



Divine verification: Introducing a CAPTCHA-based religious priming technique

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Abstract

Previous research on religious priming has predominantly relied on implicit and explicit approaches, both of which face critical limitations. Implicit primes often lack construct validity, while explicit primes are vulnerable to demand effects and social desirability biases. Moreover, the effectiveness of these methods has rarely been systematically validated. Addressing these gaps, we introduce and validate a novel technique—allusive priming—designed to minimize demand characteristics while reliably activating targeted constructs. Using allusive primes, religious themes (punitive, rewarding, forgiving, and neutral conceptions of God) were subtly embedded within CAPTCHA-like tasks. Following a preliminary calibration study ($n = 104$) to select materials, we conducted a preregistered online experiment ($n = 2770$ U.S. participants) comparing the effectiveness of two different allusive priming conditions with a standard explicit prime in how effectively they increase religious thought saliency. Participants completed a Word Completion Task to assess religious thought accessibility and a dictator game to explore prosocial outcomes. Results demonstrated that one of our two allusive primes significantly increased religious word completions. Critically, participants exposed to allusive primes exhibited lower awareness of the manipulation's purpose compared to those exposed to explicit primes, suggesting reduced demand effects. However, despite successful activation of religious thoughts, religious priming did not significantly influence generosity in the dictator game. These findings position allusive priming as a promising alternative to traditional methods, offering greater flexibility and ecological validity for priming diverse psychological constructs, while mitigating common validity threats.

Keywords Religious priming · Prosociality · Validity · Supernatural monitoring · Supernatural punishment

Introduction

Research on the cultural evolution of religion suggests that religious beliefs played a crucial role in the development of

large-scale cooperation among non-kin (Liddle & Shackelford, 2021; Norenzayan, 2013). Several theoretical frameworks have been proposed to explain how religion facilitated such cooperation (Henrich, 2020; Johnson, 2015; Norenzayan, 2013). Yet, despite rich theoretical debates, empirical progress has been constrained by the absence of valid and reliable methods for experimentally manipulating religious cognition. Compounding this challenge, recent comprehensive meta-analyses indicate that religious prosociality effects often emerge primarily in self-report measures rather than behavioral outcomes, raising concerns about their robustness (Kelly et al., 2024). While implicit, explicit, and contextual religious primes have been used to activate religious concepts experimentally, none of these methods have been systematically validated, and their effectiveness remains inconsistent (Billingsley et al., 2018). This methodological gap impedes decisive testing of religious prosociality hypotheses. To address this, before examining the causal effects of religious priming on prosociality, we first evaluated the validity of commonly

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used priming methods and then introduced and tested a novel technique developed to overcome their limitations.

Theories of religious prosociality

Several theoretical frameworks explain why religious cognition leads to increased prosociality and cooperation. The supernatural monitoring hypothesis (SMH) posits that belief in omniscient supernatural agents increases perceived surveillance, thereby enhancing reputational concerns and promoting moral behavior (Norenzayan, 2013). According to the SMH, religions featuring omniscient and omnipotent gods, capable of being present everywhere at all times, were favored through cultural evolution because such gods can effectively monitor individuals' moral behavior and promote cooperation and prosociality (Norenzayan, 2013; Norenzayan & Shariff, 2008). Consequently, when central authorities or local social networks become ineffective at preventing free-riding and breakdowns in large-scale cooperation, individuals tend to outsource social monitoring to gods. In this way, cooperation can be maintained through supernatural surveillance even in the absence of human observers. Empirical support for SMH comes from studies showing that cues of supernatural agents can increase prosocial behavior (Bateson et al., 2006; Haley & Fessler, 2005; Piazza et al., 2011). Alternatively, the Supernatural Punishment Hypothesis (SPH) emphasizes fear of divine retribution as the primary driver of moral compliance (Johnson & Bering, 2006; Johnson & Krüger, 2004; Yilmaz & Bahçekapili, 2016). According to the SPH, mere monitoring is insufficient to promote cooperation. For gods to effectively sustain cooperative behavior, omnipotence and omniscience must be coupled with the capacity to elicit fear of punishment, whether in this life or the afterlife. Fear of supernatural punishment deters free-riding, prevents cooperation breakdowns, and reinforces moral behavior when made salient. Expanding on the SMH and SPH, Lenfesty and Morgan (2019) proposed that religiously inspired prosociality may also stem from prestige-biased learning, where individuals emulate revered religious figures such as prophets, saints, or priests. Although debates continue regarding the precise mechanisms, the association between religiosity and prosociality has been consistently observed across studies with some nuances (Kelly et al., 2024; Shariff et al., 2016).

Experimental investigations of religious prosociality

Researchers employed both correlational and experimental approaches to investigate the religiosity–prosociality link. Correlational studies generally find that higher religiosity is associated with greater prosocial behaviors (Brooks, 2007; Herzog & Yang, 2018; Van Tongeren et al., 2021; Yeung,

2018), although self-report biases—particularly socially desirable responding, which is more pronounced among religious individuals (Sedikides & Gebauer, 2010; Tsang et al., 2021)—limit their interpretive power.

Experimental approaches initially favored implicit priming techniques. For instance, Shariff and Norenzayan (2007) developed a scrambled sentence task where participants were subtly exposed to religious words, aiming to activate religious concepts outside of conscious awareness. Early studies suggested that implicit religious primes could enhance prosocial behavior (Ahmed & Salas, 2011; Pichon et al., 2007; Randolph-Seng & Nielsen, 2007). However, subsequent critiques noted that these techniques often lacked formal validation and relied on small, underpowered samples (Van Elk et al., 2015). Replication failures and meta-analytic reviews have further cast doubt on the reliability of implicit religious priming (Billingsley et al., 2018; Gomes & McCullough, 2015; Yilmaz et al., 2016).

As an alternative, explicit priming methods involve directly instructing participants to think about religious concepts (e.g., writing about God). These approaches typically show positive effects on prosocial behavior (Pasek et al., 2023; White et al., 2019), though their susceptibility to demand characteristics remains a major concern (Shariff & Norenzayan, 2007; Watanabe & Laurent, 2020). When participants discern the study's aims, they may alter their behavior accordingly, undermining the internal validity of findings.

Contextual priming offers another pathway by embedding participants within ecologically valid religious environments, such as near places of worship or by exposure to auditory religious cues like the Islamic call to prayer. For example, Aveyard (2014) found that exposure to prayer calls increased honesty by 15% in a cheatable math task. Nevertheless, contextual primes, like other methods, yield mixed results and face challenges of generalizability and control.

Overall, although religious priming is often associated with enhanced prosocial behaviors (Shariff et al., 2016), the literature presents significant inconsistencies. Meta-analytic findings are mixed (Kelly et al., 2024; Van Elk et al., 2015), and concerns regarding manipulation validity and statistical power remain pervasive. Therefore, the reliability of existing priming methods in eliciting genuine religious cognition—and consequently, their capacity to robustly influence prosocial behavior—remains an open question.

The present research

Validating manipulation techniques is fundamental for establishing credible causal claims (Chester & Lasko, 2021). As discussed, implicit primes often lack efficacy, and explicit primes risk contamination through demand effects

(Billingsley et al., 2018). Thus, there is a clear need for new priming methods that can reliably activate religious concepts while minimizing participants' awareness of the manipulation's purpose.

In response, we developed two novel "allusive priming" techniques designed to increase the salience of religious thoughts subtly. These techniques aimed to improve upon traditional methods by balancing effectiveness with low demand characteristics. Furthermore, we created primes targeting distinct religious dimensions—punitive, rewarding, forgiving, and neutral—allowing for more nuanced tests of SMH and SPH.

