

Accepted on Psychological Research, December 21, 2012

## Heaven can wait

### How religion modulates temporal discounting

Fabio Paglieri<sup>a\*</sup>, Anna M. Borghi<sup>b, c</sup>, Lorenza S. Colzato<sup>d</sup>, Bernhard Hommel<sup>d</sup> & Claudia Scorolli<sup>b\*</sup>

<sup>a</sup> *Goal-Oriented Agents Lab (GOAL), Istituto di Scienze e Tecnologie della Cognizione, CNR, Rome, Italy*

<sup>b</sup> *Embodied Cognition Lab (EMCO), Dipartimento di Psicologia, Università degli Studi di Bologna, Italy*

<sup>c</sup> *Istituto di Scienze e Tecnologie della Cognizione, Rome, Italy*

<sup>d</sup> *Leiden University, Cognitive Psychology Unit & Leiden Institute for Brain and Cognition, The Netherlands*

Abstract: 152 words.

Article length: 6853 words, including tables and references.

Figures: 2; Table: 1; Supplementary Materials: 1

Running title: How religion modulates temporal discounting

**Keywords:** temporal discounting; intertemporal choice; religion; cultural differences; magnitude effect

---

\* Corresponding authors: Fabio Paglieri (fabio.paglieri@istc.cnr.it) and Claudia Scorolli (claudia.scorolli2@unibo.it).

**Abstract:**

Evidence suggests that religious systems have specific effects on attentional and action control processes. The present study investigated whether religions also modulate choices that involve higher-order knowledge and the delay of gratification in particular. We tested Dutch Calvinists, Italian Catholics, and Atheists from both countries/cultures using an intertemporal choice task where participants could choose between a small immediate and a larger delayed monetary reward. Based on the Calvinist theory of predestination and the Catholic concept of a cycle of sin-confession-expiation, we predicted a reduced delay tolerance, i.e. higher discount rate (*DR*), for Italian Catholics than for Dutch Calvinists, and intermediate rates for the two atheist groups. Analyses of discount rates support our hypotheses. We also found a magnitude effect on temporal discounting and faster responses for large than for small rewards across religions and countries/cultures. We conclude that temporal discounting is specifically modulated by religious upbringing rather than by generic cultural differences.

## 1. INTRODUCTION

Temporal discounting refers to the devaluation of future rewards as a function of how long it would take to acquire them: the longer the expected delay to acquisition the smaller the current perceived value (Strotz 1956; Rachlin 2000; Ainslie 2001; Berns, Laibson & Loewenstein 2007; Madden & Johnson 2010). Temporal discounting is considered pivotal in determining the level of self-control in intertemporal choice scenarios: when facing a choice between a lesser immediate and a larger delayed reward, the capacity to resist temptation and wait for the larger reward is affected by how rapidly delay reduces perceived value. Higher discount rates are considered an indicator of reduced delay tolerance, whereas low discount rates are assumed to facilitate intertemporal self-control. Since most choice people make involve some kind of intertemporal trade-off (e.g., buying a new car today or saving money for retirement), how they discount future utility over time is an essential parameter in their decision making.

Discount-rate estimates exhibit good one year test-retest stability (Kirby, 2009), and their external validity is attested by the observation of steeper discounting functions in various kinds of addiction (e.g., heroin and cocaine abusers: Kirby & Petry, 2004; gamblers: Petry, 2001). However, individual discount rates have been observed to vary across subjects, test conditions, and age (Green, Fry & Myerson, 1994; Frederick, Loewenstein & O'Donoghue 2002), suggesting a certain domain specificity of temporal discounting that fits observations of a domain-specificity in temptation (Tsukayama & Duckworth, 2010). Numerous studies have investigated cultural differences in delay discounting (Masuda & Nisbett 2001; Nisbett & Masuda 2003; Nisbett & Miyamoto 2005; Kim, Sung & McClure 2012) and related social attitudes (Henrich, Boyd, Bowles, Camerer, Fehr, Gintis & McElreath 2001; Levine, Norenzayan & Philbrick 2001; Oosterbeek, Sloof & van de Kuilen 2004). These studies have focused on rather crude cultural comparisons, like between US Americans and Japanese, with the standard expectation to find a more patient attitude, i.e. lower discount rates, among Easterners, since Eastern cultures differ from Western ones in their stronger emphasis on patience and perseverance (“Confucian dynamics”, Hofstede & Bond 1988), greater focus on context rather than on reward magnitude (Kitayama, Duffy, Kawamura & Larsen 2003), and a more holistic perspective on time duration (Takahashi, Hadzibeganovic, Cannas, Makino, Fukui & Kitayama 2009). This expectation has been partially confirmed by experimental findings (Du, Green & Myerson 2002; Chen, Ng & Rao 2005; Takahashi et al. 2009) and outcomes of surveys on self-reported impulsive buying (Kacem & Lee 2002). Recent neuroimaging findings (Kim et al. 2012) support the hypothesis that the steeper discounting observed in Westerners is due to a cultural difference in emotional responsivity between these cultures.

And yet, there are oddities in the data. Whereas the predicted contrast emerges quite neatly comparing Japanese or Koreans with US Americans, Chinese do not differ from US Americans (Du et al. 2002) or Canadians (Tan & Johnson 1996) in terms of time discount rates: clearly this discrepancy between Japanese and Chinese could also depend on cultural differences; the most obvious cultural difference between Japan and China is in terms of the Japanese individualistic attitude, as opposed to the Chinese collectivist tradition. But marked individualism is precisely what (most of) the USA and Japan have in common, so one would expect to find similarities among Americans and Japanese, and differences with Chinese—the exact opposite of what the data show.<sup>1</sup>

---

<sup>1</sup> As one anonymous reviewer suggested, it could be argued that these results should not be explained in terms of individualism vs. collectivism, but rather as resulting from the opposition between materialism vs. spiritualism. The suggestion here would be to stress that the USA and China share a long tradition of materialism, whereas Japanese culture, in spite of its recent consumeristic turn, is much more rooted in metaphysical concepts like “muga-mushin” (no-self, no-mind) that transcend the boundaries of the physical self. This could help explaining why Chinese and Americans are more attracted by tempting short-term options (thus exhibiting higher delay discounting) than Japanese. Regardless of the merit of this hypothesis, the very fact that multiple interpretations of cultural differences are often possible and even plausible strengthens our point: a more precise and fine-grained understanding of what drives such differences is needed, and religious beliefs offer a very promising domain in that respect.

