evidence that directly tests the role of motivated cognition in the distortion of high-stakes beliefs. Second and most importantly, while ample evidence has been documented that people could distort subjective opinions in their own minds, there is little evidence on the stronger form of motivated beliefs: whether/how people could distort objective information, even when it 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 could distort high-stakes objective information in a natural setting. In particular, we focus on an important yet under-researched form of motivated beliefs – religious beliefs, and reveal a specific underlying mechanism for information distortion: the stringency of religious constraints leaves religious followers no other choice but to obey religious rules, motivating them to self-rationalize their own religious behaviors to avoid regretting such decisions, which means they would distort objective signals suggesting high costs of their religious behaviors.

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<sup>1</sup>This literature also closely relates to an older psychology literature on motivated reasoning, as summarized by Kunda (1990).

<sup>2</sup>For examples, Eil and Rao (2011) and Mobius et al. (2011) show that people exhibits asymmetric updating behavior about self-image, Di Tella et al. (2015) shows that beliefs about others’ altruism decrease with stakes.

Our natural experiment comes from a unique empirical setting 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, and happened to fall in the month of Ramadan between 2016 and 2018, 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 of 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 extreme 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 depends on whether they could obtain an exemption from a local expert in Islamic jurisprudence (Faqih), explicitly allowing them to break the fast for the CEE. Seeing that there has been no clear exemptions from fasting made public for the CEE in our setting, we invited two well-respected Muslim religious leaders to explicitly grant their exemptions (and the Quranic reasoning) to the 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 they had 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 think they have to fast during the exam in 2018 (control group) show patterns of motivated cognition: they distort the objective information 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 objective information on the negative consequences of their religious behavior. We conduct a series of additional analysis to better understand the mechanisms. First, we find that the baseline results are mainly driven by ex-

tensive margin effects: Muslim students either became particularly accurate in information acquisition after receiving the exemption, or do not adjust their beliefs at all. This is driven 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 that 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.

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). Originated from research on motivated reasoning in psychology,<sup>3</sup> the existence and implications of motivated beliefs/cognition have attracted much scholarly interests in both experimental economics and political science<sup>4</sup>. Our study differs from the existing evidence from lab experiments in two important ways. As a field experiment,<sup>5</sup> our setting is based on a real-life event with extremely high stakes, which allows us to study motivated cognition in an important environment outside of the lab. Moreover, these lab experiments either show that subjects could distort subjective beliefs (Eil and Rao, 2011; Mobius et al., 2011), or show that they could selectively acquire information in the presence of substantial cognitive cost (Ambuehl, 2017). Our paper, instead, tests a stronger form of motivated belief: when clear objective (rather than subjective) information is presented right in front of one’s eyes (there is minimal cost of information acquisition), how could individuals still distort such objective information and fail to learn. 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 no empirical evidence to

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<sup>3</sup>See Kunda (1990) for an extensive discussion of the psychology literature.

<sup>4</sup>In economics, Eil and Rao (2011); 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) demonstrates that motivation affects information processing in reading news articles about politician.

<sup>5</sup>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 decision on exam day) is precisely the population we are doing experiment with. Moreover, the intervention we introduce is of critical relevance to their important decision in real life.

date examining its existence and underlying 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 works attribute visual bias to individuals' inherent limits in visual perception, our paper differs from that literature by showing that visual bias could also arise when individuals are motivated to avoid undesirable graphical information. Specifically, we design a novel visual-based survey module, which combined with our experimental intervention removing motivations for information avoidance (religious exemption), could allow us to quantify the magnitude of motivated visual bias in information acquisition, which (to our knowledge) is new to the literature. In a 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 objective outcomes (visual bias v.s. computational error). Another important difference is that our paper focuses more on the "information acquisition" aspect of motivated bias. Our visual-based survey module is also valuable in itself: it could be easily generalized to other settings due to pervasive role of graphs in information dissemination, decision-making and persuasion.

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 the individuals could accurately evaluate the cost and benefit 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."<sup>6</sup> Our paper complements Augenblick et al. (2016) by investigating the cost side of the decision. Since our DiD analysis could accurately quantify the costs of religious participation (taking the exam during Ramadan), we are given the unique opportunity to identify the difference between "perceived cost" and "actual cost" of religious participation, and analyze the driving-force of such 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

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<sup>6</sup>See Iyer (2016) for a detailed discussion on the different dimensions of religious benefits.

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, 2014). 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 people may be naive about the determinants of their health status such as calories intakes. A particularly relevant paper is Oosterbeek and van der Klaauw (2013), who estimate the effect of fasting during the semester on final exam performance in an economic 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.<sup>7</sup>

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 (henceforth Ningxia), which is a provincial unit with a population of 6.3 million, and has a GDP per capita of \$7103.

Among the 6.3 million residents in Ningxia, 38% are Hui, a Muslim minority ethnic group in China; and the rest are mainly Han, the majority ethnic group in China (non-Muslim).<sup>8</sup> 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 less than 200 religious sites

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<sup>7</sup>What Oosterbeek and van der Klaauw (2013) identify is a compound effect of these two factors. We could 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.

<sup>8</sup>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.

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 could hardly be distinguished from the Han people, and their mother tongue is Mandarin.<sup>9</sup> 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 the 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. And for the vast majority of students, conditional on their own stated college preferences, provincial ranking of the CEE score is the only criterion that solely determines the admissions outcome.<sup>10</sup> Given the tremendous valuation for 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 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 their submitted lists and exam scores. Due to the highly

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<sup>9</sup>In comparison, the Uyghurs speak Turkic language written with an Arabic script, and their appearances are distinct from the Han Chinese.

