

# Roman Catholic beliefs produce characteristic neural responses to moral dilemmas

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**This study provides exploratory evidence about how behavioral and neural responses to standard moral dilemmas are influenced by religious belief. Eleven Catholics and 13 Atheists (all female) judged 48 moral dilemmas. Differential neural activity between the two groups was found in precuneus and in prefrontal, frontal and temporal regions. Furthermore, a double dissociation showed that Catholics recruited different areas for deontological (precuneus; temporoparietal junction) and utilitarian moral judgments [dorsolateral prefrontal cortex (DLPFC); temporal poles], whereas Atheists did not (superior parietal gyrus for both types of judgment). Finally, we tested how both groups responded to personal and impersonal moral dilemmas: Catholics showed enhanced activity in DLPFC and posterior cingulate cortex during utilitarian moral judgments to impersonal moral dilemmas and enhanced responses in anterior cingulate cortex and superior temporal sulcus during deontological moral judgments to personal moral dilemmas. Our results indicate that moral judgment can be influenced by an acquired set of norms and conventions transmitted through religious indoctrination and practice. Catholic individuals may hold enhanced awareness of the incommensurability between two unequivocal doctrines of the Catholic belief set, triggered explicitly in a moral dilemma: *help and care in all circumstances—but thou shalt not kill*.**

**Keywords:** moral judgment; moral dilemmas; DLPFC; religion; moral emotions

## INTRODUCTION

*To put it crudely, does religion make people good [...], bad, or does it have no effect at all? [...] How could psychology not address such an important domain of belief, motivation, and action?*

(Bloom, 2012)

In standard moral dilemmas, a hypothetical agent has to decide whether to commit moral harm against a relatively minor number of people to save the lives of many. They were designed as ‘thought-experiments’ (Foot, 1967/1978) that include (or specifically exclude) particular morally relevant parameters (Thomson, 1976). As such, they provide an adequate means of experimental manipulation for the purpose of investigating, which parameters contribute most distinctively to the *moral judgment*, that is, the assessment an individual makes about the appropriateness of a moral transgression in a given situation (Greene *et al.*, 2001, 2004; Hauser *et al.*, 2007).

After more than a decade of neuroscientific research, the neural correlates of moral judgment are fairly well established [particularly, dorsolateral prefrontal cortex (DLPFC) and limbic system] (Greene, 2009; Moll and Schulkin, 2009). In addition, the importance of interindividual differences as potential mediators of moral judgment has been acknowledged and empirically addressed (e.g. Wang, 1996; Haidt and Graham, 2007; Bartels, 2008; Moore *et al.*, 2008, 2011; Fumagalli *et al.*, 2009, 2010; Graham *et al.*, 2009; Lombrozo, 2009; Bartels and Pizarro, 2011). However, evidence of the influence of

religious beliefs on moral judgment remains scarce, and results are inconclusive. Although some studies do find an effect of religiousness on moral judgment, others do not (Hauser *et al.*, 2007; Young and Saxe, 2009b; Fumagalli *et al.*, 2009, 2010). As stated by some of these authors, such inconclusive findings may be due to the fact that participants’ religiousness was not explicitly controlled for in the selection process.

Based on the previous behavioral evidence of a differential moral judgment performed by Catholic and non-religious individuals (Christensen, Gut and Cela-Conde, submitted for publication), this study aims to explore how strong religious beliefs (using Catholicism as an example) influence the neural correlates of moral judgment of standard moral dilemmas.

## Diverging belief sets: Catholics and Atheists

Although religious and non-religious individuals are educated in the same moral values and rules of a society (Greene, 2008), we suggest that some values are more present in the reasoning of religious individuals (for a theoretical development of this point, see De Waal, 2010; discussed in Bloom, 2012). Of course, the difference may be due to individual thinking style, personality traits, particularly in the case of extreme religiousness, indoctrination or religious practices, although none of these options is exclusive. However, this discussion remains outside the scope of this article.

For the purpose of our study, we used the Roman Catholic confession as an example of a religious belief system, not aiming to make any specific assumptions about the Catholic confession in particular. Thus, we defined religiousness as an experimental variable with the potential to influence moral judgments of standard moral dilemmas (and underlying neural activity). We followed the Durkheimian approach that posits that a religious belief system is a unified system of principles and practices that ties a group of individuals into a *moral community* (Durkheim, 1912/2008; Haidt and Graham, 2007; Bloom, 2012). By definition, a religious community agrees on a number of rules about certain behaviors. Some are forbidden, whereas others are promoted as *morally good*. For the Roman Catholic belief system, the Bible designates such moral guidelines (e.g. Deuteronomy 5, pp. 4–21).

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The reasons for the selection of the Roman Catholic belief system are 3-fold (see the Supplementary Data for a more detailed discussion of the choice). In a nutshell, this belief system: (1) very clearly emphasizes the fusion of thought and action (Cohen and Rozin, 2001). This may enhance feelings of conflict in Catholics about the *action* in a dilemma, even though they merely *think* about it. This becomes relevant because a moral dilemma task is a ‘thought experiment’; (2) very explicitly emphasizes the individual as a creature who must feel overtly guilty for sinful actions; and (3) explicitly involves an appeal for charity and empathy for others.

These three points are reflected in moral dilemmas as follows. Each moral dilemma proposes to *help* a group of people, saving them from death [an endeavor encouraged by the Catholic belief system (point 3)]. However, it also implies *inflicting pain* and extreme suffering (i.e. death) on another individual [promoting guilt (point 2)]. Catholics are prone to be more aware of this conflict (point 1) than are Atheists, because these two trails of action are explicitly supported by their belief system.