To date, the only cross-cultural study on temporal discounting that did not focus on the East vs. West divide compared Israeli Arabs with Israeli Jews, testing them both for temporal discounting and risk sensitivity (Mahajna, Ben-Zion, Bogaire & Shavit 2007). Israeli Arabs were found to have higher discount-rates and stronger risk aversion than Israeli Jews, consistently with their status of discriminated minority and their consequent distrust for all social transactions (Glaeser, Laibson, Scheinkman & Soutter 2000), including the kind of economic choices used as test materials. These findings are hard to explain in terms of cultural differences, since a highly collectivist society like that of Israeli Arabs would be expected to entail a safety net for its members and thus elicit lower discount rates and lower risk aversion, in comparison to the relatively individualistic society of Israeli Jews.

Taken together, these studies on cultural differences in temporal discounting indicate that cultural factors are likely to influence individual tolerance for delay, but such effects cannot be properly disentangled by using blunt distinctions, such as Westerns vs. Easterns, or Arabs vs. Jews. A probably more promising way of considering how cultural differences might influence certain cognitive processes might be to focus on religious systems, as a dimension often overlooked in cross-cultural studies (for discussion, see Tarakeshwar, Stanton & Pargament 2003). As we have argued elsewhere (Colzato, van Beest et al. 2010), investigating differences induced by (or associated with) religions has many advantages compared to studying cultural differences in general. While the notion of culture runs into the risk of being hard to define, religions have explicit and clearly defined precepts. Writings with these precepts are publicly available and continuously interpreted, discussed and communicated by experts (e.g., priests, theologians), and faithful people are typically trained to follow religious rules specified therein.

Previous studies have shown that religion overall has an impact on behavior (McKay, Efferson, Whitehouse & Fehr 2010) and often improves self-control and self-regulation (McCullough & Willoughby 2009), possibly because it acts as a buffer against anxiety and minimizes the experience of error (Inzlicht, McGregor, Hirsh & Nash 2009). Moreover, it has been observed that a specific religious training has marked and prolonged effects on perception and attentional control. In particular, studies conducted on Catholics and Calvinists revealed religious modulation of the global precedence effect (Colzato et al. 2010) and of action control in the Simon task, but not in the Stop-Signal task (Hommel et al. 2011), suggesting that being raised and trained in different religions might lead to the development of different control styles that generalize to all sorts of decisions under conditions of unpredictability or uncertainty (Hommel & Colzato 2010).

The aforementioned studies reveal that specific religions, such as Calvinism and Catholicism, have specific effects on action control processes tapping on perception and occurring in a rather fast and automatic way. The present study sought to extend previous observations of religion-specific effects to choices that involve higher-order knowledge. The intertemporal choice task employed here involves the deliberate selection of one of two mutually exclusive outcomes – either a sooner, smaller reward or a later, larger one. The subject's choices are taken to express his/her temporal preferences and thus reveal a certain time discount rate, which aggregates several different factors, such as future uncertainty (Sozou 1998; Green & Myerson 2010), time perception (Takahashi 2005; Zauberman, Kim, Malkoc & Bettman 2009), opportunity costs (Rosati, Stevens, Hare, & Hauser 2007), and anchoring to current endowment (Loewenstein & Prelec 1992). As such, intertemporal choices in experimental settings typically involve careful, explicit deliberation on the available options, instead of relying on the fast, stimulus-driven processes that our previous studies have focused on.

Looking at the basic tenets of Calvinism and Catholicism, there are two converging reasons to expect Calvinists (or Protestants in general) to show greater tolerance for delay than Catholics: the special nature of *Protestant asceticism* compared to Catholic asceticism, and the doctrine of *predestination* compared to the Catholic cycle of sin-confession-expiation. The first aspect is well characterized in Weber's classic work on *The Protestant Ethic and the Spirit of Capitalism* (1958/2003), which posits that Protestant asceticism differs from Catholic asceticism (e.g., as

embodied by the monastic orders) in that the former discourages only the immediate enjoyment and consumption of possessions, while encouraging long-term accumulation of material richness, whereas the latter frowns upon both. In the context of an intertemporal choice, e.g. deciding between an immediate purchase of a good and an investment with a long-term rate interest, the Protestant attitude would strongly favour waiting to maximize one's economic return, thus demonstrating a relatively low time discount rate. In contrast, Catholic asceticism would look at both options as morally unworthy and would not pressure the subject towards either of them.

The second relevant factor to consider is the Calvinist doctrine of predestination: the belief that everything passing in this world is predetermined and ordained by God. Crucially, this applies also to salvation: whether or not an individual will attain eternal beatitude in the afterlife is pre-established by God. This is in sharp contrast with the cycle of sin-confession-expiation countenanced by the Catholic faith. What is relevant here is that a belief in predestination puts a powerful diagnostic value on individual action: even if my deeds cannot redeem me, they can reveal my predetermined nature, either as a noble man predestined to salvation, or as a wicked sinner who cannot hope to avoid the hell-fire. It is in fact inconceivable that God's chosen would behave on Earth against His will: thus even a single infraction of His commandments is likely to be interpreted as evidence that the person in question is not among the chosen ones. This is in sharp contrast with Catholic's view that God can forgive the believers who have sinned. The protestant view of predestination gives a strong reason to behave virtuously not only in general, but also in the specific context of intertemporal decision making: insofar as the short-term option is conceived as a form of impulsive self-indulgence, whereas the long-term alternative is seen as indicative of moral fibre and self-control, Calvinists will have a much stronger incentive to opt for the latter than Catholics, thus showing lower time discount rates (for a partially different view on the relationship between predestination, self-signalling and intertemporal choice, see Bodner & Prelec 2003).