Our approach draws inspiration from CAPTCHA (Completely Automated Public Turing test to tell Computers and Humans Apart) tasks commonly encountered in online environments. In the first method (allusive-1), participants viewed a CAPTCHA-style image—a book overlaid with grid lines and a textual stimulus occupying a portion of the image—and were instructed to select squares not containing legible text. The embedded text varied according to condition ("God sees," "God punishes," "God rewards," "God forgives," or a neutral control phrase, "He runs").

In the second method (allusive-2), participants were presented with an image reflecting a religious or neutral theme, accompanied by six keywords, one of which corresponded to the image. Participants identified the matching word, reinforcing the religious prime or maintaining a neutral context for control participants.

By incorporating religious stimuli into familiar CAPTCHA-like tasks, these methods sought to subtly prime religious cognition above the threshold of awareness without overtly revealing the manipulation's intent.

Preliminary study

To identify suitable images and words for our manipulations, we conducted a preregistered preliminary study with 100 Christian participants. Initially, two graduate research assistants compiled an inventory of images categorized as either religiously themed or unrelated to religion. Images classified as non-religious were reserved for the control conditions. From the religiously themed images, the research team selected candidate stimuli reflecting distinct aspects of religion—punitive, rewarding, forgiving, and neutral—which were subsequently tested for potential use as primes.

In the main study, we planned to use a Word Completion Task (WCT; Yilmaz & Bahçekapili, 2015, Study 3) as the dependent variable to assess the effectiveness of these manipulations (detailed in the "Main Study" section). To generate candidate words for both the WCT

and the keyword selection task in the allusive-2 condition, we utilized ChatGPT.¹ ChatGPT was prompted to generate a list of words presented in a table format with four columns corresponding to the four religious aspects: punitive, rewarding, forgiving, and neutral. From initial prompts, ChatGPT produced 34 words per category. We removed duplicate entries and further evaluated each word to ensure it carried an inherent religious meaning, discarding those that did not meet this criterion.² This resulted in 19 words each for the punitive and rewarding categories, 14 for the forgiving category, and 17 for the neutral category.

Additionally, we generated 20 words unrelated to religion using a new ChatGPT session to serve as control words.³ Words with potential religious connotations, such as "apple" and "book," were excluded. From the remaining 18 words, we randomly selected 15 for inclusion in the preliminary study. Finally, participants also rated the religious target words originally employed by Shariff and Norenzayan (2007) to further validate the selected stimuli.

Methods

Participants

Participants were recruited for an online study through Prolific. In the initial data collection phase, 126 participants were enrolled. However, 23 participants were excluded due to incomplete survey responses. Additionally, a survey setup error resulted in 59 participants not completing all image and word rating tasks. In line with our preregistered exclusion criteria, these participants were also removed from the dataset. To compensate for the exclusions, we recruited an additional 60 participants. The final sample consisted of 104 Christian participants (50% female), with a mean age of 47.35 years ($SD = 15.86$). The data, code, and preregistration form of this study are available at <https://osf.io/m2s7t>.

¹ Words were generated for each condition with the prompt: "I want a list of religious words, including 60 punitive, 60 rewarding, and 60 neutral. Can you give them in a table?"

² The following prompt was used: "I want you to tell me whether some of the words I am going to give you have religious meanings on their own or not. I will give you some words and you will explain to me if the word, on its own, has a religious meaning and why. Are you ready?" After ChatGPT's initial response, each word was presented in a single chat window. Different chat windows were used for different categories (punitive, rewarding, forgiving, neutral) with the same method.

³ We used the prompt: "We need 20 neutral words that are not related to anything. Please do not use conjunction words such as 'as, or, so'. Can you give them in a table?"

Table 1 Top ten highest-rated words in each category. *Note.* Numbers within parentheses represent arithmetic means, higher scores indicate higher relation. See online repository for a full list of words presented to participants

	Religious			Non-religious
	Neutral	Punitive	Rewarding/Forgiving (Benevolent)	Control
1	Faith (9.35)	Hell (8.40)	Salvation (9.02)	Hat (1.87)
2	Prayer (9.30)	Sin (8.24)	Heaven (8.92)	Pen (1.95)
3	Worship (9.19)	Damnation (8.08)	Mercy (8.9)	Clock (2.1)
4	Holiness (9.18)	Condemnation (7.86)	Eternal Life (8.81)	Shirt (2.16)
5	Eternity (9.07)	Excommunication (7.3)	Redemption (8.75)	Plate (2.17)
6	Divine (8.99)	Abomination (7.13)	Blessing (8.52)	Table (2.17)
7	Sacred (8.62)	Blasphemy (7.09)	Paradise (8.30)	Chair (2.18)
8	Revelation (8.54)	Curse (6.76)	Rebirth (8.10)	Mirror (2.20)
9	Devotion (8.44)	Tribulation (6.56)	Repentance (8.06)	Vase (2.20)
10	Saintly (8.27)	Admonishment (6.55)	Glory (7.86)	Window (2.23)

Procedure

Participants rated each image on its perceived relevance to religion using a scale from 1 (“*Not at all*”) to 10 (“*Very much*”). Specifically, they evaluated how much each image related to religion in general (e.g., “Please rate how much this image relates to religion in general”) as well as to punitive, rewarding, and forgiving aspects of religion (e.g., “Please rate how much this image relates to punitive aspects of religion”). In total, participants evaluated 22 images: three punitive, three rewarding, eight forgiving,⁴ three neutral religious, and five control images.

Similarly, participants rated words on the same scale based on their association with religion in general and with specific religious dimensions (punitive, rewarding, forgiving). For instance, participants responded to items such as, “Please rate how much each word relates to forgiving aspects of religion.” After completing the rating tasks, participants filled out a demographic questionnaire. Based on these ratings, the highest-scoring words and images were selected for use in the main study.

Results and discussion

Table 1 shows how each word ranked in its respective category. Top-rated images in each category are presented in Table S1 in the Supplementary Materials. Highest-rated words are presented in Table S2.

We ran two paired *t* tests to test whether the images and words classified as religious were indeed rated to be more

religious compared to control images and words. Results showed that the religious words ($M = 7.94$, $SD = 1.33$) were indeed more highly rated than control words ($M = 2.40$, $SD = 1.91$), $t(108) = 26.21$, $p < .001$, Glass’s delta = 2.88. Religious images ($M = 8.73$, $SD = 1.15$) compared to control images ($M = 3.60$, $SD = 1.88$) were found to be more related to religion, $t(108) = 23.20$, $p < .001$, Glass’s delta = 2.70.

The highest-rated images in each category were selected to be used in the allusive-2 manipulation. We decided to use the highest-rated words for the WCT in the main study since this would allow for a more sensitive measurement. After selecting words for the WCT, we chose alternative highly rated words from the remaining words to be used as keywords in allusive-2. In general, forgiving words and rewarding words were highly rated in both rewarding and forgiving categories, suggesting an overlap between these concepts (see Table S2). Hence, we decided to merge rewarding and forgiving dimensions in our dependent variable (the WCT) into a single category as “benevolent” in the main study. However, we decided to keep the distinction between forgiving and rewarding in our independent variables (in the allusive priming tasks) to have these separate concepts as different primes for future tests of their prosocial effects.

We decided not to use the words from Shariff and Norenzayan’s (2007) scrambled sentence task in the main study for three reasons. First, several words were not inherently related to religious concepts (e.g., *wrath*, *spirit*, *doom*). Second, some words (e.g., *God*) were already embedded in our explicit prime condition, creating a potential confound. Third, the remaining words did not rank highly enough in terms of perceived religious relevance (e.g., *prophets*) based on participant ratings.