<sup>10</sup>Rare exceptions include winners of international Olympiad contests, students who win sports scholarships, students with exceptional art talents, etc.



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 all have strong incentives to increase their CEE scores, even just by 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," which 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.

In modern societies, many of the conflicts between 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, which was the first time after 28 years, but the game would start right after the end of the month of Ramadan. Seeing this potential conflict, the Grand Mufti of Egypt, Shawki Allam, has granted the Egypt national squad his permission to postpone their Ramadan fasting obligations in the days building up to the World Cup. On the contrary, the Tunisia 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 conditions: weight loss, metabolic changes, irritability, headaches, dehydration, sleep deprivation, and 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 litera-



ture, [Campante and Yanagizawa-Drott \(2015\)](#) show that Ramadan fasting reduces economic output, [Schofield \(2014\)](#) documents that agricultural productivity drops during Ramadan, [Oosterbeek and van der Klaauw \(2013\)](#) show that students have lower test scores due to Ramadan fasting. Relatedly, [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 will be 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 were the 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.<sup>11</sup>

Around the world, school leaders and teachers are making efforts to accommodate and support students during Ramadan in many countries, including schools in the United States,<sup>12</sup> the United Kingdom,<sup>13</sup> Germany,<sup>14</sup> France,<sup>15</sup> Canada,<sup>16</sup> and the United Arab Emirates,<sup>17</sup> etc. The popular strategies to help students who fast include rescheduling testing or event time, shortening school days, providing extra and comfortable space, and other accommodating assistance. 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 the

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<sup>11</sup>“Ramadan: Exams and Tests, 2018”, visited on Aug 5, 2018

<sup>12</sup>K-12 school example from The Seattle Times; higher education example from USA Today College.

<sup>13</sup>An Op Ed piece at School Week: “How schools can support students during Ramadan?”

<sup>14</sup>An article at World Crunch: “Hungry Students? Postponed Exams? Ramadan in German Schools”

<sup>15</sup>A news report at RT International: “Row over postponing French Muslim students’ exams for religious holiday”

<sup>16</sup>A CBC news report: “How are schools accommodating fasting students during Ramadan?”

<sup>17</sup>News report at Gulf News - Education: “Five-hour school days in Dubai during Ramadan”

spirit to our provision of exemptions.<sup>18</sup>

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 one 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 will need to take into consideration (1) the tremendous importance of the CEE for their future, (2) the negative impact of fasting on CEE performance, and (3) the flexibility to delay the fast until after CEE. While there is little doubt that most CEE-takers think highly 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.<sup>19</sup>

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

## 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 obtain 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-

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<sup>18</sup>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, which is consistent with our anecdotal observation in China, which motivated our experimental design.

<sup>19</sup>Two pieces of relevant information could be found through the online search engines: one article written by an Imam arguing that students should keep fasting during the CEE, another is a translated piece based on the statement of the Egyptian Grand Mufti, suggesting students could delay their fast under certain circumstances.

taker in Ningxia during the 6-year period, as well as their basic background information, such as ethnicity, gender, age, school, county of origin, etc.<sup>20</sup>

Exploiting the fact that the CEE fell in the month of Ramadan only in 2016, and the fact that Ramadan is only supposed to affect the performance of Muslim students, 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 to 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.<sup>21</sup> 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:

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

where  $Score_{isct}$  is defined as the CEE score of student  $i$ , who chooses track  $s$  (STEM v.s. Arts), 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,  $\lambda_{st}$  is the Track-by-Year Fixed Effect,  $\epsilon_{isct}$  is the error term. Standard error is clustered at the school level to allow for serial correlation within the same high school.

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

As can be seen in Figure 2, the regression results are highly consistent with our expectations:  $\alpha_t$  is always a precisely estimated zero between 2012 and 2015, prior to the overlap 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 take the exam during Ramadan, their performance drop 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

<sup>20</sup>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.

<sup>21</sup>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.

that the results are robust to the inclusion of gender and county fixed effects, and also robust to collapsing all the pre-treatment data as 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 the admission by a lower-ranked college, or at least a “less desirable” major within the same college.<sup>22</sup> 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.<sup>23</sup>

### 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 score in 2016 (as documented in Section 2) would likely be perceived as undesirable information. However, correctly understanding this information is of tremendous importance for them, for at least three reasons. First, knowing the cost of Ramadan fasting on exam performance helps 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 better 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.<sup>24</sup>

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 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 design and implement 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).

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<sup>22</sup>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 in the CEE.

<sup>23</sup>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).

<sup>24</sup>While the college choices are only made after the announcement of the CEE scores, students need to learn about potentially relevant colleges ex ante, based on their expected CEE score. It has been shown that finding the “suitable” shortlist of schools is central to realizing a satisfactory admissions outcome (Ye, 2018).

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, which has 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.

By agreement, 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. At the time, 533 Hui students were in presence to participate, which constitutes our population for this study. The students were informed by their classroom head teachers before the study that this is 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.<sup>25</sup> Given the huge 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 choices questions based on a 1000-word reading material.