### Five foundations of morality: emphasis on *harm/care* and *purity/sanctity*

The parameters manipulated in moral dilemma tasks are said to trigger the expression of basic human moral intuitions (Nichols and Mallon, 2006; Hauser *et al.*, 2007; Nichols and Knobe, 2007; Nichols and Ulatowski, 2007). A well-known model in this domain is the Dual Process Hypothesis of Moral Judgment (DPHMJ), which proposes that up-close and personal harm trigger fast, emotionally based responses, whereas responses to other types of harm, such as impersonal killing, are subject to more variation (Greene *et al.*, 2001, 2004). However, we believe that another model, the Five Foundations Theory (Haidt and Graham, 2007), better grasps the essence of differences between religious and Atheist individuals’ moral judgment. This theory holds that human evolutionary history has shaped five moral pillars as cognitive bases of our moral behavior: (i) *harm/care*, (ii) *fairness/reciprocity*, (iii) *ingroup loyalty*, (iv) *authority/respect* and (v) *purity/sanctity*. These pillars relate to the standard moral dilemmas used in this study (see Figure 1 for examples) in the following way: They all involve killing in situations of inequity. The choice to be made always involves approving to kill an innocent party to save a larger number of individuals (utilitarian response). Alternatively, the participant can choose not to save the threatened individuals at the price of killing somebody (deontological response). Haidt and Graham (2010) advocated that this moral controversy is related to the feeling of *disgust*. According to this theory, disgust is a motivational force helping to keep away from what is (socially) bad, by triggering the cognitive processes related to *purity/sanctity*. The authors held that this foundational pillar is the basis of religious belief systems—the members of a particular confession agree on rules, values and conventions about what is good and bad. Other individuals of the same society/culture, not belonging to the religious community, may share these values (Greene, 2008). What differs is the explicitness with which they are present in a religious belief set (Haidt, 2007); ‘... religion has its effects, at least in part, through the substantive claims that it makes about what is right and what is wrong’ (Bloom, 2012, p. 195). Accordingly, we propose that religious indoctrination results in a belief set that promotes enhancement of the emotions related to the violation of the moral intuition of (i) *purity/sanctity* (avoidance of *bad* behavior) and (ii) *harm and care* (promotion of *good* behavior).

### Hypotheses

Catholic and Atheist individuals are expected to differ in the subjective evaluations they make of moral dilemmas. Catholics will constitute a

particularly *deontological* group, preferring to refrain from harming, whereas Atheist individuals’ cost-benefit considerations will make their moral judgments more *utilitarian*.

We do not expect our Catholic participants to make *only* deontological moral judgments. However, we hypothesize that the different moral judgments (deontological or utilitarian) will have different neural underpinnings in Catholics compared with Atheist individuals. Differential neural activity is expected to be found in (i) regions related to the representation of rules and social norms and (ii) regions that encode moral emotions (e.g. guilt), conflict and perspective taking for other individuals [Theory of Mind (ToM), empathy].

## METHODS

### Participants

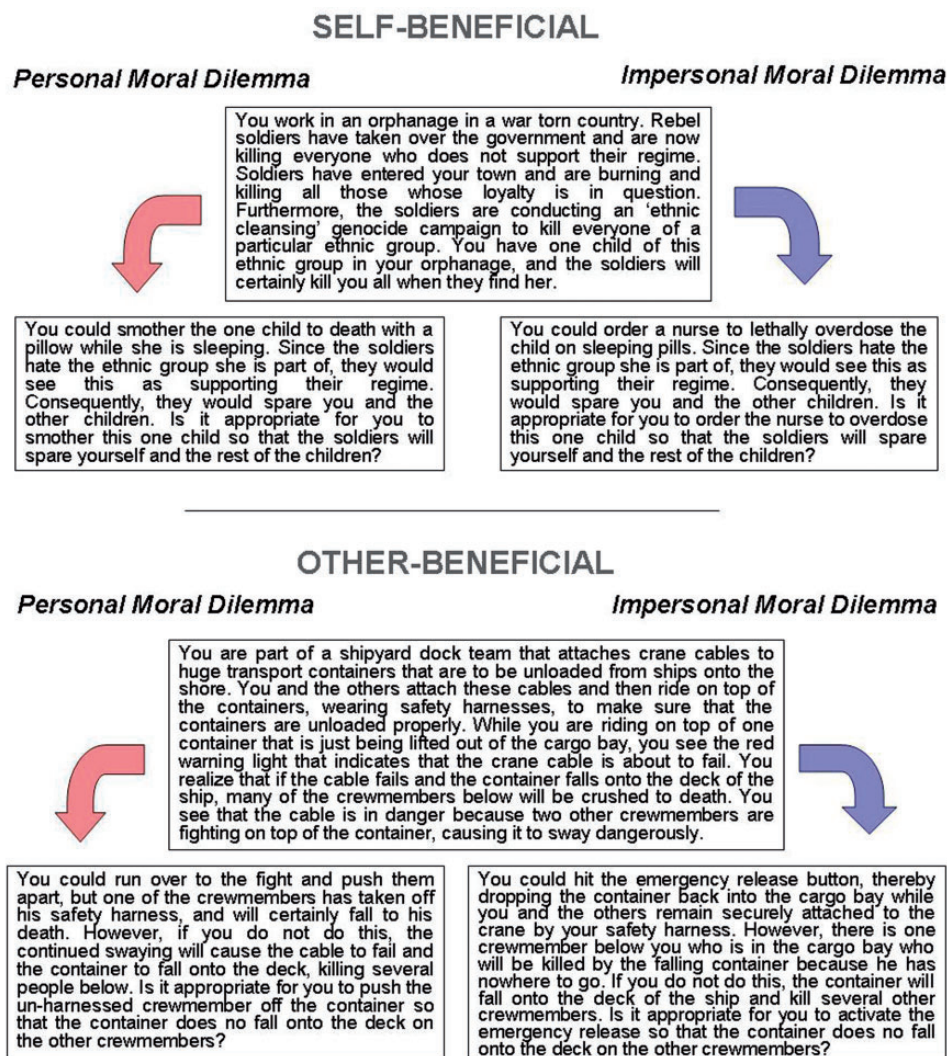
A total of 25 right-handed female participants took part in the study, 13 Atheists and 12 Catholics (see Supplementary Data). Data from one Catholic participant were excluded due to technical problems during data collection. All participants had normal or corrected-to-normal vision. Participants reported no history of psychiatric or neurological disorders. All participants were university students or former university students (within 1 year from graduation) and native Spanish speakers. The experiment was approved by the University’s Ethical Committee, and all participants gave their informed consent before participation.