⁴ We sought to select from a wider range of alternatives because the images representing the forgiving aspect were not as clear as those depicting the other traits.

Main study

The main study had two primary objectives. First, we aimed to assess the construct validity of the newly developed allusive-1 and allusive-2 priming techniques, alongside a traditional explicit priming method. Second, we examined their effects on socially desirable responding, given persistent concerns about demand characteristics associated with explicit primes. To evaluate construct validity, we employed a WCT, in which participants were presented with word fragments and asked to complete them. We hypothesized that if our manipulations successfully heightened the accessibility of religious concepts, participants in the religious prime conditions would be more likely to complete the fragments with religiously meaningful words relative to control participants.

The first four hypotheses were preregistered to address these validation aims. Although the primary design focused on testing priming efficacy, we included a dictator game (DG) following the WCT to explore the potential effects of religious priming on prosocial behavior. Consequently, two additional hypotheses (H5 and H6) were preregistered, informed by distinctions between SMH and SPH. Furthermore, prior research suggests that religious primes may be more effective on believers who practice their religion regularly (Galen, 2012; Shariff et al., 2016) and religious prosociality effects may also be stronger for those who report regular religious practice (Kelly et al., 2024). Thus, we also aimed to explore whether religious practice moderated the effectiveness of the primes.

Our six preregistered hypotheses were as follows: In H1, we expect that religious primes will increase the saliency of general religious thoughts (mean score of all domains of religious thought saliency) compared to the control group, and in H2, we expect punitive primes to increase the saliency of punitive religious thoughts compared to other groups. In H3, we expect that rewarding and forgiving primes increase the saliency of benevolent religious thoughts compared to other groups. In H4, we predict that explicit primes increase socially desirable responding, while allusive primes do not increase socially desirable responding scores compared to their control conditions. Finally, we predict that religious primes (H5) and punitive primes (H6) increase generosity compared to the control groups. The materials, data, code, and preregistration form are openly accessible at the project repository <https://osf.io/7m5bn>.

Methods

Participants

A power analysis revealed that, with a small effect size of $f=0.10$, .05 alpha, and .95 power, we would need 2760

participants for a one-way ANOVA with 15 conditions. Based on Shariff et al.'s (2016) meta-analysis, we expected our primes to only work effectively with Christian believers, and not atheists or agnostics. Therefore, we collected online data from Christian participants only using Prolific. To explore potential differences between practicing and non-practicing Christians, we also pre-screened these Christian participants based on whether they practiced their religion (either publicly or privately) or not using Prolific's pre-screen criteria. We cross-checked these answers by including the same pre-screening questions in our demographic questionnaire. While we aimed to collect 1380 practicing and 1380 non-practicing Christians, we removed the pre-screening criterion of religious practice after reaching 1000+ participants due to insufficient Prolific users to meet the criterion. A total of 3087 participants in the US participated in the study. As preregistered, we excluded 187 participants due to incomplete responses and 6 due to duplicate entries. Additionally, 124 participants were excluded because they identified with a religious belief other than Christianity, declared themselves as atheist or agnostic, or selected the "other" category for religious affiliation. The final sample size consisted of $n=2770$ Christian participants ($M_{\text{age}}=41.71$, $SD_{\text{age}}=14.54$, 55% female). Regarding religious activity, 45.7% of the participants practice publicly and privately, and those who do not practice at all constitute 23.4%. The rest of the participants reported attending only public (4.2%) or private (22.7%) religious activities. Some participants preferred not to report their religious activity (4%).

Materials

Explicit priming Participants in this condition were presented with a text saying either "God sees" in the religious-neutral condition, "God punishes" in the punitive condition, "God rewards" in the rewarding condition, or "God forgives" in the forgiving condition and "He runs" in the control condition. Below this short text, participants were asked to write four sentences about what the text made them think. The priming text in each explicit prime condition was the same as the priming text in allusive-1 primes.

Allusive priming Participants were assigned to one of the allusive priming conditions (either allusive-1 or -2) completed the tasks explained below. Participants were randomly assigned to either punitive, rewarding, forgiving, neutral, or control conditions.

Allusive-1. We used an image of an open book for the allusive-1 prime. This image was split into sixteen squares using grid lines; the four squares in the top-right corner contained the priming text, which varied across conditions

to prime different aspects of religion (“God punishes” for punitive, “God rewards” for rewarding, “God forgives” for forgiving, “God sees” for religious-neutral, and “He runs” for the control). The image remained the same across all five conditions. Imitating an ordinary CAPTCHA task, the prime contained these instructions: “To continue, select all squares without legible text.” Participants were able to select individual squares and were able to proceed only after selecting the correct squares. Figure 1 demonstrates an example allusive-1 prime.

Allusive-2. For allusive-2, we used the highest-rated image in each category to construct the CAPTCHA prime (see Supplementary Materials for all images). The image appeared in the middle of the prime and participants were instructed: “To continue, select one keyword that best describes the image.” Participants were presented with six keywords below the image. Among these six keywords, one was the target keyword that participants needed to choose to continue. We used the highest-rated words from the preliminary study as target keywords in allusive-2. The target keywords were not used in the WCT. Participants were only able to continue after choosing the correct keyword. Figure 2 demonstrates an example allusive-2 prime. For the control condition, we used an image of a table, which was rated as the least related to religion in the preliminary study.

Control conditions For each of the three experimental conditions, a corresponding control condition was included. In the explicit prime condition, the control stimulus consisted of the sentence “He runs.” For the allusive-1 prime, the control condition embedded the sentence “He runs” in the top-right corner of the image. In the allusive-2 prime condition, the control stimulus featured an image of a table accompanied by the matching keyword “table.”

The Balanced Inventory of Desirable Responding – Short Form (BIDR-16) Participants’ tendency for socially desirable responding was measured with the BIDR-16 (Hart et al., 2015). This Likert-type scale is composed of 16 items and two dimensions: impression management ($\alpha = .79$), which measures the tendency to modify responses to impress others, and self-deceptive enhancement ($\alpha = .77$), which measures the tendency to respond more positively to questions about themselves.

Word completion task We used a Word Completion Task (WCT) as our main outcome measure of saliency of religious thoughts (Yilmaz & Bahçekapili, 2015). Relying on the results of our preliminary study, we selected five target words with the highest ratings from each category (punitive,