Both Protestant compared to Catholic asceticism and the doctrine of predestination compared to the idea that God can forgive believers' sins motivate the prediction that Calvinists should exhibit less steep temporal discounting than Catholics (that is, Calvinists should be more willing to wait than Catholics), especially when members of each group had been raised in a culture with a religious ethos consistent with their own belief system. To verify this hypothesis, we compared the performance of Calvinists raised in a predominantly Calvinist culture (The Netherlands) with that of Catholics from a Catholic culture (Italy), and also with the behaviour of atheists taken from either culture to test for possible effects of country/culture. We predicted that Dutch Calvinists would exhibit lower time discount rates than Italian Catholics, and that this effect would be caused by their religious beliefs and not by generic cultural differences: thus, we also predicted an effect of religion within each culture (Dutch Calvinists would be more willing to wait than Dutch atheists, and Italian Catholics would be less willing to wait than Italian atheists), and that culture alone would not produce any difference (same discount rates for both atheist groups).

In addition, we were interested to see whether the *magnitude effect* would be replicated in our data. The effect refers to the tendency to apply lower time discount rates to larger rewards (that is, being more willing to wait for such rewards), when the ratio between short-term and long-term rewards remains constant. This effect has been replicated several times (Kirby & Marakovic 1996; Kirby 1997; Green, Myerson & O'Connell 1999) and did not change across cultures when comparing Westerners and Easterners (Tan & Johnson 1996; Du et al. 2002), which led us to predict that subjects exhibit lower time discount rates for larger rewards (magnitude effect) irrespective of culture and religion.

To test these predictions, we used an intertemporal choice questionnaire, based on the one developed by Kirby and Marakovic (1996). The questionnaire provides an estimate of individual discount rates for different intervals of reward magnitude and a measure of the degree of consistency in the subject's responses. In addition, response times were recorded for all choices: this constitutes an important methodological innovation in temporal discounting studies. Since intertemporal choices involve a deliberate process, we did not expect to find any significant

differences in reaction time across different cultures or religions. But we were interested to explore whether the magnitude effect could also be manifested by different reaction times. In particular, we speculated that choices for large rewards might be processed more rapidly than choices for small rewards, since the difference in amounts between the options increases as a function of reward magnitude.

## 2. EXPERIMENTAL METHOD

### 2.1 Participants

Eighty-nine Dutch students from the University of Leiden and ninety Italian students from the University of Bologna took part in the experiment for financial reward. All were native Dutch or Italian speakers, right-handed and all had normal or corrected-to-normal vision. Their ages ranged from 18 to 34 years old (Dutch group: mean = 26.78; s.d. = 2.80; Italian group: mean = 26.24; s.d. = 3.13). They all were educated in the country they lived in, were exposed to the same educational style and institutional type, and reported similar social-economical background. They constituted four experimental groups: Italian Catholics (n = 49), Italian Atheists (people who grew up in a laic environment, n = 41), Dutch Calvinists (n = 40) and Dutch Atheists (never baptized, n = 49).<sup>2</sup> Subjects were assigned to each of these groups based on answers provided to a questionnaire aimed at assessing a possible training on both *directly religious issues* (e.g. daily prayer) and *moral-ethical issues* (e.g. views on same-sex marriage). They were provided with an explanation of the nature of the study; to begin the experiment participants had to confirm their voluntary participation by written consent. The study was approved by the local ethics committee.

### 2.2 Materials

Stimulus materials consisted of 48 choice items, each one including a smaller reward available immediately (e.g. “25 euro today”) vs. a larger reward available after a certain delay (e.g. “30 euro in 25 days”); the 48 choice items are listed in the Supplementary Materials. The critical trials corresponded to an expanded and computerized version of the questionnaire developed by Kirby and Marakovic (1996). The questionnaire is designed to yield an estimate of the subjects’ rate of temporal discounting with hypothetical monetary rewards, both relative to the magnitude of the delayed rewards (small, medium, large) and as an aggregate mean value; it also provides an ex post consistency measure for these estimates, in terms of the percentage of actual responses that are consistent with them. The procedure used to assign a discount rate value to each subject and measure its consistency was exactly as described by Kirby and Marakovic (1996, p. 102). Further details are provided in the Supplementary Materials.

### 2.3 Procedure

The experiment was programmed using the EPrime (Psychology Software Tools, Inc, U.S.A) software to control sequence and duration of the presentation of the material. Members of both groups were tested individually in a quiet laboratory room: they sat in front of a computer screen and were instructed to look at a fixation cross for 1000 ms. Then a question appeared on the screen for 5000 ms (e.g. “Would you prefer to receive 30 euro in 25 days or 26 euro today?”); the timer started operating when the question appeared on the screen. For each question, participants performed an intertemporal choice with hypothetical monetary rewards (i.e. subjects did not receive the amounts of money they chose). The use of hypothetical rewards is commonplace in studying temporal discounting with adults, as subjects do not behave differently when real rewards are used

---

<sup>2</sup> Due to the practical difficulties involved in testing subjects belonging to different religious groups across two countries, we were unable to have exactly the same number of participants for each group. However, we managed to keep numerical variation across groups within reasonable limits.

(Johnson & Bickel 2002; Madden et al. 2003; 2004; Lagorio & Madden 2005). Participants had to choose between the smaller and the larger reward by pressing two different keys (on the right vs. on the left) on the keyboard. The 48 choice items were presented in random order; within each item, the order of presentation (left or right) of the larger option was counterbalanced across trials.

### 3. RESULTS

Results for both discount rates and response times are summarized in Table 1, in which columns refer to different groups (Italian Catholics, Dutch Calvinists, Italian atheists, Dutch atheists), and rows to different magnitude sizes manipulated within subjects (Small, Medium, Large). In what follows, we will first present results for discount rates, and later those concerning response times.