### Control of participant characteristics

- (1) Participants were classified into two groups—Catholics and Atheists—according to their scores in the *Royal Free Interview for Spiritual and Religious Beliefs* (King *et al.*, 2001)—see Supplementary Data for details of the questionnaire. The questionnaire assesses different aspects of religiousness, allowing us to ensure that the Catholic individuals showed (i) a stronger awareness of their actions (e.g. they held a ‘strong religious view of life’), (ii) an enhanced awareness of the rules of their religious value system (e.g. they considered ‘the practice of their belief in their daily life’ to be important) and (iii) a strong awareness of some external entity supervising their actions (e.g. they believed in ‘a spiritual power other than themselves that can influence the course of events’). All three components were crucial to the assumptions of our hypotheses regarding the sociocognitive components: *perspective taking* of other individuals [i.e. (i)], the *representation of rules and social conventions* of their religious value system [i.e. (ii)] and of *moral emotions* [i.e. (iii)].

Participants were recruited from the university community, religious youth clubs and local churches. We specifically did not include ‘professional’ religious participants (nuns, monks, priests, etc.) because this would have made our groups unequal in terms of life style and experience.

- (2) As one of our hypotheses involved assumptions about brain activation related to emotions and empathy, participants were assessed in three standard empathy measures (Mehrabian and Epstein, 1972; Davis, 1983; Baron-Cohen and Wheelwright, 2004) to ensure that they did not differ with respect to their level of empathy (see Supplementary Data). Thus, differences in brain activity observed in emotion-processing networks could more reliably be attributed to the religious belief set than to interpersonal differences in empathy levels.
- (3) Individuals’ so-called Thinking Style has lately been found to influence moral judgment of moral dilemmas (e.g. Bartels, 2008). Therefore, in a postexperiment session, participants were invited to complete the extensively used *Need for Cognition Scale* (Cacioppo *et al.*, 1984). This scale measures whether an individual



**Fig. 1** Examples of personal and impersonal versions of two dilemmas. The *Orphanage* dilemma is a *self-beneficial* and *instrumental* moral dilemma, whereas the *On the Waterfront* dilemma is an *other-beneficial* and *accidental death* moral dilemma. *Self-beneficiency* is indicated by the fact that the proposed moral transgression involves that the protagonist's life is also saved, as opposed to the case where the transgression does not imply any direct benefit to the protagonist. The *Instrumentality* of a transgression is designated by the fact that the protagonist uses the victim's body in a certain way to save others (i.e. *harm as a means*). Conversely, *accidental harm* means that the victim dies as a *undesired side effect* of the act of saving the other individuals. See also Christensen and Gomila (2012) for further clarifications on moral dilemma conceptualization.

enjoys and often engages in deliberate reasoning about problems. Thus, the score of this instrument indicates an individual's thinking style when faced with a complex problem. Seventeen of the 24 participants responded to our call (9 Catholics and 10 Atheists). Results showed that there was no significant group difference in the Thinking Style scores (see Supplementary Data). This enabled us to conclude that any effects of differences between the two groups would at least not be due to differences in general Thinking Style between the groups. See Table 1 for a summary of participant characteristics.

## Materials and procedures

### Stimuli—the dilemmas

We used a total of 48 standard moral dilemmas and 4 practice dilemmas. The dilemmas were partly those originally used by Greene et al. (2001, 2004) and optimized by Moore et al. (2008), and partly a number of additional stimuli that were created by the latter authors (Moore et al., 2008). There were 24 *personal* moral dilemmas (PMD)

and 24 *impersonal* moral dilemmas (IMD). In each of these 2 categories, 12 of the 24 scenarios were *self-beneficial* and 12 were *other-beneficial* dilemmas. Among the dilemmas, some were scenarios with *accidental harm* (10 dilemmas: 5 personal and 5 impersonal) and some with *instrumental harm* (22 dilemmas: 11 personal and 11 impersonal). For a detailed description of the rationale behind the dilemma classification, see the Supplementary Data. Dilemma examples appear in Figure 1.

### Procedure

Experimental sessions took place at the Hospital *Clinica Rotger*, Palma (Spain). After providing informed consent and completing the questionnaires regarding demographic data, religious affiliation and strength of religious belief, task instructions were given. The participants responded to the empathy questionnaires after the scanning session.

Dilemma presentation largely followed the procedure by Greene et al. (2001). Dilemmas were presented written on three subsequent



**Table 1** Participant characteristics

	Catholics		Atheists	
	Mean	s.d.	Mean	s.d.
Age	23.82	3.31	23.21	3.62
Religiousness score (education)	41.64 (student)	11.10	0 (student)	0
Empathy scores				
The Questionnaire of Emotional Empathy (Mehrabian & Epstein, 1972)	49.80	6.29	29.75	10.31
The Interpersonal Reactivity Index (Davis, 1983)	46.60	2.41	42.17	1.874
The Empathy Quotient (Baron-Cohen & Wheelwright, 2004)	46.20	2.36	44.75	3.62

black screens, followed by an interstimulus interval (a black screen with a fixation cross), which lasted for 14 s. Participants read the dilemma advancing from screen to screen by pressing a button of the response grip. The third screen presented the moral transgression. Participants were informed that they would be given a maximum of 46 s to read and respond to all three screens; 20 s for the first, 16 s for the second and 10 s for the question. If too slow, a note would appear *Please try to read/answer faster*, and the next trial was launched (data from missed trials were discarded). Participants responded using a response grip button device (left or right, counterbalanced) to indicate whether they considered the proposed moral transgression to be appropriate (= *utilitarian* response) or inappropriate (= *deontological* response). Seven null events lasting the whole trial length ( $\approx 60$  s) were included to reduce stimulus onset predictability and to establish a baseline (Friston *et al.*, 1999). Presentation of events (trials and null) was randomized.

Four practice trials familiarized the participant with the procedure. The epochs obtained here were later discarded as dummy trials. See the Supplementary Data for further details.

# fMRI data acquisition

Functional images were acquired using a 1.5-T scanner (Siemens MAGNETOM Symphony). Blood oxygenation level dependence sensitive functional images were acquired using a single-shot gradient echo-planar imaging sequence (TR = 3700 ms, TE = 50 ms, field of view = 192 mm, matrix =  $64 \times 64$  and flip angle =  $90^\circ$ ). Each functional run consisted of 810 whole brain volumes comprising 36 transversal slices (voxel size  $3 \times 3 \times 3$  mm) axially aligned [anterior cingulate (AC)-posterior cingulate (PC)] with a gap between them of 0.75 mm. The acquisition was interleaved, bottom-up. An automatic shimming procedure was performed before each scanning session.

Following the experimental session, structural images were acquired sequence (TR/TE/TI inversion time 2140 ms/3.93 ms/1100 ms).