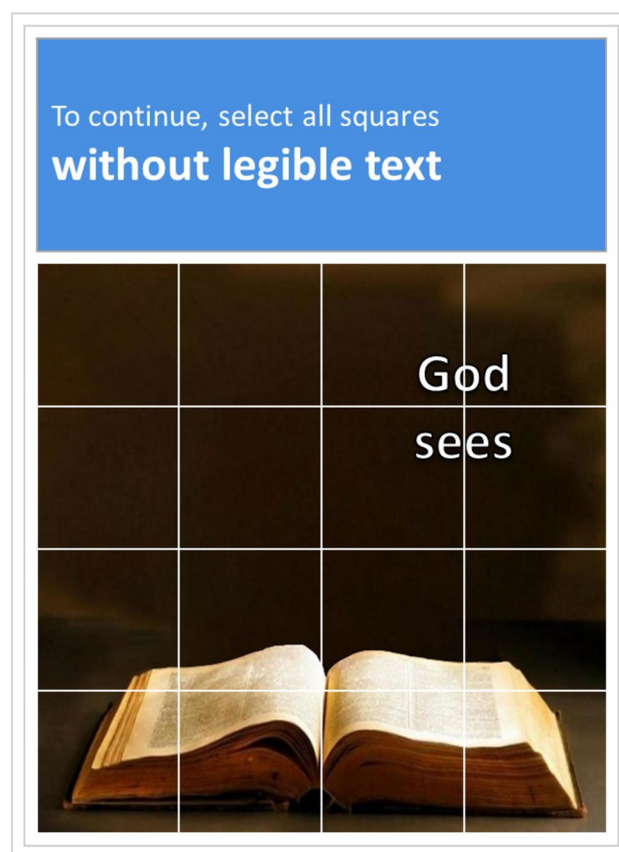


Fig. 1 Neutral allusive-1 prime

benevolent, neutral). We also selected five words that were least related to religion as filler words. Therefore, the WCT had a total of 20 words. Each word was presented with a few initial letters exposed. For example, for the word “faith”, the first three letters of the word were presented as “f a i _ _”. Participants were asked: “Please fill in the blanks with letters that meaningfully complete the word and then write the complete word inside the corresponding box. Do not just write down the missing letters.” We did make visible how many other letters were left to be filled. However, participants were not obligated to meet the exact word length and could complete the word as a shorter or longer one. For shorter words in the WCT, fewer initial letters were given (e.g., only the letters “s” and “i” were given for the target word “sin.”). Words were presented in a random order on a single page. Participants needed to complete all the words to continue. All responses provided for each word in the WCT were individually reviewed by the researchers. Answers containing only minor spelling errors or missing letters, but still clearly resembling meaningful religious words, were accepted and included in the relevant categories as well as in the total WCT scores.

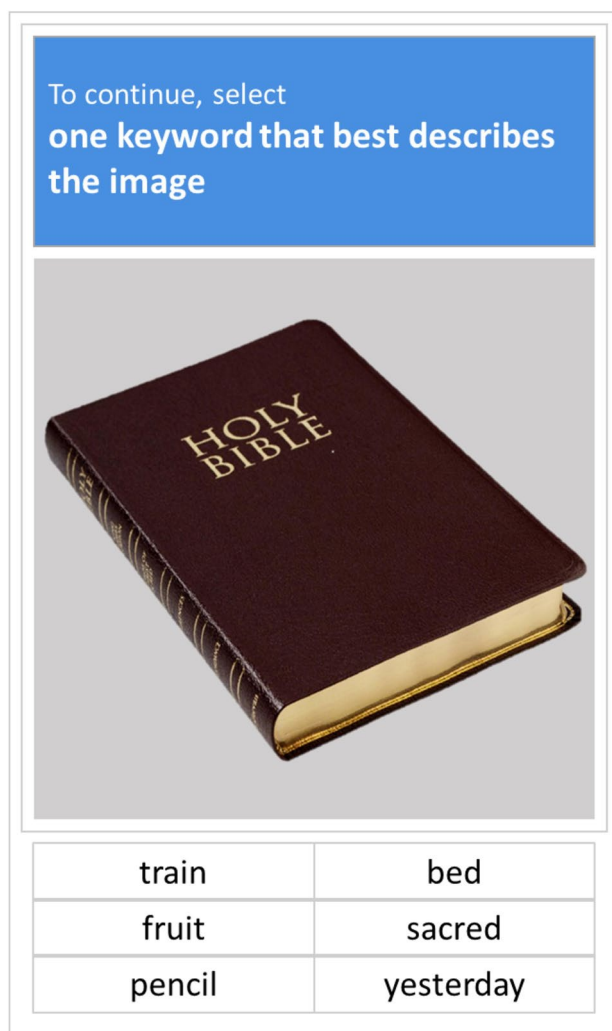


Fig. 2 Neutral allusive-2 prime

Dictator game To explore religious primes' effect on prosociality, we added an incentivized dictator game (DG) following the WCT. In the DG, the active player decides how much of their endowment to share with an anonymous and passive participant in a one-shot anonymous interaction. Additional payments were calculated based on the DG allocation and made to participants who were randomly selected through a lottery system (Cubitt et al., 1998; Umer, 2023).

Suspicion probes and demographic questions To assess whether participants understood the aim of the study, we used a suspicion probe asking participants "What do you think about the aim of the study?" Following this probe, participants completed a questionnaire that included demographic measures (e.g., age, gender, subjective socioeconomic status, and political ideology), as well as items assessing religious beliefs (e.g., participation in

religious activities, strength of belief in God) and religious identity.

Procedure

Using a between-subjects design, participants were randomly assigned to either the explicit, allusive-1, or allusive-2 condition, where they received either punitive, rewarding, forgiving, neutral (e.g., general religious symbols), or non-religious (control) priming manipulations. After the manipulation, all participants completed the WCT, the DG, BIDR-16, the suspicion probe, and finally, the demographic questionnaire, in this exact order. Participants across conditions did not differ in demographics and self-report measures (see Table S3).

Results

Confirmatory analyses

In H1, we hypothesized that religious primes would increase the saliency of general religious thoughts compared to control conditions. A one-way analysis of variance (ANOVA) was conducted to compare general religious thoughts across fifteen conditions ($F(14, 2755) = 13.83, p < .001, \eta_p^2 = .066$). Post-hoc pairwise comparisons using Tukey's HSD indicated that general religious thought scores in all explicit prime manipulations were significantly higher than in the explicit control condition. While the rewarding, forgiving, and neutral manipulations in the allusive-2 significantly enhanced general religious thoughts compared to the allusive-2 control condition, the punitive allusive-2 manipulation did not lead to significant score differences compared to the control condition. On the other hand, all allusive-1 priming manipulations did not significantly change general religious thoughts compared to the control condition (see Table 2). Explicit priming methods increased religious thoughts in each aspect of religion. Overall, while the allusive-2 manipulations were partially effective, the allusive-1 manipulations did not increase religious thoughts. Consequently, the effectiveness of the three manipulation methods was partially supported (H1). The mean score of general religious thoughts across the three control and 12 experimental conditions is shown in Fig. 3.

In H2, we hypothesized that punitive primes would specifically increase the saliency of punitive religious thoughts compared to other groups. A one-way ANOVA on punitive religious thought scores was carried out. The model revealed that punitive thoughts were significantly different across conditions ($F(14, 2755) = 6.51, p < .001, \eta_p^2 = .032$). We ran Tukey's HSD test for post hoc pairwise comparisons to check if the three punitive prime conditions affected the saliency of punitive religious thoughts compared to other

Table 2 Sample sizes and WCT means per condition, and results of Tukey's HSD tests

Manipulations	<i>n</i>	Total WCT		vs. Explicit control ^a		
		<i>M</i>	<i>SD</i>	<i>p</i>	95% CI	
					<i>LB</i>	<i>UB</i>
Explicit punitive	182	7.53	2.89	<.001	1.23	3.27
Explicit rewarding	173	7.71	2.91	<.001	1.40	3.46
Explicit forgiving	174	7.48	2.62	<.001	1.17	3.23
Explicit neutral	183	7.34	2.81	<.001	1.04	3.07
vs. Allusive-1 control ^b						
				<i>p</i>	95% CI	
					<i>LB</i>	<i>UB</i>
Allusive-1 punitive	190	6.19	2.82	.660	-.34	1.63
Allusive-1 rewarding	186	6.17	2.92	.723	-.37	1.61
Allusive-1 forgiving	186	6.45	2.83	.127	-.09	1.89
Allusive-1 neutral	186	5.93	2.70	.994	-.61	1.37
vs. Allusive-2 control ^c						
				<i>p</i>	95% CI	
					<i>LB</i>	<i>UB</i>
Allusive-2 punitive	196	6.47	3.04	.097	-.06	1.89
Allusive-2 rewarding	188	7.11	3.15	<.001	.56	2.54
Allusive-2 forgiving	191	6.79	2.86	.002	.25	2.22
Allusive-2 neutral	191	6.89	3.02	<.001	.35	2.31