**Table 1. Raw Discount Rate scores and Response Times across religious groups, for small, medium and large magnitude sizes**

DISCOUNT RATES AND RTs ACROSS RELIGIONS								
	ITALIAN CATHOLICS		DUTCH CALVINISTS		ITALIAN ATHEISTS		DUTCH ATHEISTS	
magnitude sizes	<i>discount rates</i>	<i>RTs (ms)</i>						
SMALL	.036	2301.35	.018	2141.89	.027	2435.61	.023	2162.70
MEDIUM	.038	2252.11	.014	2086.00	.024	2425.74	.018	2155.40
LARGE	.029	2222.77	.013	2039.87	.019	2371.65	.016	2100.36

#### 3.1 Discount Rates

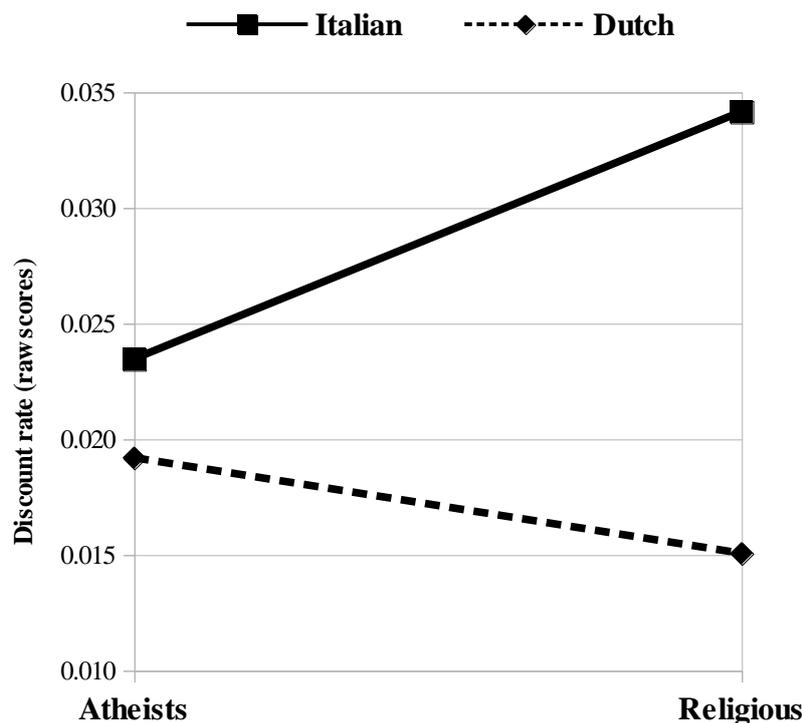
Participants were assigned to impulsiveness ranges that yielded the highest proportion of choices consistent with those predicted by a hyperbolic discounting function. For each subject we computed the proportion of choices consistent with assignment to each of the impulsiveness ranges, and the subject was assigned to the range that yielded the highest consistency. In the rare cases for which two or more ranges yielded equal consistency, the subject was assigned to the geometric midpoint of those ranges. Finally, the trials were grouped into three delayed reward sizes and the parameter estimation procedure was repeated within each size.

We normalized the raw discount rate scores by means of a logarithmic transformation [natural log (mean discount rate parameter)] (Kirby & Marakovic, 1996). To check the internal consistency of participants' responses we calculated, for each subject, the percentage of responses that were consistent with his/her discount rate estimate (consistency parameter). Consistency scores were in line with those of Kirby and Marakovic (1996), in the study from which our procedure was derived: the estimates yielded by the test were capable of explaining the vast majority of actual responses (83.8%), and the four groups were remarkably similar in their mean consistency levels (Italian atheists = 85.31; Dutch atheists = 84.14; Italian Catholics = 82.87; Dutch Calvinists = 82.86). Consistency scores were also submitted to a 2 (Culture: Italian, Dutch) X 2 (Religiosity:

Religious, Atheist) X 3 (Magnitude size: Small, Medium, Large) ANOVA, with Magnitude size *within* participants. No main effect of Culture ( $p = .71$ ), Religiosity ( $p = .23$ ), or Magnitude size ( $p = .15$ ) was observed.

To test the effect of different religions on discount rates, and disentangle it from the mere effect of culture, we submitted the discount rate scores to a 2 (Culture: Italian, Dutch) X 2 (Religiosity: Religious, Atheist) X 3 (Magnitude size: Small, Medium, Large) ANOVA with Magnitude size *within* participants. Magnitude size yielded a reliable main effect,  $F(2, 350) = 20.88$ ,  $MSe = 0.55$ ,  $p < .0001$ , showing that discount rates increased from small over medium to large magnitudes (Small:  $M_{log} = -4.32$ , raw scores mean,  $M = 0.026$ ; Medium:  $M_{log} = -4.65$ ,  $M = 0.024$ ; Large:  $M_{log} = -4.83$ ,  $M = 0.020$ ).

No main effect of Religiosity was observed ( $F(1, 175) = 0.03$ ,  $MSe = 4.61$ ,  $p = .86$ ): importantly, this is consistent with our hypothesis, since we expect Calvinism and Catholicism to influence discount rates in *opposite directions*, so that these two effects would indeed cancel each other when considering the more general parameter of Religiosity. This is supported by the combination of the other results of this ANOVA: there was in fact a main effect of Culture ( $F(1, 175) = 10.12$ ,  $MSe = 4.61$ ,  $p < .005$ ) and a significant interaction between Culture and Religiosity ( $F(1, 175) = 9.46$ ,  $MSe = 4.61$ ,  $p < .005$ ). In particular, post-hoc LSD showed that Italian Catholics exhibited higher discount rates than all other groups ( $p < .05$ ) and Dutch Calvinists showed lower discount rates than any other group ( $p < .05$ ), with the sharpest difference being the one between Dutch Calvinists and Italian Catholics ( $p < .0001$ ), whereas Dutch and Italian atheists did not differ at all in discount rates ( $p = .94$ ; see Figure 1). Finally, no other interaction was significant.