A full factorial design was created including the factors *Group* (Catholic vs Atheist), *Dilemma* (PMD vs IMD) and *Response* (appropriate vs inappropriate). We carried out three data examinations: (i) a whole-brain main effects analysis explored the average and main effects; (ii) a double dissociation informed of differential neural responses between the two groups for the two types of moral judgment: *utilitarian* (consenting harm) and *deontological* (refraining from harm); and (iii) an exploration using a priori established individual bilateral regions of interest (ROIs) masks [Wake Forest University Pickatlas tool; Maldjian *et al.*, 2003] informed of activity related to moral judgment and (a) learning processes—precuneus, cingulate cortex; (b) abstract reasoning processes, conflict and memory—DLPFC and temporal pole (TP); and (c) moral emotions (e.g. guilt) and perspective taking of other individuals (ToM,

empathy)—PFC and temporal regions such as insula, superior temporal sulcus (STS), and temporoparietal junction (TPJ).

For further details on the theoretical background of these ROI, see ‘Introduction’ section. The coordinates of the activated regions are reported according to the Montreal Neurological Institute (MNI) system.

# RESULTS

## Behavioral results

### Analysis 1: dilemma categories influence RT

To investigate the influence of the different types of dilemmas on the reaction time (RT) of our two experimental groups, we conducted a  $2 \times 2 \times 2 \times 2$  repeated measures mixed factorial analysis of variance (ANOVA) using the within-group factors *Personal Force* (impersonal vs personal), *Beneficiency* (self vs others) and *Evitability of Harm* (avoidable vs inevitable). *Religiousness* (Catholic vs Atheist) was the between-group factor [Table 2, repeated measures (RM) ANOVA—main effects on RT (personal force, beneficiency, evitability and religiousness) for the statistics of the analyses included in this section].

Participants’ RT to respond to the dilemmas depended largely on the dilemma category and on the between-group factor *Religiousness*. Both groups judged PMD faster than IMD (main effect:  $P = 0.002$ ). Moreover, the between-group factor *Religiousness* showed a trend effect on RT, indicating that Catholics were generally slower when making their moral judgment ( $p = 0.065$ ). Furthermore, there was a significant interaction between *Religiousness* and *Personal Force* regarding the time needed to respond to PMD and IMD ( $p = 0.025$ ). Follow-up independent *t*-tests confirmed that, specifically, the Catholic participants needed longer to respond to IMD than the Atheists ( $p = 0.018$ ). However, no such difference was found between the groups for PMD, see Table 2, tests to break down the interaction religiousness  $\times$  personal force.

None of the other within-group factors yielded significant main effects. However, there was a significant interaction of *Personal Force*  $\times$  *Beneficiency*  $\times$  *Evitability*  $\times$  *Religiousness*. See the Supplementary Data for further analyses.

### Analysis 2: religious individuals make more deontological moral judgments

A mixed ANOVA compared the two groups on the mean number of deontological and utilitarian responses they made in the two dilemma categories. Thus, the variables were number of PMD deontological responses, PMD utilitarian responses, IMD deontological responses and IMD Utilitarian responses. The Catholics made more deontological moral judgments than the Atheists, for whom utilitarian responses prevailed, irrespective of the type of dilemma, see Table 3 and Figure 2.

### Analysis 3: RT depends on the type of response and on religiousness

Subsequently, we conducted an item analysis (Greene *et al.*, 2001, 2004) to investigate whether the two groups differed in their RT when participants chose to make a utilitarian or a deontological moral judgment.

As we only found significant main effects for the factor *Personal Force* and *Religiousness* on the RT in our first analysis about the dilemma categories, we ignored the remaining dilemma categories hereafter. We conducted a  $2 \times 2 \times 2$  mixed repeated measures ANOVA with the factors *Type of Dilemma* (PMD vs IMD) and *Type of Response* (deontological vs utilitarian) as within-group factors and *Religiousness* (Religious vs Atheists) as the between-group factor.

**Table 2** Main effects on RT and tests to break down the interaction Religiousness  $\times$  Personal Force

	Mean	SE	F-test (1,22)	P	r
RM ANOVA—main effects on RT (personal force, beneficency, evitability and religiousness)					
Personal force					
Personal (PMD)	4432.14	149.29	11.903	.002	0.59
Impersonal (IMD)	4810.74	155.65			
Religiousness (between subjects)					
Catholics	4845.29	209.45	3.758	.065	0.38
Atheists	4345.59	192.67			
Interactions					
Religiousness $\times$ Personal Force <sup>a</sup>			5.764	.025	0.45
Force $\times$ Beneficency $\times$ Evitability $\times$ Religiousness <sup>b</sup>			6.661	.017	0.48
	Mean	SE	t-test (22)	P	r
Tests to break down the interaction religiousness $\times$ personal force					
Personal moral dilemmas					
PMD (Catholics)	4568.21	235.26	0.926	0.364	ns
PMD (Atheists)	4291.56	189.62			
Impersonal moral dilemmas					
IMD (Catholics)	5218.31	229.11	−2.567	0.018	0.48
IMD (Atheists)	4403.17	210.76			

Effects not described in this table (main effects of beneficency, evitability and other interactions) were not significant.

<sup>a</sup>See table 'Specific tests to break down Religiousness  $\times$  Personal Force interaction'.

<sup>b</sup>See tables 'RM ANOVA Catholics' and 'RM ANOVA Atheists'.

There was a significant main effect of the *Type of Response* on the RT ( $P=0.006$ ). In general, participants were faster when making a deontological moral judgment than when making a utilitarian one. There was also a significant main effect of *Religiousness*, indicating that Catholics and Atheists differed in their RT ( $P=0.029$ ). The interaction between the *Type of Response* given (deontological or utilitarian) and *Religiousness* showed a trend effect ( $P=0.07$ ), indicating that the time needed to make a certain type of judgment differed between Catholic and Atheist participants, see Table 4, RM ANOVA—main effects on RT (type of dilemma, type of response and religiousness).

To break down this interaction, we performed independent *t*-tests. We found that the two groups differed when making a utilitarian moral judgment ( $P=0.009$ ), but not when making a deontological one ( $P=0.209$ ); see Figure 3 and Table 4, specific tests to break down religiousness–type of response interaction effect on RT.

Finally, we examined the within-group differences between the RT of *deontological* and *utilitarian* moral judgments for each group separately. For the Atheists, there were no significant main effects on their RT either for the *Type of Dilemma* or the *Type of Response* (Table 5).