To create variation in the stringency of religious practices, 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 combine them as an article of about 1000 Chinese words. Specifically, we interviewed an established Muslim scholar, the Imam of a historical 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 placebo reading material, we edited an article from a famous Chinese writer Xiaobo Wang, which is about the different perspectives to appreciate art, and is roughly of the same length as the religious reading. For both treatment and placebo readings, to ensure that students understand the materials correctly, we ask three multiple choices reading comprehension questions after the main texts, and students get monetary rewards if they

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<sup>25</sup>20 Yuan is not a trivial amount in this setting: an average student spends about 10 Yuan on meals every day.

answer the questions correctly.<sup>26</sup>

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 (randomly-selected) students 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 think that they do not have to fast during the CEE, and would thus be able to absorb the information with less 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, 2014). To verify whether this is true in our context, for half of the students (randomly chosen), 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.<sup>27</sup> By doing so, we could elicit students’ priors regarding the Hui-Han CEE gap, in the absence of any interventions. In addition, for these 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 fast should not affect motivations to distort beliefs about Sino-Japanese income gap, we expect no difference in reading the gap in this graph.

As summarized in Table 2, our survey experiment has a 2-by-2 design. Randomly, half of the students read a material containing the exemptions to delay fast for the CEE (*Ex-*

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<sup>26</sup>The translated versions of treatment and placebo reading materials can be found in Appendix B.

<sup>27</sup>If the accuracy of one’s guess is above the median student, he will receive a cash reward of 3 Yuan.

*emption*), the other half read an article on art and philosophy (*No Exemption*). In the meantime, we cross-randomize the information received by students: half of the students are incentivized to read a graph about the Hui-Han CEE score gap (*Information*), while the other half are incentivized to read a graph about Sino-Janpanese income gap (*No Information*). The 533 Muslim students participating in the study are randomized into one of these four arms.

For students in all four arms, in addition to the randomized contents (religious V.S. placebo reading; Hui-Han V.S. 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 prays daily, whether never 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 have completed all the common questions, and the reading materials and gap estimation specific to their assigned arm, we also conduct a common “List Experiment” for every student, where we provide five statements about the CEE, four of which are 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 the familiarity with the material rather than actual intelligence,” and one statement is about Ramadan fasting, “(5) delaying fast until after the CEE is acceptable.” We ask 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 religious constraint on fasting behavior, as well as the indirect effect of better learning about the cost of religious behavior on fasting attitudes.

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 include 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 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 everyday, 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; (2) whether or not to break fast during the CEE. By doing so, he maximizes his own utility, which consists in three components: (1) anticipatory utility of exam results; (2) benefits from sticking to the religious practice; and (3) 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** *If students are unaware of the negative impacts of fasting on exam performance, reading about the exemption alone does not change such erroneous beliefs.*

A conjecture made by Kuran (2014) is that most people who commit to Ramadan fasting are actually ignorant about the potential cost of such behavior. Since our DiD estimate on the “cost of Ramadan fasting on exam performance” is a unique piece of information that Muslim students could barely have access to, it is expected that in the absence of such objective information, even if they receive the exemption to delay fast, they will still not

be able to update their priors. If this prediction is confirmed, then we can also rule out the possibility that the religious reading alone might contain some information that changes priors.

**Hypothesis 2** *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 beliefs: 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 to be overly optimistic.

**Hypothesis 3** *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 4** *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 would imply that the choice on belief manipulation would also be polarized. This means that adjustment in accuracy happens 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.

**Hypothesis 5** *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 debias more.*

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, to gain psychological reliefs. 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 fast for the CEE would have a stronger debiasing effect on them, rather than those students who did not always fast anyways.

**Hypothesis 6** *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 debias more.*

This follows a similar logic to Hypothesis 5. 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 reliefs. But in the presence of exemptions to delay the fast, since the information on the “cost of fasting” is more valuable to them,<sup>28</sup> they would respond to the exemptions more strongly and debias more.

**Hypothesis 7** *When reading the Sino-Japanese income gap from Figure 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 Sino-Japanese income gap is unrelated to either Ramadan or the CEE, any motivated beliefs associated with reading Figure 3 would not be alleviated by the exemptions.

**Hypothesis 8** *Both getting the exemption and reading the Hui-Han CEE gap could make Muslim students more likely to delay the fast until after the CEE. 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.*

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

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<sup>28</sup>The information could help them maximize their performance in the CEE, which they value highly.

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 exemption with information in one intervention, it should reach 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, 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 accurate 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 impacts on performance.<sup>29</sup>

Given that students are largely unaware of the impact of fasting, Hypothesis 1 predicts that in the absence of new information, the exemption to delay fast has a negligible impact on the prior of Muslim students. To test this hypothesis, we compare the elicited guesses on the enlarged 2016 Hui-Han gap between “*No Exemption\*No Information*” and “*Exemption\*No*

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<sup>29</sup>A T-test suggests that the average guess in this arm is not different from -16.4 in any statistically meaningful way.

*Information.*” Formally, for all the Muslim students that did not read the Hui-Han CEE gap figure (*No Information*), we estimate:

$$Gap_i = \alpha \cdot Exemption_i + X_i' \cdot \beta + \epsilon_i \quad (2)$$

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 from the religious leaders through our reading materials, and 0 otherwise.  $X_i$  is a vector of individual characteristics, and  $\epsilon_i$  is the error term.

Table 4 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, confirming Hypothesis 1.

## 5.2 Existence of Motivated Cognition and Effects of Exemption

Hypothesis 2 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. Moreover, Hypothesis 3 claims that the relaxation of 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 that were asked to read the enlarged 2016 Hui-Han CEE gap from Figure 1. 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).