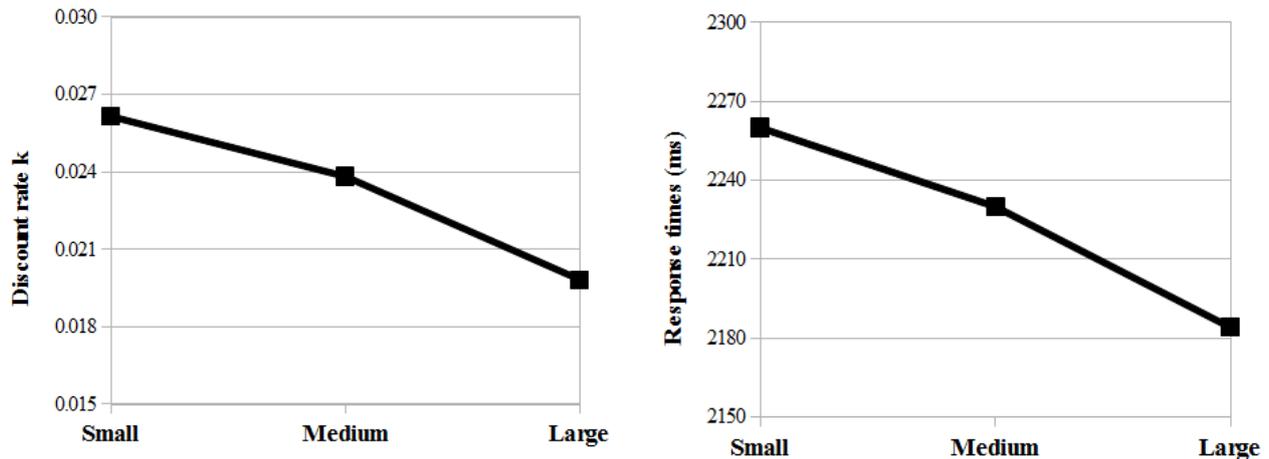


**Figure 1.** Discount rates, interaction between Culture and Religiosity: Calvinism reduces delay discounting, Catholicism enhances it

### 3.2 Response Times

In line with previous cross-cultural studies on delay discounting (Tan & Johnson 1996; Du et al. 2002), we expected specific religion to have no impact on magnitude effects: so for this analysis again we grouped together Catholics and Calvinists, as opposed to atheists, and submitted response times to a 3 (Magnitude: Small, Medium, Large) X 2 (Culture: Dutch, Italian) X 2

(Religiosity: Religious, Atheist) ANOVA with Magnitude size *within* participants. As predicted, we found a main effect of the Magnitude size,  $F(2, 342) = 6.72$ ,  $MSe = 38486.1$ ,  $p < .005$  (see Table 1): participants on average responded more quickly to Large magnitude items ( $M = 2183.66$  ms) than to Medium ( $M = 2229.81$  ms) and Small Magnitude ( $M = 2260.38$  ms) items. Post-hoc LSD showed that the Large condition differed significantly from the Medium one ( $p < .05$ ) and from the Small one ( $p < .0005$ ). This magnitude effect on response times closely mirror the magnitude effect observed for discount rates (Figure 2). No other effect or interaction was significant, except for a main effect of Culture, with Italian participants taking longer than Dutch subjects to respond ( $M^T = 2334.87$  ms,  $M^{NL} = 2114.37$  ms;  $F(1, 171) = 8.94$ ,  $MSe = 706535.1$ ,  $p < 0.005$ ).



**Figure 2.** Magnitude effect on discount rates (left panel) and response times (right panel)

Finally, to verify whether the effect was independent from the choice made by the subject (now or delayed), response times were submitted to a 3 (Magnitude size: Small, Medium, Large) X 2 (Choice type: Now, Delayed) ANOVA with participants as random factor. The main effect of magnitude was confirmed ( $F(2, 322) = 5.26$ ,  $MSe = 87768.06$ ,  $p < .05$ ), without any effect of choice type and no interaction. Post-hoc LSD showed that response times in the Large condition were shorter than in the Small condition ( $p < .005$ ) and the Medium condition, albeit in the latter case this was only a trend ( $p = 0.096$ ).

#### 4. DISCUSSION

The differences between Protestant asceticism and Catholic asceticism, and the opposition between the Calvinist theory of predestination and the Catholic cycle of sin-confession-expiation, led us to expect a stronger inclination to accumulate wealth over time in Calvinists than in Catholics. Consistent with this expectation, we found that:

- Dutch Calvinists are more willing to wait for monetary prizes than both Italian Catholics and Dutch atheists;
- Italian Catholics are less tolerant of delay than either Dutch Catholics or Italian atheists;
- atheists from both countries do not differ in their attitudes towards delay.

Apparently, then, heaven can wait longer for Calvinists than it does for Catholics. Apart from confirming our predictions, this fits with previous observations of a more focused, stronger top-down-oriented control style in Calvinists than in Catholics (Hommel et al., 2011). Assuming that opting for the larger delayed reward in an intertemporal choice task involves giving greater weight to long-term utility maximization (top-down processing) than to immediate, stimulus-driven gratification (bottom-up processing), lower discount rates and stronger top-down control in Calvinists are two faces of the same coin. This study provides the first demonstration of a clear

effect of religion on temporal discounting, as opposed to previous studies that focused either on generic cultural effects (e.g. Westerners vs. Easterners; see Du et al. 2002; Kacen & Lee 2002; Chen et al. 2005; Takahashi et al. 2009; Kim et al. 2012) or on minority vs. majority dynamics (Mahajna et al. 2007). More generally, the study adds to the growing body of evidence (Colzato et al. 2008; 2010; Hommel & Colzato 2010; McKay et al. 2010; Hommel et al. 2011) on the effects of specific religions on cognitive attitudes and skills, and it complements it by looking at a task, intertemporal decision making, that typically mobilizes higher order knowledge.

We also observed a clear magnitude effect on discount rates: larger rewards elicited greater delay tolerance than smaller ones. This is consistent both with the vast majority of studies on temporal discounting (see for instance Kirby & Marakovic 1996; Kirby 1997; Green et al. 1999), and with common sense: keeping fixed the ratio SS/LL between short-term and long-term rewards, increasing the size of LL also proportionally increases how much the individual will gain by waiting for it. Take any intertemporal choice between a smaller sooner option SS and a larger later reward LL (e.g., “5 € now or 10 € after one week?”): if you now want to test for a magnitude effect with a delayed reward twice as large as LL, i.e. 2LL (in this case, 20 € after one week), then also the size of SS has to be doubled to 2SS (10 € now), to keep the ratio constant, so that now opting to wait will deliver  $2LL - 2SS$  (10 €), which is equivalent to  $2(LL - SS)$ , that is, the double of what the individual would have gained (5 €) waiting with magnitude LL for the delayed reward. The lower discount rates observed with larger delayed rewards reflect the simple fact that waiting for these rewards guarantees a better pay-off.