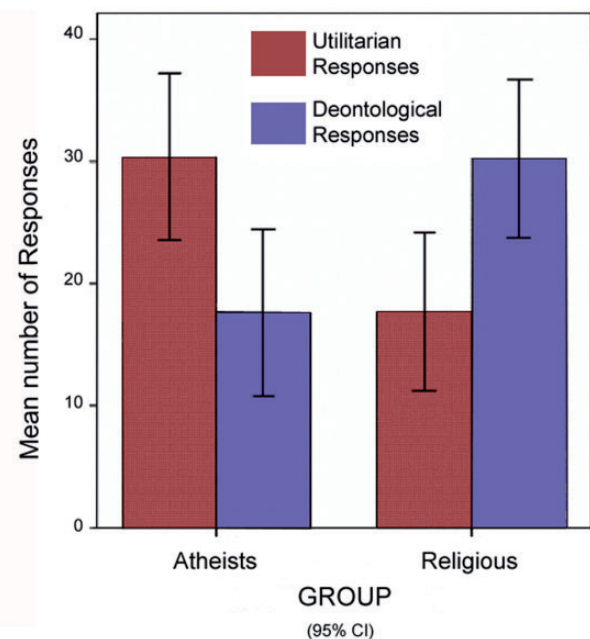
However, for the Catholics, there was a significant main effect of the *Type of Dilemma*, indicating that the difference between PMD and IMD affected Catholics' judgments ( $P=0.008$ ). Specifically, the time Catholics needed to judge a PMD was significantly shorter than when they judged an IMD ( $P=0.01$ ). See Table 6.

As this is an exploratory study, we decided to carry out a more detailed examination of the data to determine whether there might be an interaction trend of *Type of Dilemma* and the *Type of Response* given by the Catholic participants, in spite of the rather small sample size. *Post hoc t*-tests revealed that the time participants needed to make a *utilitarian* judgment of a PMD was significantly longer than when they made a *deontological* one ( $P=0.01$ ). However, for IMD, no such difference in RT was found, see Table 7.

**Table 3** Types of responses (ANOVA): Catholics vs Atheists

Type of dilemma	F-test (1,22)	P	r
PMD deontological response	9.247	0.006	0.54
PMD utilitarian response	9.247	0.006	0.54
IMD deontological response	5.927	0.023	0.45
IMD utilitarian response	5.927	0.023	0.45

See Figure 2.



**Fig. 2** The proportion of utilitarian and deontological ratings of the two groups of participants, irrespective of the type of dilemma. The Catholic participants judged the moral transgressions to be inappropriate more often than the atheist participants, who, conversely, preferred consenting harm.

## fMRI results

### Analysis 4: whole brain analysis

We carried out a whole brain analysis, looking for main effects. Differential activity was found between Catholics and Atheists. No other effects or interactions were found significant. Table 8 summarizes the results.

To break down the main effect of *Religiousness*, we carried out two *t*-contrasts: Catholics > Atheists and the reverse (Atheists > Catholics). Table 9 summarizes the results and Figure 4 illustrates them.

Enhanced activity in the Catholic participants was found in precuneus, posterior cingulate cortex (PCC), middle temporal pole and medial superior frontal gyri. Conversely, Atheists showed additional activation in superior parietal gyrus (SPG) (BA7).

### Analysis 5: differential brain activity between the two groups for deontological and utilitarian moral judgments

We carried out a double dissociation to test for differential brain activity between Catholics and Atheists when both groups carried out *deontological* or *utilitarian* moral judgments. The neuroimaging results showed that for *deontological* responses, Catholics recruited differentially (compared with atheists) the precuneus, STS–TPJ, precentral sulcus and parahippocampal gyrus. Conversely, for *utilitarian* responses, Catholics showed more activity in the DLPFC, the TP and

the precuneus than the atheists. However, Atheists only showed differential activity in the SPG (BA7), both when giving *utilitarian* and *deontological* responses. Figures 5 and 6 show uncorrected  $P < 0.001$  results with an extent threshold of  $k = 10$  voxels. The activation did not survive FWE correction.

**Table 4** Main effects and interactions for the factors type of dilemma, type of response, and religiousness, and tests to break down the interaction religiousness  $\times$  type of response

	Mean	SE	F-test (1,22)	P	r
RM ANOVA—main effects on RT (type of dilemma, type of response and religiousness)					
Type of dilemma			ns		
Type of response					
Deontological	4447.211	160.373	9.334	0.006	0.55
Utilitarian	4888.861	173.605			
Religiousness (between subjects)					
Catholics	5021.161	217.677	5.492	0.029	0.45
Atheists	4314.911	208.410			
Interactions					
Type of Response $\times$ Religiousness <sup>a</sup>			3.548	0.07	0.07
	Mean	SE	t-test (1,22)	P	r
Specific tests to break down religiousness $\times$ type of response interaction effect on RT					
Utilitarian responses					
Catholics	5378.133	250.794	−2.868	0.009	0.52
Atheists	4399.590	240.117			
Deontological responses					
Catholics	4664.190	231.679	−1.294	0.209	0.27
Atheists	4230.232	221.816			

No other main effects were significant.

<sup>a</sup>See Supplementary Table S3.

# **Analysis 6: deontological vs utilitarian moral judgments of PMD and IMD have different neural underpinnings in the two experimental groups**