Total WCT scores of control conditions: ^a*n* = 171, *M* = 5.28, *SD* = 2.43; ^b*n* = 186, *M* = 5.55, *SD* = 2.64; ^c*n* = 187, *M* = 5.56, *SD* = 2.43; CI = confidence interval; *LB* = lower bound; *UB* = upper bound

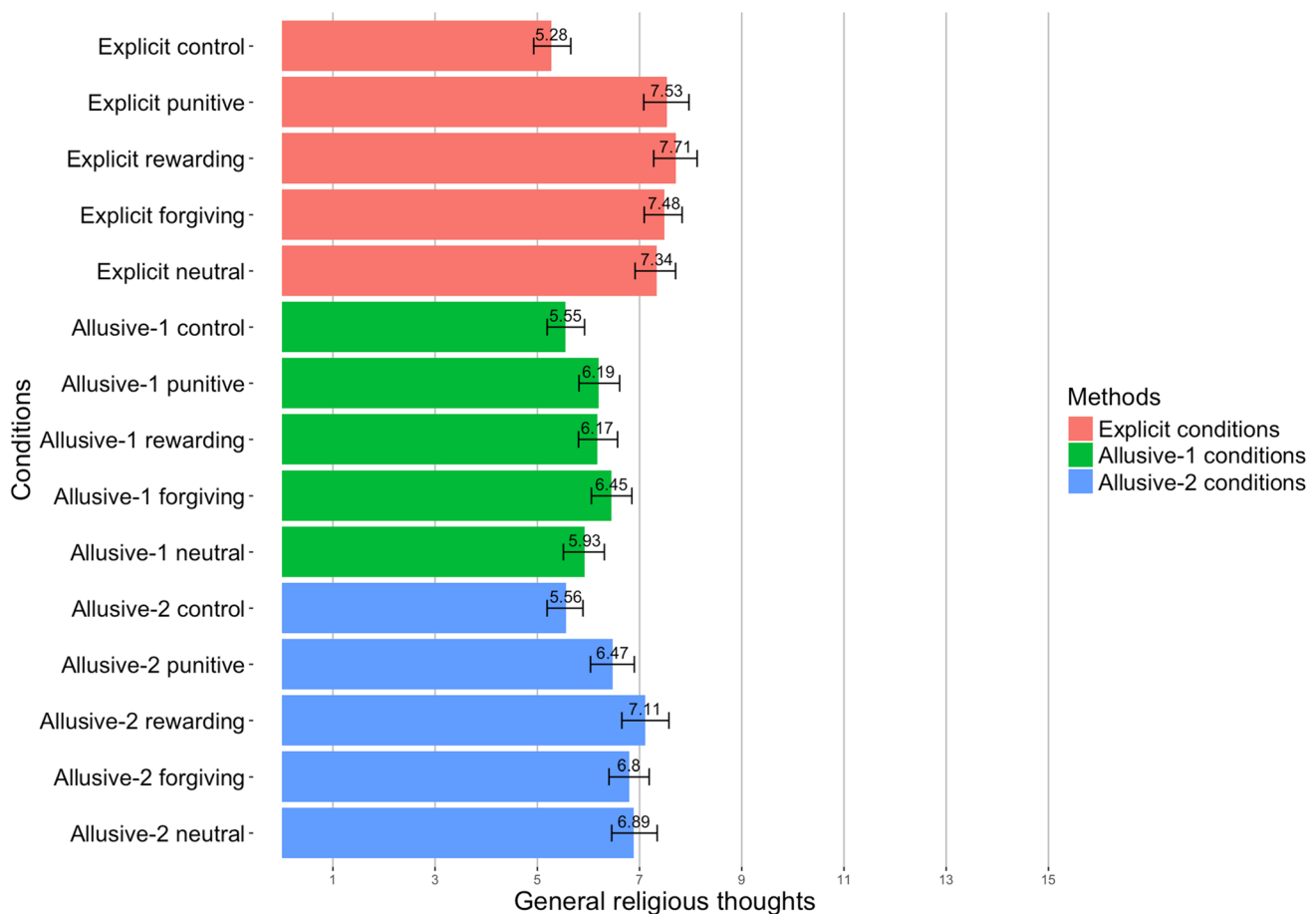
conditions in the same method (i.e., rewarding, forgiving, neutral, and control). Accessibility of punitive religious thoughts was significantly higher in the explicit punitive condition (*M* = 2.03, *SD* = 1.20) only compared to the explicit control (*M* = 1.37, *SD* = 1.01, *p* < .001). Punitive religious thoughts were found to be more salient in the allusive-2 punitive condition (*M* = 1.83, *SD* = 1.22) than the allusive-2 control condition (*M* = 1.43, *SD* = 0.90, *p* = .023). On the other hand, the allusive-1 punitive manipulation (*M* = 1.64, *SD* = 1.08) did not increase punitive religious thoughts compared to allusive-1 control condition (*M* = 1.48, *SD* = 0.94, *p* = .987); Fig. 4 indicates the mean punitive religious thought scores across control and all priming conditions.

In Hypothesis 3, we hypothesized that rewarding and forgiving religious primes would increase the saliency of benevolent religious thoughts compared to other groups. A one-way ANOVA model showed that benevolent religious thought significantly differed across 15 conditions ($F(14, 2755) = 6.49$, $p < .001$, $\eta^2_p = .032$). Post hoc analyses were conducted using Tukey's HSD test. Results for rewarding religious manipulations showed that explicit rewarding manipulation (*M* = 2.70, *SD* = 1.22) significantly affected benevolent religious thought compared to the explicit control condition (*M* = 2.07, *SD* = 1.03, *p* < .001). Allusive-2 rewarding was (*M* = 2.64,

SD = 1.23) significantly higher in benevolent thought than allusive-2 control condition (*M* = 2.18, *SD* = 1.11, *p* = .006). Among forgiving religious manipulations, only explicit forgiving (*M* = 2.7, *SD* = 1.08) increased benevolent religious thought compared to the explicit control condition (*p* < .001); forgiving religious priming in allusive-1 (*M* = 2.4, *SD* = 1.15) and allusive-2 (*M* = 2.44, *SD* = 1.1) failed to significantly affect the saliency of benevolent religious thoughts compared to their control conditions (*p* = .672 and *p* = .625, respectively). Figure 5 summarizes these results.

In Hypothesis 4, we predicted that explicit priming conditions would increase socially desirable responses, but this effect would not be observed with allusive primes. To test this, we conducted three one-way ANOVAs for each priming method, using the total scores from the BIDR-16 as the dependent variable. The results showed that the total BIDR-16 scores were not significantly influenced by either explicit primes ($F(4, 878) = 1.596$, *p* = .173) or by the allusive primes (allusive-1: $F(4, 929) = 1.603$, *p* = .172; allusive-2: $F(4, 948) = 1.010$, *p* = .401) when compared to their respective control groups.

Further analyses examined the BIDR-16 Self-deceptive Enhancement and Impression Management subscales using six ANOVAs with a Bonferroni-corrected threshold



Note. Error bars represent 95% confidence intervals

Fig. 3 The mean scores of general religious thoughts in WCT across the conditions

of $p = .008$. For Self-deceptive Enhancement. Explicit primes ($F(4, 878) = 1.135, p = .339$) or allusive-2 primes did not have a significant effect ($F(4, 948) = .434, p = .784$). The allusive-1 effect was not significant at the corrected threshold ($F(4, 929) = 2.495, p = .042$). Similarly, Impression Management did not differ across prime categories within explicit ($F(4, 878) = 1.585, p = .176$), allusive-1 ($F(4, 929) = .737, p = .567$), and allusive-2 conditions ($F(4, 948) = 1.896, p = .109$).