We also collected and analysed response latencies in choice behaviour, which constitutes a small but potentially far-reaching methodological innovation with respect to previous studies on temporal discounting. Indeed, we observed a magnitude effect also on response latencies, with items involving larger rewards being processed more rapidly than items involving smaller prizes. To the best of our knowledge, this is the first time that this finding is reported in the literature. This trend in response latencies is consistent with the one observed in discount rates, and potentially liable of two different, not mutually exclusive explanations. According to a *motivational* account, the larger difference between short-term and long-term rewards characteristic of choices between larger options is responsible for both lower discount rates (the delayed prize is more convenient) and faster response times (the choice is easier to make). According to a *perceptual* account, the magnitude effect on response times is due to the increased perceptual saliency of choice stimuli (they are easier to tell apart, hence the choice is quicker – an instance of the well-known symbolic distance effect, see Moyer & Baier 1976).

The analysis of response times in relation to choice types (now or delayed) supports the latter account but not the former. If subjects are quicker to opt for the delayed prize with Large magnitudes because of the increased pay-off of doing so, they should also be slower to opt for the immediate prize in such condition, since in that case the non-chosen option would be more valuable (thus more likely to interfere) than with Small magnitudes. In contrast, if decision making is faster just because the options are easier to tell apart with Large magnitudes, then this effect should apply to whatever choice the subject makes, which is indeed the pattern we observed. It is also worth noting that the magnitude effect, either on discount rates or on response latencies, did not interact with culture or religion, consistently with previous findings in comparing Westerners and Easterners (Tan & Johnson 1996; Du et al. 2002). This suggests that the effect is too powerful to be modulated by culture or religion, inasmuch as it reflects a basic responsiveness to the allure of larger pay-offs and the perceptual distinctiveness of options.

These results invite taking greater notice of response times in future studies on temporal discounting: the fact that intertemporal choice is a deliberate, non-automatic task does not necessarily imply that latencies cannot reveal interesting aspects on the underlying decision making process. Aside from the results on magnitude effects just discussed, we also observed an unexpected effect of Culture on response times, with Italian subjects taking longer to react than Dutch ones. Albeit not expected, this effect is consistent with what was previously observed with the Simon task

and the Stop-Signal task (Hommel et al. 2011), in which again Italian participants (both Catholics and atheists) took longer to answer than Dutch subjects (both Calvinists and atheists). Exploring the reasons behind this apparent Italian tendency to “taking one’s time” in making a choice goes beyond the aims of this study, yet it would be worthy of further investigation. Based on current evidence, this does not seem a religious-based effect, though, since Religiosity had no impact on response times, and no interaction with Culture.

Our results also serve to exclude effects on delay discounting of some other key religious differences between Calvinism and Catholicism, regardless of the fact that these aspects might influence other cognitive processes. Religions are complex cultural constructs, consisting of many interwoven beliefs and precepts, so that focusing on one facet rather than another might lead to the formulation of very different predictions on behavioral and cognitive attitudes. Calvinism and Catholicism differ also in the view of society that each religion endorses: whereas Calvinism places a strong emphasis on individual responsibility, Catholicism places a greater weight on social solidarity. This religious difference has been successfully used to predict variations in the size of the global precedence effect between Calvinists, Catholics, Orthodox Jews, and Atheists (Colzato, van den Wildenberg & Hommel 2008; Colzato et al. 2010), so it is natural to speculate whether it might affect also temporal discounting. If that was the case, Calvinists would be expected to exhibit higher discount rates than Catholics, based on existing evidence of a negative correlation between delay discounting and social solidarity in experimental conditions, measured both in the Prisoner’s Dilemma (Harris & Madden 2002) and in a public-good game (Curry, Price & Price 2008). These findings are consistent with the hypothesis that moderate delay discounting is a precondition for reciprocal altruism (Stevens & Hauser 2004) and support the view that stronger social solidarity correlates with greater patience: hence, Catholics would show lower discount rates than Calvinists, which is the opposite of what we observed in this study.

Importantly, this lack of impact of individualistic vs. collectivist attitudes on delay discounting is consistent with previous cross-cultural studies: for instance, Mahajna and colleagues (2007) observed higher discount rates for the more collectivist Israeli Arabs than for the markedly individualistic Israeli Jews; similarly, comparisons between Eastern and Western cultures repeatedly reported lower discounting in Japanese than in Western respondents (Du et al. 2002; Tan & Johnson 1996; Takahashi et al. 2009), but no significant difference in time discount rates was found between Chinese and US Americans (Du et al. 2002) or Canadians (Tan & Johnson 1996). As mentioned in the Introduction, this pattern of cultural variation in discounting behavior is not accounted for by the collectivist vs. individualistic dichotomy. Taken together with our own findings, these results suggest that differences in social attitude are not particularly relevant in determining cultural or religious modulation of delay discounting, which instead is influenced by other factors.

More generally, the link between patience and social solidarity is in itself rather controversial: whereas a negative correlation between discount rates and collaborative behavior has been observed in some studies (Harris & Madden 2002; Curry et al. 2008), others did not find such an effect (Jones & Rachlin 2009), and two studies (Du et al. 2002; Ito, Saeki & Green 2011) comparing Japanese and US Americans revealed opposite cultural differences in terms of delay discounting and social discounting, a direct measure of one’s willingness to share a reward with others (Rachlin & Raineri 1992; Jones & Rachlin 2006). The fact that Japanese were more willing to wait but less inclined to share than US Americans is at odds with the alleged correlation between patience and social solidarity. In addition, delay discounting and social discounting are affected in opposite ways by the magnitude of delayed/shared rewards (Rachlin & Jones 2008), which further suggests that individual attitudes towards delay and social solidarity are the result of partially independent mechanisms.