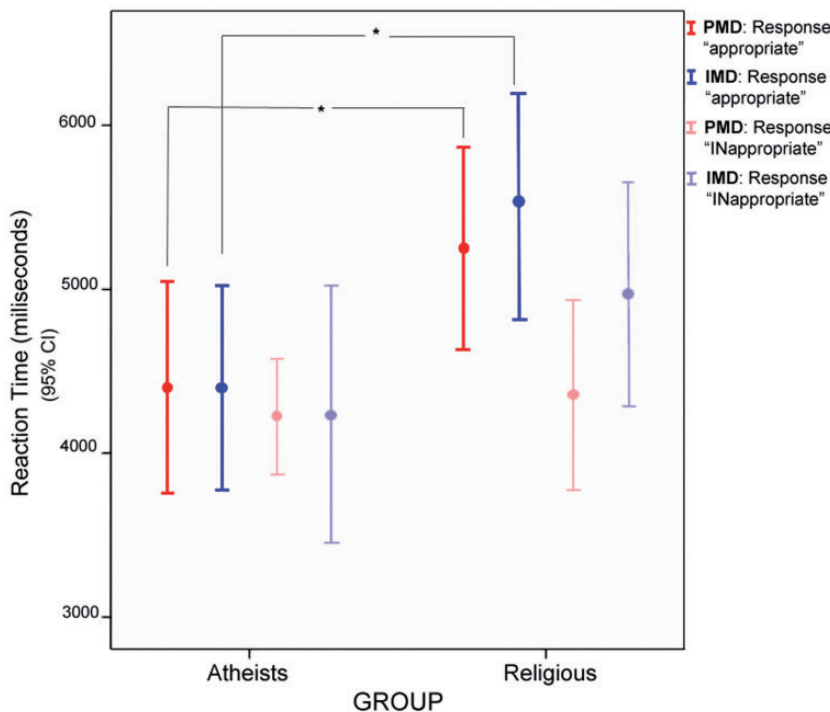
To test specific hypotheses regarding differential neural underpinnings between the groups during judgments of PMD and IMD, we performed planned contrasts on the ROIs established a priori by our hypotheses. These involved the cingulate cortex, insula, STS, TPJ, medial PFC and DLPFC.

We found that for *utilitarian* judgments of IMD, Catholics specifically recruited DLPFC and PCC (Figure 7), whereas the inverse contrast (differential activity of Atheists) yielded no suprathreshold effects. Furthermore, for *deontological* judgments of PMD, the Catholics selectively recruited left anterior cingulate cortex (ACC) and right STS (Figure 8). Neither the reverse nor any other comparisons yielded any suprathreshold effects. See Supplementary Data for an additional discussion of the neuroimaging results.

## **GENERAL DISCUSSION**

This study examined the influence of an individual's sentiments of religious affiliation on the neural activity observed during her moral judgment. Specifically, our hypotheses focused on the brain regions that have been previously associated with both moral judgment and the two aspects of the Roman Catholic belief system outlined in the introduction: *harm/care* and *purity/sanctity*.

At first glance, our behavioral results confirmed the DPHMJ (Greene *et al.*, 2001). However, when contrasting the groups, it became clear that *only* the assumption about the emotional saliency of PMD (and thus faster judgments to such dilemmas) held for both experimental groups. Conversely, *only* the Catholic group showed the difference of faster *deontological* than *utilitarian* moral judgments; moreover, Catholics were slower than Atheists in making any kind of moral judgment. Accordingly, we propose that our results question



**Fig. 3** Comparisons between the groups: particularly, when making a utilitarian moral judgment, the Catholic participants needed significantly more time than the atheists, irrespective of the type of dilemma. Conversely, participants of both groups needed approximately the same time for a deontological moral judgment. PMD = personal moral dilemmas; IMD = impersonal moral dilemmas.

the assumption of automaticity of deontological moral judgments of the DPHMJ—as they are modulated by an educationally acquired set of norms and conventions, for example, *Religiousness*.

Maybe this difference in findings is because Greene *et al.* (2001, 2004) did not control for *Religiousness*. We have tried to make sure that the experimental groups represented the extremes of a continuum between atheism and religiousness, present in the society the sample was drawn from. Thus, our sample was recruited in a Mediterranean coastal city in Spain, where religion is definitely part of the everyday life; yet, nowadays, the younger generations are rather free about the choice and strength of their religious beliefs. Therefore, our Catholic group contrasts very well with the atheist group. This issue clearly alerts (i) of the importance of controlling for participants' level of religiousness in studies with moral judgment tasks and maybe also (ii) of the value of taking cross-cultural research—particularly also on moral judgment—seriously (Henrich *et al.*, 2010).

Accordingly, we hold that our findings are more in accordance with the Five Foundations account by Haidt and Graham (2007); at least as are concerned the two foundations *harm/care* and *purity/sanctity*. The Roman Catholic belief system seems to have an enhancing effect on the

individual in aspects of moral dilemmas related to *harm* and *care*—a fact that is reflected both behaviorally and neurally in four instances:

- (1) For deontological moral judgments, the activations in precuneus and STS in Catholics suggest that such judgments might be related to an enhanced feeling of agency and to a conscious analysis of their actions and perspective taking over the whole situation (Cavanna and Trimble, 2006; Northoff *et al.*, 2006; Cavanna, 2007; Uddin *et al.*, 2007; Young and Koenigs, 2007; Young and Saxe, 2008, 2009a). This increased awareness of the situation and its outcome may have made them refrain from action. Conversely, Catholics' utilitarian moral judgments entrained enhanced activity in classical moral judgment regions: DLPFC, TP and precuneus (Greene and Haidt, 2002; Moll *et al.*, 2008a, 2008b; Moll and Schulkin, 2009). Altogether, with the increased RT found in this group, this activation may suggest that, in such cases, Catholics overrode a strong cognitive conflict: Importantly, the DLPFC has also been previously found to be particularly involved in (i) abstract reasoning processes (Miller and Cohen, 2001), (ii) the application of rules and event knowledge to morally ambiguous situations (Forbes and Grafman, 2010) and (iii) the resolution of moral dilemmas considered particularly *severe* by the individual (Hayashi *et al.*, 2010). The evidence reported here is also in accordance with another line of research that investigates the brain systems implied in deontic reasoning, that is, reasoning about rules that are considered mandatory by some kind of social contract. The medial portion of the DLPFC has been found active when people considered deontic rules, compared with non-social precautionary rules (Fiddick *et al.*, 2005). These authors conclude that the brain mechanisms implied in reasoning about rules depends—at least—on the origin of the prescriptive content on the rule (social or non-social). Also, in this study, the local maximum of the activation within the DLPFC is located in the medial portion. Therefore, we may consider this as another indicator that strengthens the argument that, especially for *utilitarian* moral judgments, Catholics were torn between two competing social rules of their social community—to benefit others *vs* not to kill anyone.
- (2) The fact that both types of moral judgment included activity in memory-related areas (precuneus, TP) may show that Catholics have been back checking their religious value system's rules. In the Religious Beliefs questionnaire, these participants had indicated that they strongly adhered to their religious value system. Thus, the activations reported here could represent the neural correlates of that adherence, as the TP have been associated with memory and other executive functions (Uddin *et al.*, 2007; Moll *et al.*, 2008a,b). Casebeer (2003) reviewed literature on moral judgment and pointed out that TP might facilitate the conscious recollection of schemes and memories of past situations to generate an

**Table 5** Separate RM ANOVA (Atheists) for the factors type of dilemma and type of response

	<i>F</i> -test (1,12)	<i>P</i>	<i>r</i>
Type of dilemma	0.001	0.980	ns
Type of response	0.758	0.403	ns

No other main effects were significant.