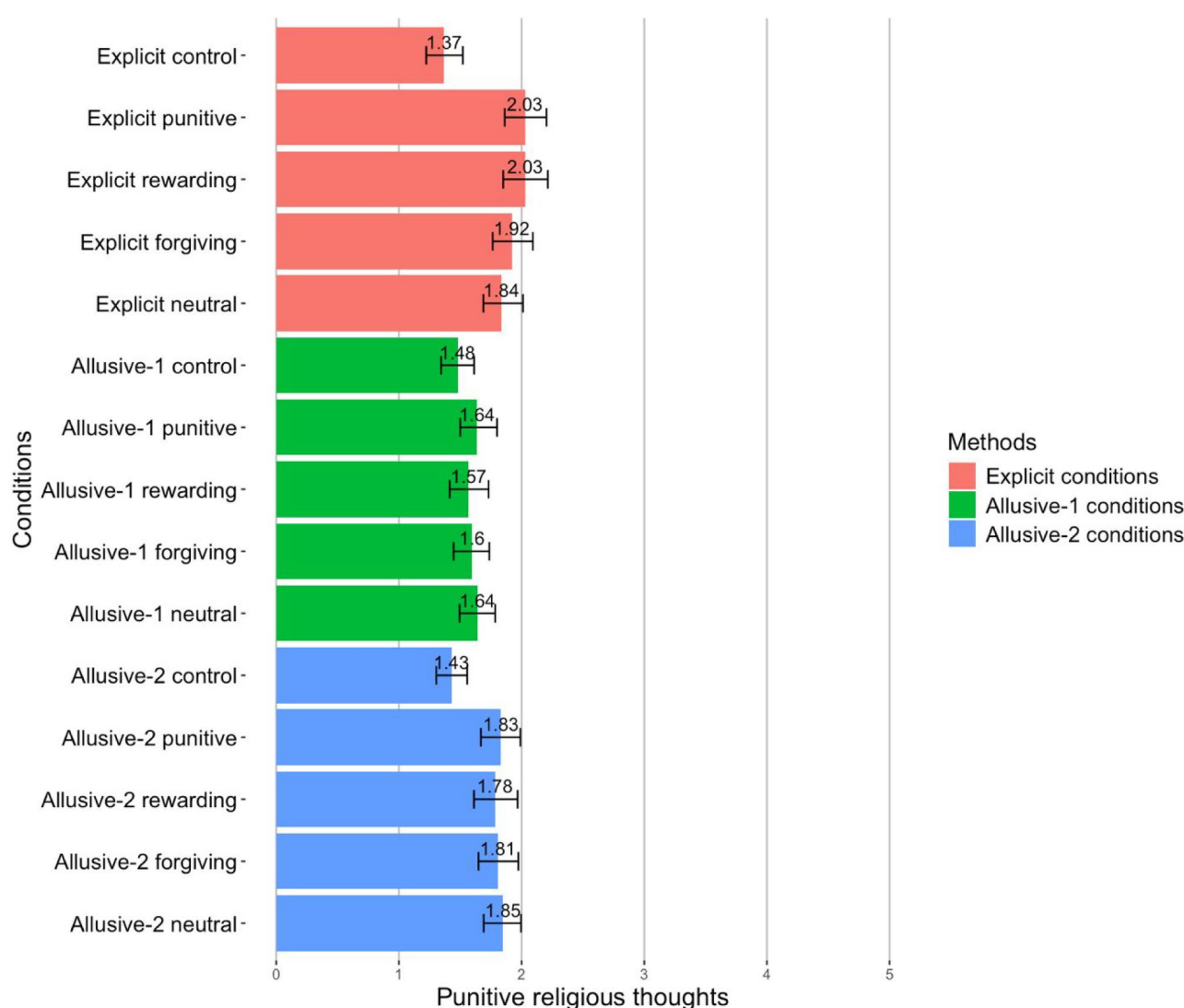
Therefore, our results did not support Hypothesis 4. Consequently, we conducted further analyses using suspicion probe questions to examine the potential effects of social desirability. These findings are detailed in the Exploratory Analyses section below.

In H5, we predicted that religious priming in general would increase generosity compared to the control groups. And in H6, we predicted that punitive religious primes would increase generosity compared to other groups. For H5, a one-way ANOVA model of 15 conditions revealed that generosity did not significantly differ

across 15 conditions ($F(14, 2755) = 1.10, p = .352$; see Fig. S2). Since participants' DG responses tended to be at the midpoint of 25 cents (42.6% of participants), we conducted a follow-up ordinal regression analysis by categorizing DG responses into three levels (below, at, and above the midpoint). The null findings were replicated (see Analysis S1). For H6, we conducted a post-hoc analysis with Tukey's HSD test over the ANOVA model to detect if generosity has changed in punitive primes compared to the rest of the conditions. Results showed that generosity scores in none of the punitive priming methods (explicit, allusive-1 and -2) significantly differed from the other conditions (all $ps > .291$).

Exploratory analyses

To examine which manipulation method had the strongest effect in priming religious thought, we compared the effects of the different priming manipulations by running a linear regression model, with manipulation type (explicit,



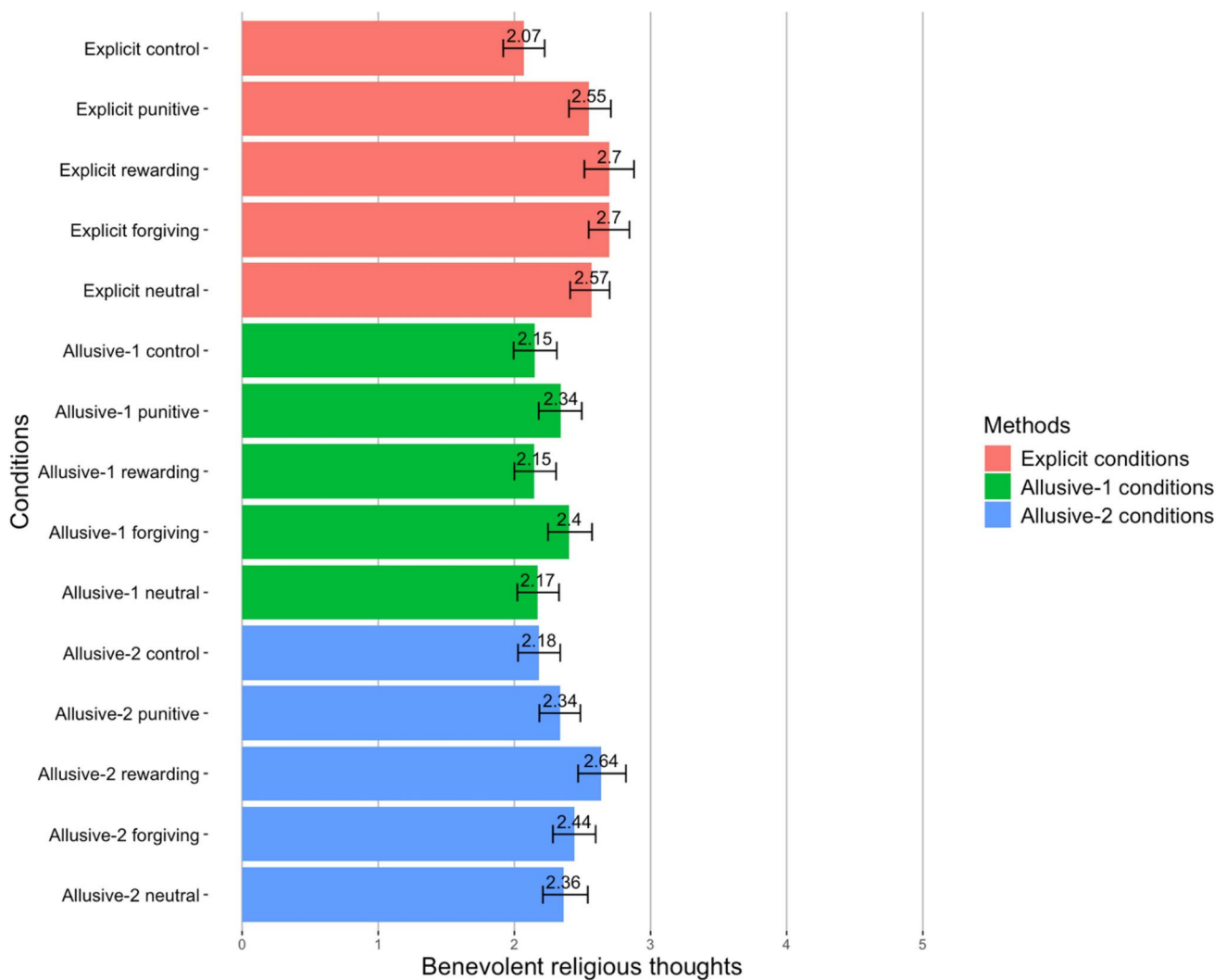
Note. Error bars represent 95% confidence intervals