As shown in table 5, for those without exemptions, the average estimated gap is -24.4, which understates the true gap by about 4 points.<sup>30</sup> When randomly assigned an exemption, the estimated gap enlarged by about 2 points, eliminating roughly half 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 points, more than 30% of which could be eliminated by the religious intervention.<sup>31</sup>

<sup>30</sup>Compared to the control mean in Table 4 (-17.9), the control mean here is -25.4, suggesting that the Muslim students could partially absorb the objective information from the figure, consistent with our model assumption that belief distortion is not costless.

<sup>31</sup>The difference between using the two outcome variables mainly arise 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.

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.

Hypothesis 4 predicts extensive margin adjustment: students decided not to fast will have highly accurate cognition, supporting evidence for which will be presented in the following subsection. Note that this is not in conflict with our results here that the religious exemption eliminates about one third, rather than 100%, of the baseline bias in Hui-Han CEE gap estimation, because not all Muslim students would change their fasting behavior after receiving the exemption, and only the compliers would adjust at the extensive margin.<sup>32</sup>

## 5.3 Mechanisms

### 5.3.1 Extensive Margin Adjustment

Our model implies that 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 4). 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 v.s. No Exemption*). As can be seen, the 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.”<sup>33</sup> 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 the “intensive

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<sup>32</sup>There are mainly two reasons why students might not comply with the exemption: (1) some non-religious Muslim students might not intend to fast anyways (“always-taker”); (2) some highly religious Muslim students might still decide to fast even with the exemption (“never-taker”).

<sup>33</sup>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!

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 4.<sup>34</sup>

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 from 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 highly robust to the inclusion of class fixed effects and the full set of individual characteristics.

### 5.3.2 Motivation Driven by Fasting History

Hypothesis 5 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 5, we estimate the following modified version of Equation 2:

$$Gap_i = \alpha \cdot Fasted_i + \beta \cdot Exemption_i + \gamma \cdot Fasted_i \cdot Exemption_i + X_i' \cdot \delta + \epsilon_i \quad (3)$$

where  $Fasted_i$  equals 1 if student  $i$  strictly practiced Ramadan fasting during high school, and 0 otherwise. Under this specification,  $\alpha$  measures the extra baseline bias of the students who strictly practiced fasting,  $\beta$  identifies the treatment effect of the exemption on students who did not strictly practice fasting, while  $\gamma$  identifies the additional treatment effect of the exemption on students who strictly practiced fasting. According to Hypothesis 5, we expect that  $\alpha > 0$ ,  $\gamma < 0$ , and  $\beta + \gamma < 0$ .

As shown in Table 8, the negative and significant  $\alpha$  indicates that students who strictly practiced fasting had larger downward biases than their non-fasting counterparts. The statis-

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<sup>34</sup>Some covariates, such as “access to computers” and “whether always kept fasting,” are good predictors of “Deviation.” These variables do not show up significantly either in our balance test. Details for the balance tests are available upon request.



tical insignificance and small magnitude of  $\beta$  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  $\gamma$  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.

### 5.3.3 Motivation Driven by Valuation for College

Hypothesis 6 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, and could avoid more utility loss by choosing to believe that fasting is not bad for CEE performance; and 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 if the student self-reports to have high valuation for college education. As reported in Table 9, in the absence of exemptions, students who report high stake 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-stake students respond more strongly by fully eliminating the extra baseline bias.

Compared to the results on fasting history reported in Table 8, the results in Table 9 are in general weaker: while the signs of main coefficients are always consistent with Hypothesis 6, they tend to have smaller magnitudes and are only marginally significant/insignificant at the 10% level. The comparison between Table 8 and Table 9 suggests that both “motivation due to fasting history” and “motivation due to valuation for college” are driving the baseline patterns of motivated cognition, but the former plays a more salient role.

### 5.3.4 Placebo Test

As stated in Hypothesis 7, receiving the exemption to delay fast 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 read the Sino-Japanese income gap (*Exemption\*No Information*), and others read the placebo article (about art) and were required to read the same Sino-Japanese income gap (*No Exemption\*No Information*). Estimating Equation 2 for students that read 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 7, students in general tend to underestimate the Sino-Japanese income gap.<sup>35</sup> 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.

### 5.3.5 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 could extend the definition of “Accuracy” to every student in any of the four arms: it equals one either you read the Hui-Han gap and make an error within 2 points, or you read the Sino-Japanese gap and make an error within 1000 dollars; and zero otherwise.

Following this definition, we are able to compare the accuracy of graph-reading across all the 4 different arms. Since the Hui-Han information is more relevant for these 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*

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<sup>35</sup>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 baseline was driven by active information distortion rather 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 8, changes in beliefs would also lead to changes in fasting decisions, which we test empirically in this subsection.

The main difficulty here is that 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, commonly seen in the political science literature, 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?” In the five statements, one of the statements is about fasting attitudes, which we are interested in, and the rest four statements concern ways of CEE preparation which are irrelevant to students’ religion and the answers depend on students preferences. Students only have to tell us how many of the statements they agree with and need not to answer explicitly which statements specifically. To minimize the potential social pressure, we also tell students that their response will not be released. Under these procedures, students should be free to state their attitudes in a roundabout way.<sup>36</sup>

As asserted by Hypothesis 8, when students are generally unaware of the harm of fasting during exam, both accurate information and exemption granted by religious leaders may be helpful in terms of 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, we do know from the prediction that combining both exemption and information will be most helpful in changing attitudes, as there is an interaction effect between the religious and information interventions: relaxing the stringency of religious norms could lead to better acquisition of information, which further changes religious behavior.