Finally, in light of the opposite effects of Catholicism and Calvinism on temporal discounting, it might seem especially odd that we did not include in our experimental design also Italian Calvinists and Dutch Catholics, since this would have allowed us to make an even stronger

case for considering religion, rather than not just culture, as the key variable in modulating discount rates. We agree that further studies should test also such groups, yet we had two reasons not to include them already in this study. The first reason is practical: it is extremely hard and time-consuming to find people properly belonging to such groups, especially concerning Italian Calvinists, thus we decided it was better to start with samples that were simpler to recruit and would allow us to make a strong preliminary case for our hypothesis. The second reason is more substantial: even if we had managed to recruit a sufficiently large sample of Italian Calvinists, their status as a religious minority in their country would have introduced a powerful confounding factor in our design. Thus, we decided to restrict ourselves to religious groups that did not have any minority status in their respective country. This does not imply, of course, that future studies should not try to overcome this problem (e.g., choosing countries where both religions are relatively widespread, such as the USA, or The Netherlands themselves), to check whether the greater tolerance for delay manifested by Calvinists with respect to Catholics is present also within the same country.

#### ACKNOWLEDGMENTS

The research of the first author was funded by an ISTC-CNR intramural grant. The authors are grateful to the participants of the *Intertemporal Day* workshop (Rome, 29/05/2012), for providing useful comments on a previous version of this manuscript. We are also indebted to Wilfried Kunde and two anonymous reviewers for their insightful criticisms and suggestions for improvement.

#### REFERENCES

- Ainslie, G. (2001). *Breakdown of will*. Cambridge: Cambridge University Press.
- Berns, G., Laibson, D., & Loewenstein, G. (2007). Intertemporal choice – toward an integrative framework. *Trends in Cognitive Sciences*, 11, 482-488.
- Bodner, R., & Prelec, D. (2003). Self-signaling and diagnostic utility in everyday decision making. In I. Brocas, & J. Carrillo (Eds.), *The psychology of economic decisions. Vol.1: Rationality and well-being* (pp. 105-126). Oxford: Oxford University Press.
- Chen, H., Ng, S., Rao, A. (2005). Cultural differences in consumer impatience. *Journal of Marketing Research*, 42, 291-301.
- Colzato, L., van Beest, I., van den Wildenberg, W.P.M., Scorolli, C., Dorchin, S., Meiran, N., Borghi, A.M., & Hommel, B. (2010). God, do I have your attention? *Cognition*, 117, 87-94.
- Colzato, L. S., van den Wildenberg, W., & Hommel, B. (2008). Losing the big picture: how religion controls visual attention. *PLoS ONE*, 3(11), e3679. doi:10.1371/journal.pone.0003679.
- Curry, O., Price, M.E., & Price, J.G. (2008) Patience is a virtue: cooperative people have lower discount rates. *Personality and Individual Differences*, 44, 780–785.
- Du, W., Green, L., & Myerson, J. (2002). Cross-cultural comparisons of discounting delayed and probabilistic rewards. *Psychological Record*, 52, 479-492.
- Frederick, S., Loewenstein, G., & O'Donoghue, T. (2002). Time discounting and time preference: A critical review. *Journal of Economic Literature*, 40, 351-401.
- Glaeser, E., Laibson, D., Scheinkman, J., Soutter, C. (2000). Measuring trust. *Quarterly Journal of Economics*, 115 (3), 811-846.
- Green, L., & Myerson, J. (2010). Experimental and correlational analyses of delay and probability discounting. In G. J. Madden, & W. K. Bickel (Eds.), *Impulsivity: the behavioral and neurological science of discounting* (pp. 67-92). Washington: American Psychological Association.

- Green, L., Fry, A., & Myerson, J. (1994). Discounting of delayed rewards: a life-span comparison. *Psychological Science*, 5, 33–36.
- Green, L., Myerson, J., & O'Donoghue, P. (1999). Amount of reward has opposite effects on the discounting of delayed and probabilistic outcomes. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 25, 418–427.
- Harris, A., & Madden, G. (2002). Delay discounting and performance on the prisoner's dilemma game. *Psychological Record*, 52, 429–440.
- Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H., & McElreath, R. (2001). In search of *Homo economicus*: behavioral experiments in 15 simple societies. *American Economic Review*, 91 (2), 73–78.
- Hofstede, G., & Bond, M. (1988). The Confucius connection: from cultural roots to economic growth. *Organizational Dynamics*, 16 (4), 4–18.
- Hommel, B., & Colzato, L. S. (2010). Religion as a control guide: on the impact of religion on cognition. *Zygon: Journal of Religion & Science*, 45, 596–604.
- Hommel, B., Colzato, L., Scorolli, C., Borghi, A.M., & van den Wildenberg, W.P.M. (2011). Action control and religion: Faith-specific modulation of the Simon effect but not stop-signal performance. *Cognition*, 120, 177–185.
- Inzlicht, M., McGregor, I., Hirsh, J., & Nash, K. (2009). Neural markers of religious conviction. *Psychological Science*, 20, 385–392.
- Ito, M., Saeki, D., & Green, L. (2011). Sharing, discounting and selfishness: a Japanese-American comparison. *The Psychological Record*, 60, 59–76.
- Johnson, M. W., & Bickel, W. K. (2002). Within-subject comparison of real and hypothetical money rewards in delay discounting. *Journal for the Experimental Analysis of Behavior*, 77, 129–146.
- Jones, B., & Rachlin, H. (2006). Social discounting. *Psychological Science*, 17, 283–286.
- Jones, B., & Rachlin, H. (2009). Delay, probability, and social discounting in a public goods game. *Journal of the Experimental Analysis of Behavior*, 91, 61–73.
- Kacen, J., & Lee, J. (2002). The influence of culture on consumer impulsive buying behavior. *Journal of Consumer Psychology*, 12 (2), 163–176.
- Kim, B., Sung, Y.S., & McClure, S. (2012). The neural basis of cultural differences in delay discounting. *Phil. Trans. R. Soc. B*, 367, 650–656.
- Kirby, K. (1997). Bidding on the future: evidence against normative discounting of delayed rewards. *Journal of Experimental Psychology: General*, 126, 54–70.
- Kirby, K. (2009) One-year temporal stability of delay-discount rates. *Psychonomic Bulletin & Review*, 16, 457–462.
- Kirby, K., & Marakovic, N. (1996). Delay-discounting probabilistic rewards: rates decrease as amounts increase. *Psychonomic Bulletin & Review*, 3, 100–104.
- Kitayama, S., Duffy, S., Kawamura, T., & Larsen, J. (2003). Perceiving an object and its context in different cultures: a cultural look at new look. *Psychological Science*, 14, 201–206.
- Lagorio, C. H., & Madden, G. J. (2005). Delay discounting of real and hypothetical rewards III: steady-state assessments, forced-choice trials, and all real rewards. *Behavioral Processes*, 69, 173–187.
- Kirby, K., & Petry, N. (2004). Heroin and cocaine abusers have higher discount rates for delayed rewards than alcoholics or non-drug-using controls. *Addiction*, 99, 461–471.
- Levine, R., Norenzayan, A., & Philbrick, K. (2001). Cross-cultural differences in helping strangers. *Journal of Cross-Cultural Psychology*, 32 (5), 543–560.
- Loewenstein, G., & Prelec, D. (1992). Anomalies in intertemporal choice: evidence and an interpretation. *Quarterly Journal of Economics*, 107 (2), 573–597.
- Madden, G. J., Begotka, A. M., Raiff, B. R., & Kastern, L. L. (2003). Delay discounting of real and hypothetical rewards. *Experimental and Clinical Psychopharmacology*, 11, 139–145.