Fig. 4 The mean scores of punitive religious thoughts in WCT across the conditions

allusive-1, allusive-2) and a binary condition type indicator (neutral, punitive, rewarding, forgiving versus control) as predictors. Given that allusive-1 did not have statistically significant effects, we chose allusive-2 as the baseline, as we were interested in how it compared to explicit and allusive-1. Interaction terms between manipulation and condition type tested whether the effect of each manipulation differed relative to its control. Results showed that relative to allusive-2, allusive-1 manipulation showed a smaller increase in religious thought, but this difference was not statistically significant ($B = -0.62$, $SE = 0.33$, $p = .057$). Explicit priming method had a significantly greater increase in religious thought than allusive-2 ($B = 0.98$, $SE = 0.33$, $p = .003$) and it also exceeded allusive-1 ($B = 1.60$, $SE = 0.33$, $p < .001$; see

Table S5 for model coefficients). Overall, explicit priming showed the strongest effect relative to its control, followed by allusive-2 and allusive-1.

Suspicion probes We asked participants: “What do you think about the aim of the study?” to see whether participants figured out they were being primed. Responses were coded as 0 if the aim of the study was not correctly guessed. In other words, we coded the answers as 0 if the participants did not imply a causal link between the CAPTCHA shown in the beginning and word completion or dictator game behavior in their answers. Answers were coded as 1 only if the answer indicated an understanding of the manipulation’s purpose. This method allowed us to gauge



Note. Error bars represent 95% confidence intervals

Fig. 5 The mean scores of benevolent religious thoughts in WCT across the conditions

Table 3 Frequencies of participants who reported awareness of manipulation in the suspicion probes

Condition	Understood the manipulation (with %)	Did not understand the manipulation (with %)
Explicit	105 (11.2%)	826 (88.8%)
Allusive-1	45 (4.6%)	934 (95.4%)
Allusive-2	62 (6.3%)	984 (93.7%)

which manipulation technique may be more susceptible to demand characteristics. Frequencies are presented in Table 3. We ran three chi-square tests to compare suspicion probe scores across conditions. Results revealed that the participants in the explicit priming condition understood

the aim of the manipulation more frequently than both allusive-1 ($\chi^2(1)=28.52, p<.001$) and allusive-2 ($\chi^2(1)=14.27, p<.001$). Allusive-1 and -2 did not significantly differ from each other ($\chi^2(1)=2.44, p=.110$), indicating that explicit primes may suffer from social desirability compared to the allusive primes.

Religious practice Due to the small cell sizes in each prime and each category of religious practice (public, private, public and private, none; see Table S4), we conducted exploratory analyses with two subgroups: those who practice religious activities publicly and privately, and those who do not practice at all. Participants who practiced only publicly, only privately, or preferred not to say were excluded from the analyses. The moderation analyses were conducted

separately for each religious manipulation method (explicit, allusive-1, and allusive-2). Before examining the moderating role of religious practice on the effects of priming methods on religious thought, a Bonferroni correction was employed to reduce type I error rate. Given the five conditions within each method and the division into religious practicing and non-practicing groups, each moderation analysis involved 10 comparisons. Therefore, the p value of .05 was divided by 10 ($\alpha_{\text{adjusted}} = .05/10 = .005$). Thus, a p value should be $p < .005$ to determine if the priming methods and religious practice are significantly interacting.

Three different 5 (punitive, rewarding, forgiving, neutral, or control) $\times$ 2 (practicing or non-practicing) two-way ANOVA analyses were run for each manipulation method (explicit, allusive-1, or allusive-2) while considering the general religious thought score as the dependent variable. Overall interaction between religious priming conditions and religious practice was not significant in any of the priming methods (interaction in explicit method ($F(4, 602) = 1.19$, $p = .315$, $\eta^2_p = .008$), interaction in allusive-1 ($F(4, 631) = 2.63$, $p = .034$, $\eta^2_p = .016$), interaction in allusive-2 ($F(4, 651) = 1.01$, $p = .401$, $\eta^2_p = .006$)). However, post hoc pairwise comparisons using the Tukey test showed differences between groups. Among explicit priming conditions, rewarding manipulations enhanced the saliency of religious thought more among participants who practice both private and public religious activities ($M = 8.20$, $SE = 0.30$) compared to non-practicing participants ($M = 6.77$, $SE = 0.40$, $p = .004$). Similarly, the religious thought score of practicing participants ($M = 7.95$, $SE = 0.28$) was higher than those of non-practicing ($M = 6.05$, $SE = 0.42$, $p < .001$) in the explicit forgiving condition. Furthermore, among allusive-1 conditions, forgiving manipulation primed religious thought more effectively among practicing participants ($M = 7.22$, $SE = 0.29$) compared to non-practicing participants ($M = 4.75$, $SE = 0.42$, $p < .001$), and there was a difference between practicing participants ($M = 5.93$, $SE = 0.28$) and non-practicing participants ($M = 4.54$, $SE = 0.39$, $p = .004$) in the control condition. Conversely, allusive-2 punitive manipulation increased religious thought scores more in practicing participants ($M = 6.78$, $SE = 0.29$) than in non-practicing participants ($M = 5.11$, $SE = 0.41$, $p < .001$). We also conducted the same interaction analyses on generosity; however, none of the interactions for any of the experimental methods were significant (all $ps > .110$).

Discussion

In this study, we developed a religious priming technique that effectively activates the intended psychological constructs while minimizing demand characteristics. Through a preliminary study with Christian participants, we selected

materials that demonstrated strong relevance to religious themes. From these materials, we developed two novel priming methods—allusive-1 and allusive-2—designed to prime distinct aspects of religion (e.g., punitive, rewarding, forgiving). In the main study, we evaluated the construct validity of these techniques. Results indicated that the allusive-2 technique significantly increased the completion of religious words compared to the control condition. Furthermore, punitive and rewarding allusive-2 primes selectively enhanced religious word completion in their respective categories, whereas the forgiving prime did not show a comparable effect. Exploratory analyses also suggested that the allusive primes in general may induce fewer demand effects than explicit primes: although all priming methods similarly influenced socially desirable responding, participants exposed to allusive primes were less likely to discern the true purpose of the study. This indicates the promise of allusive techniques as lower-demand alternatives. However, despite successfully increasing the salience of religious thoughts, the explicit and allusive-2 primes did not successfully increase prosociality.