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<sup>36</sup>The proportion of students who agree/disagree with all the 5 statements are 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 compute 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. Another take-away is that the combination of both religion and information is most effective, which is consistent with the prediction of our theoretical framework. To make sure that our finding is statistically robust, we run the following regression:

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

where  $List_i$  is the number of statements that student  $i$  agrees to in the list experiment.  $\gamma_1$  is the constant representing the average of  $list$  for students in group “*No Exemp \* No Info*,” while  $\gamma_2, \gamma_3, \gamma_4$  represents the point estimate of different treatment effects relative to this baseline. It follows from Table 11 that the statistical evidence we find is consistent with the visual representation, robust across different specifications. The positive and significant  $\gamma_2$  represents the mechanical effect of allowing students to delay fast, the positive yet insignificant  $\gamma_3$  suggests that information treatment alone is not as effective as the exemption, whereas the large and significant  $\gamma_4$  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  $\gamma_4$  is larger than the coefficients for  $\gamma_2$  and  $\gamma_3$  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.

## 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 collected 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 suggest that while providing either information or exemption alone could potentially change students' fasting behavior, they are most effective when combined together 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 also have essential policy implications. 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 reality, 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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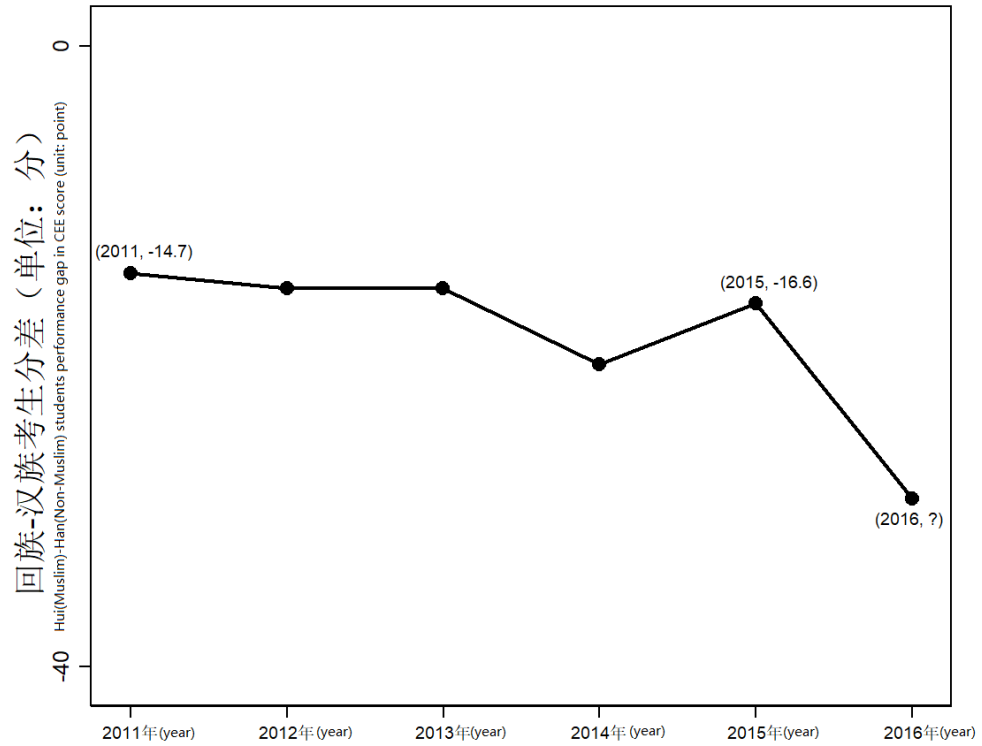
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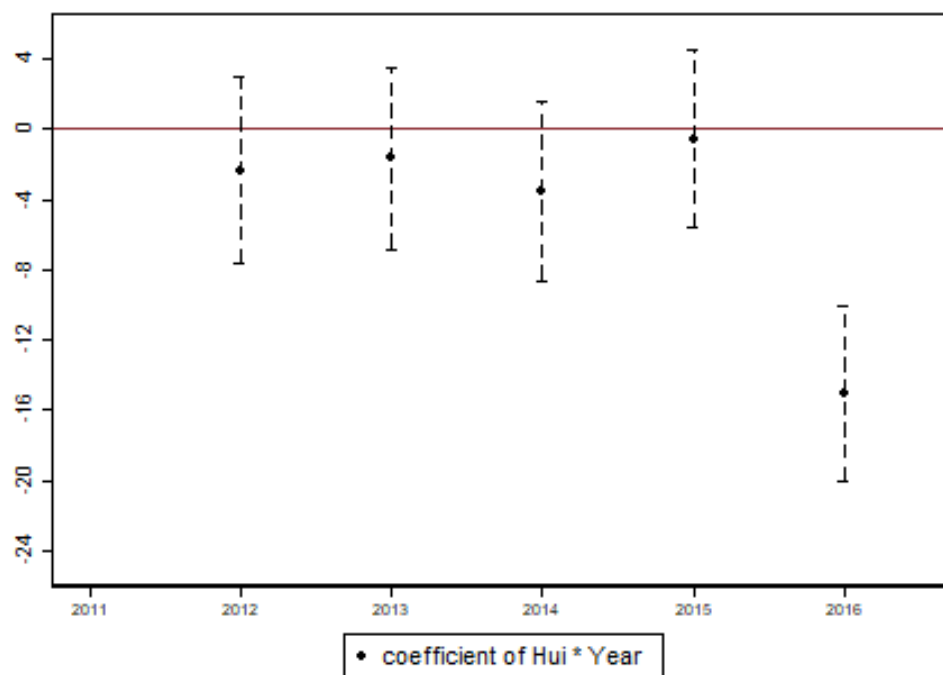
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Figure 1: Hui-Han CEE Gap (2011-2016)