**Table 6** Separate RM ANOVA (Catholics) for the factors type of dilemma, type of response

Type of dilemma	Mean	SE	Test	<i>P</i>	<i>r</i>
PMD	4568.21	235.26	$F(1,10) = 11.038$	0.008	0.72
IMD	5214.20	192.81	$t(10) = -2.991$	0.01	0.69

No other main effects were significant.

**Table 7** *Post hoc t*-tests for utilitarian and deontological moral judgments of PMD

	Mean	SE	<i>t</i> -test (10)	<i>P</i>	<i>r</i>
Utilitarian to PMD	5246.42	277.49	3.013	0.01	0.69
Deontological to PMD	4356.87	259.81			
IMD comparisons	ns				

**Table 8** Whole brain analysis

Contrast	Region of activation	Cluster size	Lat	Brodman Areas	Z-score	MNI coordinates
Average effect of condition	Calcarine sulcus and other primary visual cortices	4552	B	17	Inf	−6 −85 −5
	Cerebellum	1270	B		Inf	−39 −79 −35
	Precuneus–Hippocampus–Parahippocampal gyrus	1200	B	37, 27, 29	Inf	−21 −46 7
	Prefrontal and frontal areas ACC	4370	B	8, 9, 10, 24, 32, 46,	Inf	−24 50 28
Main effect of Catholics–Atheist	Precuneus	25	B	30	5, 8	−3 −55 19
	Superior Medial Frontal Cortex	11	B	10	5, 45	3 62 7

*F*-tests ( $P < 0.05$  FWE corrected).

Whole-brain analysis for the main and average effects. Baseline was established by the inclusion of null events in which participants saw a blank screen and did not do anything related to the task (see Methods). Cluster size in voxels. 'Lat' indicates laterality (B = bilateral, R = right, L = left). 'Inf' means that value tends to infinite.

Degrees of freedom = [1.0, 76.0].



integrative representation of social perceptual, functional and structured-event knowledge. This knowledge is necessary to make a moral judgment in accordance with what one considers to be acceptable behavior.

(3) Catholics and Atheists appear to process differently the emotional saliency of PMD and the abstract nature of IMD. Although we had

ensured by means of the questionnaire that the groups did not differ either in their general empathy levels or in Thinking Style, they did report diverging mindsets regarding the importance of practicing dogmas. Also, the speed of their *deontological* moral judgments indicated an enhanced perceived emotional saliency toward such dilemmas. The enhanced activity in ACC and STS in Catholics during *deontological* moral judgments of PMD might also be related to their religiousness. The enhanced tendency to perspective taking in Catholics (ToM-related processing: STS activity) appeared to make them anticipate more strongly the negative affect potentially resulting from consenting a moral transgression that would harm another person (empathy-related processing: ACC activity). Catholics' *utilitarian* moral judgment of IMD was associated with differential neural activity in DLPFC and PCC. This indicates that, for such judgments, Catholics incurred more strongly in abstract reasoning processes, a fact reflected at the behavioral level with longer RTs for such judgments (correlating with activity in DLPFC). *Utilitarian* moral judgments may also have involved a strong feeling of awareness of one's own

Table 9 t-Tests ( $P < 0.05$  FWE corrected)

Contrast	Region of activation	Cluster size	Lat	Brodmann areas	Z-score	MNI Coordinates
Catholic>Atheist	Precuneus (PCC)	35	B (L)	30	5, 92	-3 -55 19
	Middle temporal pole	10	R	20	5, 82	39 11 -38
Atheist>Catholic	Superior parietal gyrus	10	L	7	5, 37	-27 -64 64

Cluster size in voxels. 'Lat' indicates laterality (B = bilateral, R = right, L = left). Degrees of freedom = [1.0, 76.0].

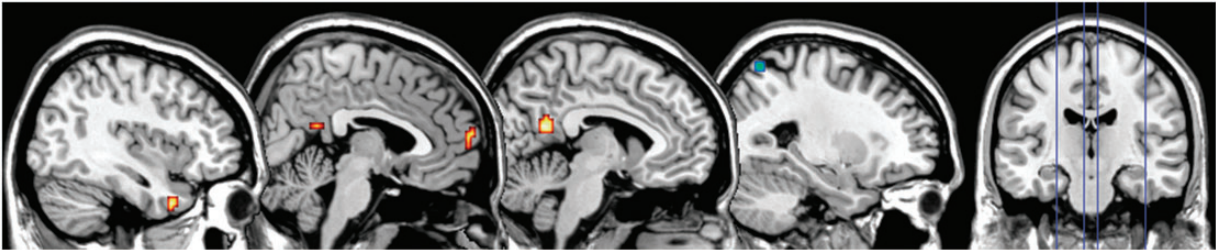


Fig. 4 Comparison Catholics vs atheists. Catholic > Atheist contrast (red) reveals activity in right Temporal Pole, middle Superior Frontal Gyri (BA10), ventral portion of the Precuneus and left Posterior Cingulate Cortex. Atheist > Catholics contrasts (blue) reveals left superior parietal gyrus activity.

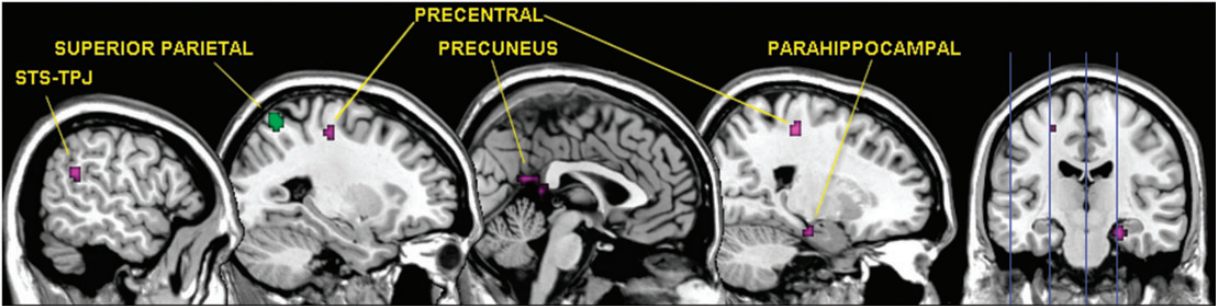


Fig. 5 Activity related to deontological responses for Catholic (violet) and atheist (green) participants.