To assess our first three hypotheses and the construct validity of our priming methods, we analyzed participants' completions in the Word Completion Task following the prime conditions. Both explicit and allusive-2 primes led to a significant increase in religious word completions relative to control groups, partially supporting Hypotheses 1, 2, and 3. These results affirm that both the explicit prime and the newly developed allusive-2 technique effectively heightened religious cognitive accessibility. Further analyses revealed that the explicit prime exerted the strongest influence. Allusive-2 did not significantly differ from allusive-1 in manipulation strength, despite the fact that allusive-2 differentiated from control while allusive-1 did not. Whether these differences reflect true variation in priming efficacy or are partly attributable to heightened demand effects in explicit conditions remains an open question, emphasizing the need to evaluate potential social desirability biases.

In Hypothesis 4, we predicted that explicit priming would elevate socially desirable responding, whereas allusive primes would not. However, the tendency for social desirability measured by BIDR-16 did not significantly differ across conditions. Two considerations temper this null finding: first, the BIDR-16 was administered after the WCT rather than immediately following the prime, possibly allowing any priming effects to dissipate. Second, the BIDR-16 may be assessing relatively stable individual differences, which may be less susceptible to subtle, short-term manipulations. Thus, the absence of priming effects on BIDR-16 scores does not necessarily undermine the validity of the priming techniques.

Analyses on suspicion probes revealed that participants in both allusive conditions were less aware of the study's

purpose than those in the explicit prime condition, consistent with previous findings that explicit primes may evoke greater demand characteristics (Billingsley et al., 2018). However, although awareness was reduced in allusive conditions, it was not eliminated, suggesting that even subtle primes can introduce some demand awareness. Nonetheless, the relatively lower awareness observed supports the utility of CAPTCHA-based allusive priming as a promising alternative to traditional explicit techniques.

We hypothesized that religious primes in general (H5) and punitive primes specifically (H6) would increase generosity in the DG relative to control conditions, in line with the SMH and the SPH. However, no significant effects were observed. Several factors may account for the absence of prosocial effects. First, because the primary aim was to validate primes, participants engaged in the DG after completing the WCT, which may have weakened priming effects. Additionally, the WCT itself might have inadvertently influenced DG outcomes by potentially activating unwanted cognitive states, such as verbal processing or reflective thinking. Second, generosity typically shows weaker associations with religiosity compared to other prosocial behaviors, such as charitable giving or volunteering (Kelly et al., 2024), possibly limiting detectable effects. Future studies could address these alternative explanations by employing alternative behavioral measures such as charitable giving.

Religious practice did not moderate total word completion across all primes. However, subgroup analyses indicated nuanced effects. Practicing Christians showed higher religious word completion in response to forgiving and rewarding explicit primes and to punitive allusive-2 primes compared to non-practicing participants. Although it was not uniform across different types (explicit vs. allusive) and categories of primes (punitive, rewarding, forgiving, neutral), these findings suggest that religious practice may moderate the effectiveness of religious priming, warranting further investigation in future research.

Strengths and limitations

Our study directly addresses the construct validity issues that have long challenged religious priming research. To our knowledge, no previous research has systematically validated religious priming techniques to this extent, despite their widespread use. Our study had a rigorous methodological framework. We adopted a bottom-up approach—first selecting stimuli based on perceived religious relevance, then validating their effectiveness with a behavioral measure—to develop an effective experimental manipulation technique. Unlike many prior studies that suffered from small samples and limited statistical power (Shariff et al.,

2016), our design prioritized methodological rigor. By pre-registering and achieving enough statistical power to detect smaller effect sizes, we enhanced the transparency and robustness of our findings.

Our findings indicate that the allusive-2 technique successfully enhances religious cognitive accessibility while reducing demand effects, offering a flexible tool for future research. The CAPTCHA primes can be further improved to reduce participant awareness by being presented before or after a neutral CAPTCHA. Beyond religious cognition, this technique can be adapted to prime various concepts, including secular authority, opening new avenues across psychological domains. The CAPTCHA primes can be implemented to any online context, enabling easy and subtle practical applications.

Despite its promise, allusive-1 did not significantly increase religious thought saliency across all conditions. This finding is particularly interesting given that the sentences used in the explicit and allusive-1 primes were the same, and these sentences were employed across various studies showing religious prosociality effects (e.g., Pasek et al., 2023). This suggests that the effects stem from the way these sentences are employed rather than their content. The explicit prime prompted participants to reflect on these sentences, while allusive-2 required participants to reflect on the meanings of words and images briefly. Allusive-1 might have failed because participants who received the prime did not process the information as deeply as participants in the other conditions. In allusive-1, we intentionally asked participants to select the squares that *do not* include any legible text. While we aimed to minimize their awareness, this might have resulted in participants not paying sufficient attention to the prime material, that is, the sentences. This technique might be improved by requesting participants to select the squares that *do* contain legible text. Another potential limitation of this prime may be the visual embedded within the CAPTCHA. An image with stronger religious connotations might improve the effectiveness of allusive-1.

Several limitations must be acknowledged. Because we recruited exclusively Christian participants from the United States—a WEIRD (Western, Educated, Industrialized, Rich, and Democratic) sample (Henrich et al., 2010)—the generalizability of our findings to other religious or cultural groups remains uncertain. The images used in allusive-2 will almost certainly require adaptations in other religious and cultural contexts. Additionally, our prioritization of prime validation necessitated administering the WCT before outcome measures like the dictator game and BIDR-16, potentially weakening causal inferences regarding prosociality and social desirability. Future studies should consider alternative designs to assess behavioral outcomes following priming directly.

Another limitation concerns the mode of administration: the CAPTCHA-based primes are inherently digital, restricting their applicability to computer-based environments. Although this limits generalizability in populations with low internet access, it aligns well with the growing prevalence of online psychological research in WEIRD contexts. Future adaptations might extend these techniques to virtual reality environments to enhance ecological validity. Despite these limitations, our study provides a much-needed methodological advance in religious priming research. Given the increasing reliance on online research platforms, the development of reliable, low-demand religious priming methods is both timely and essential.

Conclusion

Although religious priming methods have been widely used for nearly two decades, systematic validation efforts have been largely absent, contributing to the broader validity crisis facing psychological science (Chester & Lasko, 2021; Flake et al., 2022; Schimmack, 2021; Vazire et al., 2022). This methodological gap has slowed theoretical and empirical progress, and concerns over the reliability of religious priming effects have contributed to a decline in research activity in recent years.

In response, this study systematically developed and validated a novel religious priming technique that addresses longstanding concerns about construct validity and demand effects. Beyond contributing to the religious priming literature, the method introduced here offers a flexible and adaptable approach to activating a range of psychological constructs without inducing overt demand effects. This work provides a foundation for more robust and replicable research in both religious cognition and broader areas of psychological science.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.3758/s13428-026-03147-1>.

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Data availability See the Open Practices Statement.

Code availability See the Open Practices Statement.

Declarations

Conflicts of interest/Competing interests The authors have no relevant financial or non-financial interests to disclose.

Ethics approval Ethical approval for the studies was received from Kadir Has University with protocol number: E-82741295–604.01.01–29719.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent for publication All participants agreed by signing a consent form that the data collected in this research would be published in an aggregated and anonymized form.

Open practices statement The data, code, and all materials used in this research are openly available at <https://osf.io/m2s7t> and <https://osf.io/7m5bn>.

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