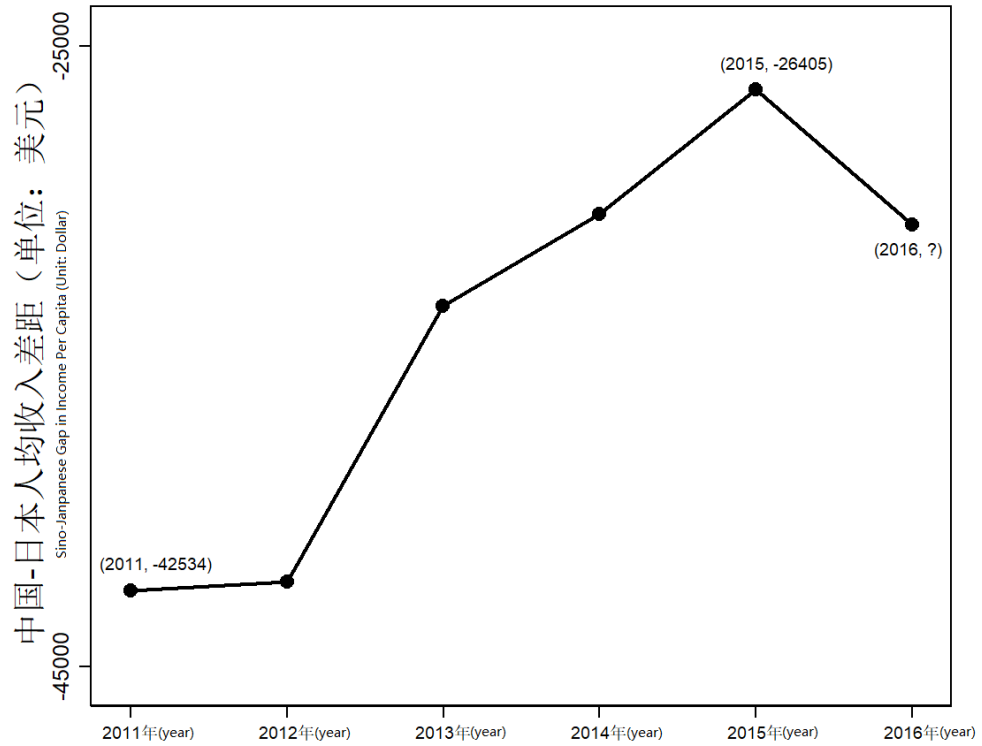
Note: This figure displays the Hui-Han average CEE score gap for all urban students in Ningxia between 2011 and 2016. This is the same figure that was presented to the students in our experimental sample (with Chinese labels). The first dimension of the coordinates marked beside a data point is year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



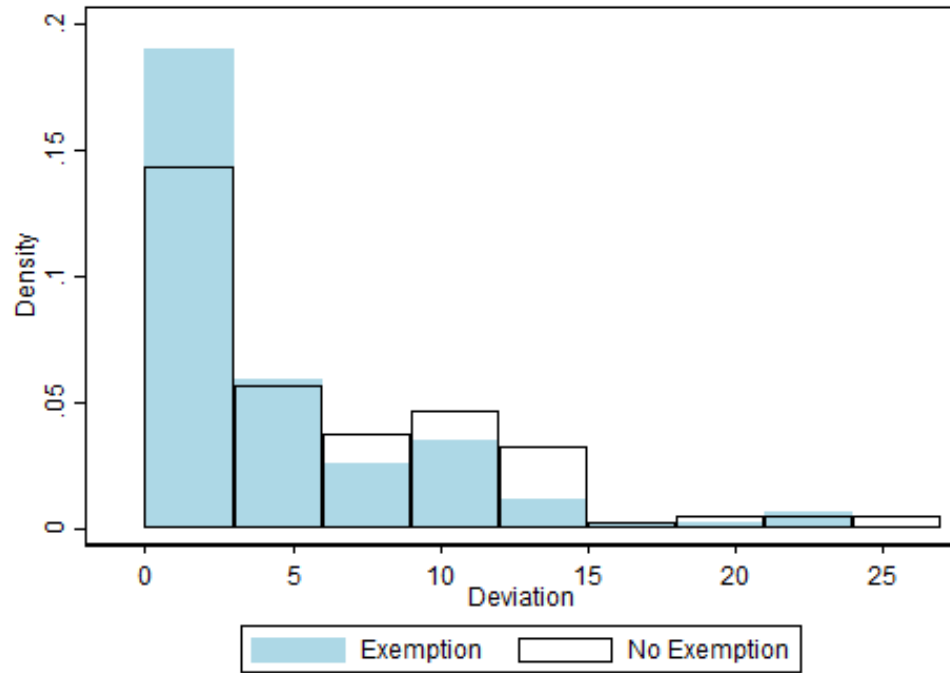
Note: This figure presents the event study estimates of the dynamics of the Hui-Han CEE score gap, with 5% confidence intervals plotted around each coefficient. As can be seen, the Hui-Han gap remained highly flat during 2011-2015, but enlarged significantly in 2016.