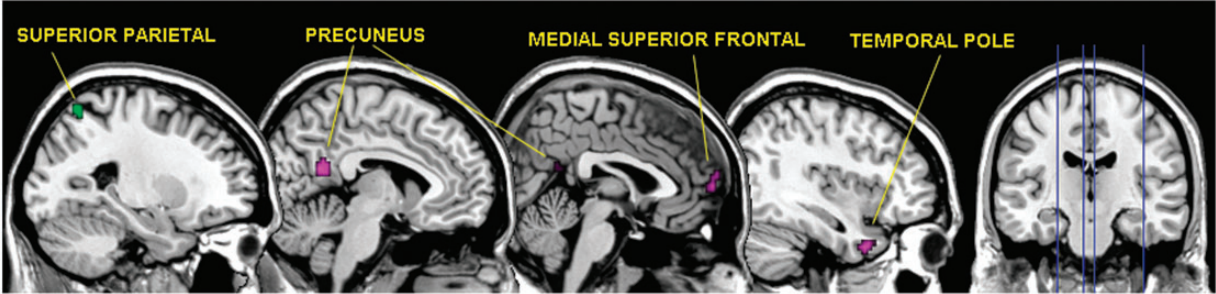


Fig. 6 Activity related to utilitarian responses for Catholic (violet) and atheist (green) participants.



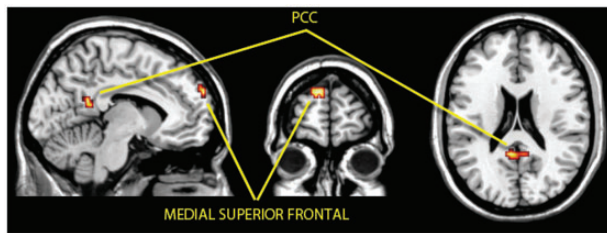


Fig. 7 Activity related to utilitarian judgments of IMD by Catholics.

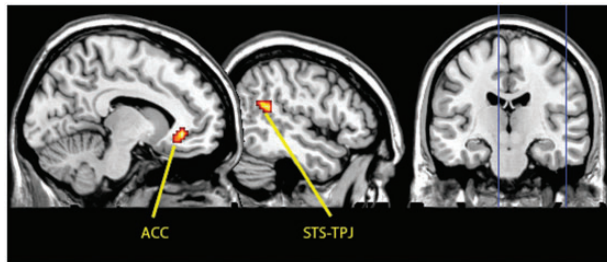


Fig. 8 Activity related to deontological judgments of PMD by Catholics.

actions and interactions with the external world (activity in PCC) (Legrand and Ruby, 2009).

- (4) The repeatedly found enhanced neural activity in the DLPFC in Catholics deserves a closer look. The DLPFC has been proposed to be part of a network that encodes moral emotions such as shame, guilt and compassion and, specifically, embarrassing social norm violations (Berthoz et al., 2002, 2006; Moll et al., 2007; see also Moll and Schulkin, 2009, for a review). Furthermore, it plays a key role in knowledge retrieval based on learned associations of self-perceived learned behavior when applied to morally ambiguous situations. Also, it responds to the adherence to socially and personally acceptable beliefs and norms (reviewed in Haidt, 2007; Forbes and Grafman, 2010).

Moral emotions and social norms guide our behavior to be morally and socially acceptable within the standards of a given community (Moll et al., 2005, 2008b; Zahn et al., 2009). Norms serve as an educationally acquired set of 'ought' codes—possibly sustained by the five foundational moral intuitions (Haidt and Graham, 2007)—whereas moral emotions serve as an internal motivational force for the achievement of these standards (see the motivational approach by Moll et al., 2008a). However, the elicitation of such moral emotions is said to be especially dependent on the social evaluation other people may make of an individual's actions (Tangney et al., 2007). Catholics reported strongly believing in a spiritual power or force other than themselves, with the power to influence events. This indicates that these individuals may feel implicitly 'supervised' in their actions, making them more prone to feel emotions related to others' evaluation of their actions. In view of the findings of this study, particularly the DLPFC activity, we speculate that membership in a religious community has an increasing effect on the elicitation of moral emotions such as guilt, which makes Catholics diverge from Atheists in their moral judgment.

Of course, our study has the common features of any exploratory study. Without doubt, it needs replication with a larger sample, including both male and female participants, to make results generalizable. We operated with a relatively small sample size, which makes statistical significance hard to achieve. Furthermore, two of our pairwise comparisons in the 'Behavioral results' section showed only trend effects

(see behavioral results sections 'Analysis 1: dilemma categories influence RT' and 'Analysis 3: RT depends on the type of response and on religiousness') and the results of one fMRI analysis ('fMRI results' section, above) did not survive FWE correction.

In spite of the danger of incurring in a type I error (false positives), we chose to report also trend effects because (i) this is an exploratory study, (ii) our behavioral results match findings of a previous study by our group (Christensen, Gut and Cela-Conde, submitted for publication) and (iii) the regions we found active have repeatedly been reported to be involved in moral judgment tasks in other studies. The same applies for the use of anatomical ROIs. We chose to run such an approach to reduce the severity of correction for multiple tests. However, we believe that the danger of false discovery rate (Poldrack, 2007) is minimized because of extensive work already available supporting the selection of those particular regions stipulated by our hypotheses.

Another criticism might be related with personality trait issues. They could be the cause for the differences in the assessment of moral dilemmas between Catholics and Atheists. As we have not controlled for personality traits, we just hold that membership in a religious community constitutes a condition that has the potential to modulate the behavioral and neural expression of basic moral intuitions in a moral judgment. To disentangle the specific role of personality traits from religious indoctrination in moral judgment remains an endeavor for future testing.

Finally, to answer the initial question by Bloom (2012): Yes, psychology urgently needs to address the phenomenon 'religion' because it has demonstrable effects on the human mind, reflected at both behavioral and neural levels.

## SUPPLEMENTARY DATA

Supplementary data are available at SCAN online.

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