- Madden, G. J., Raiff, B. R., Lagorio, C. H., Begotka, A., Mueller, A., Hehli, D., & Wegener, A. (2004). Delay discounting of potentially real and hypothetical rewards. Part II: between- and within-subject comparisons. *Experimental and Clinical Psychopharmacology*, *12*, 251-261.
- Madden, G., & Johnson, P. (2010). A delay-discounting primer. In G. Madden, & W. Bickel (Eds.), *Impulsivity: the behavioral and neurological science of discounting* (pp. 11-37). Washington: APA.
- Mahajna, A., Ben-Zion, U., Bogaire, R., & Shavit, T. (2007). Subjective discount rates among Israeli Arabs and Israeli Jews. *Working Papers 07-10, Ben-Gurion University of the Negev, Dept of Economics*.
- Masuda, T., & Nisbett, R. (2001). Attending holistically vs. analytically: comparing the context sensitivity of Japanese and Americans. *Journal of Personality and Social Psychology*, *81*, 922-934.
- McCullough, M., & Willoughby, B. (2009). Religion, self-regulation, and self-control: Associations, explanations, and implications. *Psychological Bulletin*, *135*, 69-93.
- McKay, R., Efferson, C., Whitehouse, H., & Fehr, E. (2010). Wrath of God: religious primes and punishment. *Proceedings of the Royal Society B*, *278*, 1858-1863.
- Moyer, R., & Bayer, R. (1976). Mental comparison and the symbolic distance effect. *Cognitive Psychology*, *8* (2), 228-246.
- Nisbett, R., & Masuda, T. (2003). Culture and point of view. *Proceedings of the National Academy of Sciences*, *100*, 11163-11170.
- Nisbett, R., & Miyamoto, Y. (2005). The influence of culture: holistic versus analytic perception. *Trends in Cognitive Sciences*, *9*, 467-473.
- Oosterbeek, H., Sloof, R., & van de Kuilen, G. (2004). Cultural differences in Ultimatum Game experiments: evidence from a meta-analysis. *Experimental Economics*, *7*, 171-188.
- Petry, N. (2001). Pathological gamblers, with and without substance abuse disorders, discount delayed rewards at high rates. *Journal of Abnormal Psychology*, *110*, 482-487.
- Rachlin, H. (2000). *The science of self-control*. Cambridge: Harvard University Press.
- Rachlin, H., & Jones, B. (2008). Social discounting and delay discounting. *Journal of Behavioral Decision Making*, *21*, 29-43.
- Rachlin, H., & Raineri, A. (1992). Irrationality, impulsiveness, and selfishness as discount reversal effects. In G. Loewenstein & J. Elster (Eds.), *Choice over time* (pp. 93-118). New York: Russell Sage Foundation.
- Rosati, A. G., Stevens, J. R., Hare, B., & Hauser, M. D. (2007). The evolutionary origins of human patience: temporal preferences in chimpanzees, bonobos, and human adults. *Current Biology*, *17*, 1663-1668.
- Sozou, P. (1998). On hyperbolic discounting and uncertain hazard rates. *Proceedings of the Royal Society of London B*, *265*, 2015-2020.
- Stevens, J., & Hauser, M. (2004). Why be nice? Psychological constraints on the evolution of cooperation. *Trends in Cognitive Science*, *8*(2), 60-65.
- Strotz, R. (1956). Myopia and inconsistency in dynamic utility maximization. *The Review of Economic Studies*, *23* (3), 165-180.
- Takahashi, T. (2005). Loss of self-control in intertemporal choice may be attributable to logarithmic time-perception. *Medical Hypotheses* *65*, 691-693.
- Takahashi, T., Hadzibeganovic, T., Cannas, S., Makino, T., Fukui, H., & Kitayama, S. (2009). Cultural neuroeconomics of intertemporal choice. *Neuroendocrinology Letters*, *30* (2), 185-191.
- Tan, C., & Johnson, R. (1996). To wait or not to wait: the influence of culture on discounting behavior. In W. Loke (Ed.), *Perspectives on judgment and decision making* (pp. 297-305). Maryland, UK: Scarecrow Press.
- Tarakeshwar, N., Stanton, J., & Pargament, K. (2003). Religion: An overlooked dimension in cross-cultural psychology. *Journal of Cross-Cultural Psychology*, *34*, 377-394.

- Tsukayama, T., & Duckworth, A.L. (2010). Domain-specific temporal discounting and temptation. *Judgment and Decision Making*, 5, 72-82.
- Weber, M. (1958/2003). *The Protestant ethic and the spirit of capitalism*. Mineola, NY: Dover Publications.
- Zauberman, G., Kim, B., Malkoc, S., & Bettman, J. (2009). Discounting time and time discounting: subjective time perception and intertemporal preferences. *Journal of Marketing Research* 46, 543-556.