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



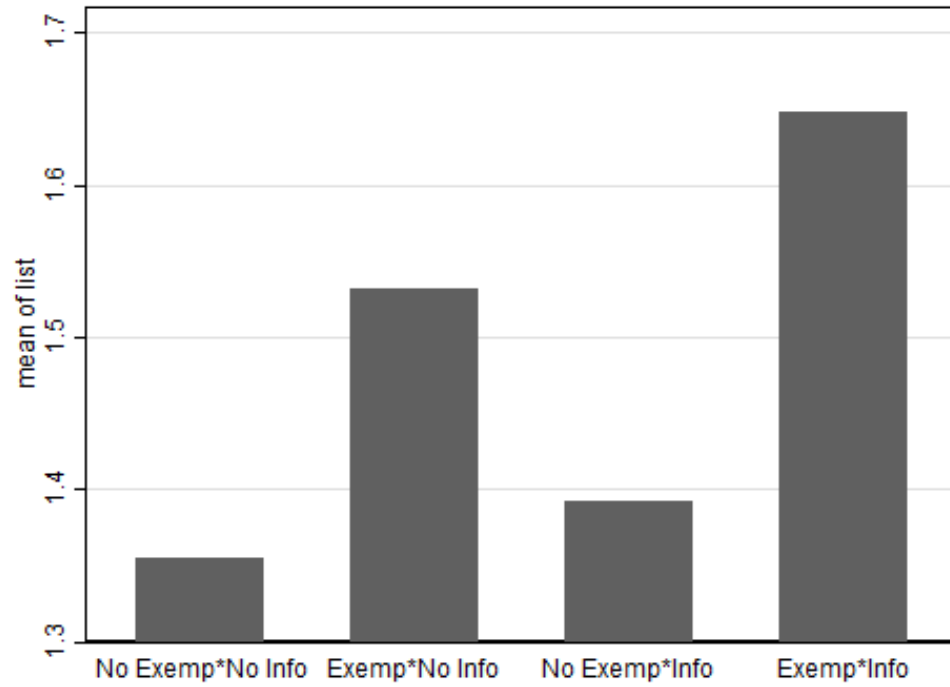
Note: This figure displays the gap between GDP pc of China and that of Japan during 2011-2016. This is the same figure that was presented to the students in our experimental sample (with Chinese labels). The first dimension of the coordinates marked beside a data point is year (horizontal axis) and the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

	(1)	(2)	(3)	(4)
	Score	Score	Score	Score
Hui	-13.3878*** (1.9153)	-2.0819 (1.8237)	-15.0209*** (0.8130)	-3.6553*** (0.8254)
Hui*Year_2012	-2.3302 (2.7061)	-2.3538 (2.5481)		
Hui*Year_2013	-1.6581 (2.6406)	-2.2123 (2.4864)		
Hui*Year_2014	-3.5299 (2.6026)	-2.2280 (2.4510)		
Hui*Year_2015	-0.5688 (2.5676)	-1.0453 (2.4185)		
Hui*Year_2016	-15.0378*** (2.5556)	-13.1334*** (2.4069)		
Hui*Ramadan			-13.4047*** (1.8771)	-11.5543*** (1.7674)
Mean of Dep Variable	383.323	383.323	383.323	383.323
STEM-Year FE	Yes	Yes	Yes	Yes
County FE	No	Yes	No	Yes
Gender FE	No	Yes	No	Yes
Number of Observations	124335	124335	124335	124335
R squared	0.025	0.136	0.025	0.136

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.

Table 2: 2\*2 Experimental Design

<b>Information</b> <b>Religion</b>	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	<b>Exemp*Info</b>	<b>Exemp*No Info</b>
No Exemption	<b>No Exemp*Info</b>	<b>No Exemp*No Info</b>

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

Variables	All		No Exp*No Info	Exp*No Info	No Exp*Info	Exp*Info	Anova Test	
	Mean	Std.Dev	Mean	Mean	Mean	Mean	F-stat	p-value
Gender: male	0.405	0.491	0.445	0.398	0.393	0.387	0.38	0.765
Parents with college education	0.045	0.208	0.016	0.047	0.044	0.070	1.57	0.195
Access to computer	0.390	0.488	0.390	0.375	0.400	0.394	0.06	0.980
Access to internet	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.

Table 4: The Effect of Exemption under Unawareness

	(1)	(2)	(3)
	Gap	Gap	Gap
Exemption	-0.0699 (0.9995)	-0.2167 (1.0141)	-0.1481 (1.0586)
Constant	-17.9325*** (0.7082)		
Mean of Control	-17.933	-17.933	-17.933
Class FE	No	Yes	Yes
Control Variables	No	No	Yes
Number of Observations	247	247	246
R squared	0.000	0.116	0.218

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.

Table 5: The Effect of Exemption on Graph Reading (Hui-Han Gap)

	(1)	(2)	(3)	(4)	(5)	(6)
	Gap	Gap	Gap	Deviation	Deviation	Deviation
Exemption	-1.9032** (0.7387)	-1.9881*** (0.7387)	-2.1985*** (0.7451)	-1.6436*** (0.6295)	-1.6625*** (0.6346)	-1.8617*** (0.6396)
Constant	-24.3954*** (0.5289)			5.8576*** (0.4507)		
Mean of Dep Variable	-25.371	-25.340	-25.368	5.015	5.016	4.996
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.

Table 6: Extensive Margin Adjustment

	(1)	(2)	(3)
	Accuracy	Accuracy	Accuracy
Exemption	0.1152* (0.0594)	0.1312** (0.0618)	0.1573** (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 15 percentage points more likely to make such accurate guesses.

Table 7: The Effect of Exemption on Graph Reading (GDP Per Capita)

	(1)	(2)	(3)
	GDP gap	GDP gap	GDP gap
Exemption	-712.0839 (1088.0785)	-876.2845 (1146.5201)	-1126.3227 (1202.9627)
Constant	-2.843e+04*** (760.9419)		
Mean of Control	-28433.923	-28433.923	-28433.923
Class FE	No	Yes	Yes
Control Variables	No	No	Yes
Number of Observations	229	229	228
R squared	0.002	0.061	0.161

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.

Table 8: Heterogeneity Based on Fasting History

	(1)	(2)	(3)	(4)	(5)	(6)
	Gap	Gap	Gap	Deviation	Deviation	Deviation
Exemption	-0.5822 (1.0672)	-0.9368 (1.0734)	-0.8654 (1.0935)	-0.2870 (0.9092)	-0.5661 (0.9238)	-0.5823 (0.9372)
Fast	2.5805** (1.0425)	2.8892*** (1.0518)	2.9742*** (1.0753)	2.1833** (0.8881)	2.3905*** (0.9052)	2.4848*** (0.9216)
Exemption*Fast	-2.6181* (1.4617)	-2.2005 (1.4859)	-2.5483* (1.5348)	-2.6392** (1.2453)	-2.2253* (1.2788)	-2.4455* (1.3154)
Constant	-25.6952*** (0.7399)			4.7579*** (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.

Table 9: Heterogeneity Based on Valuation for College

	(1)	(2)	(3)	(4)	(5)	(6)
	Gap	Gap	Gap	Deviation	Deviation	Deviation
Exemp	-0.6302 (1.1463)	-0.8284 (1.0363)	-1.5129 (1.1299)	-0.1375 (1.0021)	-0.2705 (0.8102)	-0.7869 (0.9496)
High Stake	1.6253 (0.9799)	1.8244* (0.9927)	1.4605 (1.0089)	1.7088* (0.8758)	1.9717** (0.8203)	1.5580* (0.8946)
Exemp*High Stake	-1.9577 (1.2178)	-1.6064 (1.1791)	-1.0526 (1.2647)	-2.2478* (1.1994)	-1.9938* (1.0543)	-1.6693 (1.0971)
Constant	-25.4623*** (0.9796)			4.6856*** (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.

Table 10: Active Information Distortion

	(1)	(2)	(3)
	Accuracy	Accuracy	Accuracy
Exemp*No Info	-0.0313 (0.0622)	-0.0356 (0.0624)	-0.0367 (0.0632)
No Exemp*Info	-0.1769*** (0.0613)	-0.1837*** (0.0618)	-0.1674*** (0.0622)
Exemp*Info	-0.0617 (0.0606)	-0.0573 (0.0611)	-0.0440 (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.



Table 11: Fasting Attitudes

	(1)	(2)	(3)
	Agreed Statements	Agreed Statements	Agreed Statements
Exemp*No Info	0.1769* (0.1065)	0.1924* (0.1085)	0.2168* (0.1107)
No Exemp*Info	0.0383 (0.1051)	0.0540 (0.1074)	0.0485 (0.1089)
Exemp*Info	0.2936*** (0.1038)	0.2988*** (0.1063)	0.3216*** (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.

# 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  $\hat{\rho} \equiv P\{\rho_i = 1\}$ .<sup>37</sup> 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  $\kappa h$ , 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  $\rho_i$  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  $\epsilon_{i0}$  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

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<sup>37</sup>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  $\rho_i$  but instead, they form a posterior about  $\rho_i$  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:

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

where  $\epsilon_{i1}$  is governed by distribution  $F_1(\epsilon_{i1})$ . Denote the joint distribution of  $(\epsilon_{i1}, v_i)$  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  $\rho_0$  had motivated beliefs been not at play. We assume that  $C(\cdot)$  is twice continuously differentiable, minimized at 0. We also assume  $\rho_0$  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  $\rho_0$  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  $\rho_0$  in their paper as this is not their focus, we directly test the additional implication of a wrong  $\rho_0$  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-stake 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  $(\epsilon_{i1}, f_0)$ ,  $\hat{\rho} < \rho_0$  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  $\rho_0$ . 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  $(\epsilon_{i1}, f_0)$ ,  $\hat{\rho}$  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  $\kappa$  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 respect to past fasting behavior  $f_0$ . While the prediction of model in general may not be entirely clear given different  $\kappa$ ,  $f_0$ ,  $C(\cdot)$  and the joint distribution of  $v_i$  and  $\rho_i$ , with assumption on  $\kappa$ , we can derive the following results.

**Proposition 4** When  $\kappa$  is sufficiently small, the distribution of  $v_i$  given  $f_0 = 1$  stochastically dominates that given  $f_0 = 0$ . Hence given the same  $\rho_0$ ,  $E[\hat{\rho}|f_0 = 1] < E[\hat{\rho}|f_0 = 0]$

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  $\kappa$  is large <sup>38</sup> 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  $\omega_i$  increases.

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

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<sup>38</sup>When  $\kappa$  is large,  $f_0$  is affected by both  $\rho_i$  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  $\rho_0$  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  $\rho_0$ , 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  $\epsilon_{i1}$  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  $\epsilon_{i1}$ , 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  $\epsilon_{i1}$ , 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 Reading Materials

### B.1 Reading on Exemption

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.”

## **B.2 Reading on Art**

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...