

Original Article

Costly signaling, ritual and cooperation: evidence from Candomblé, an Afro-Brazilian religion

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Abstract

The apparent wastefulness of religious ritual represents a puzzle for rational choice theorists and evolutionary scholars. In recent years, it has been proposed that such rituals represent costly signals that promote intragroup cooperation precisely because of the effort and resources they require. This hypothesis was tested over the course of a 14-month long ethnographic study in the northeast of Brazil. The research focused on adherents of Candomblé, an African diasporic religion organized in autonomous congregations primarily located in low-income urban areas. Individuals who reported higher levels of religious commitment behaved more generously in a public goods economic game and revealed more instances of provided and received cooperation within their religious community. This suggests that ritual as a costly signaling may effectively predict willingness to cooperate with other group members and that the signaler may accrue benefits in the form of received cooperation. Socioeconomic variables are also shown to mediate religious signaling. This raises the possibility that signalers strategically alter their expressions of commitment as their needs and circumstances change.

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1. Introduction

Recently, the study of religion has been revitalized by a surge of interdisciplinary work (see Barrett, 2000; Bulbulia et al., 2008; Bulbulia, 2004a; Feierman, 2009; Volland and Schiefelhövel, 2009). This emerging field can be roughly divided into two main areas: cognitive studies and behavior-centered approaches. The former have focused on the acquisition and transmission of religious concepts as by-products of other cognitive capacities (e.g., Atran, 2002; Barrett, 2004; Boyer, 1994; 2001; Cohen, 2007; Dawkins, 2006; Dennett, 2007; Guthrie, 1993; Kirkpatrick, 2004; Lawson and McCauley, 1990; McCauley and Lawson, 2002; Shariff and Norenzayan, 2007; Tremplin, 2006; Whitehouse, 2004; but see Bering and Bjorklund, 2004; Bering, 2002), while the latter have been more concerned with adaptationist explanations that center on the relationship between ritual and prosociality (e.g., Alcorta & Sosis, 2005; Bering & Johnson, 2005; Bulbulia, 2004b; Cronk, 1994; Irons, 1996;

2001; Johnson & Bering, 2006; Sosis & Bressler, 2003; Sosis, 2003; Sosis & Ruffle, 2003, 2004; Wilson, 2002; see also Pyysiäinen & Hauser, 2010; Sosis, 2001).

While theory has rapidly advanced and diversified, there is comparatively little empirical research. Behavioral approaches in particular are rich in theoretical material but suffer from a lack of data. In this area, costly signaling has become an important framework for understanding the role of religious ritual. Costly signaling or ‘handicap’ theory emerged in biology (Grafen, 1990; Zahavi & Zahavi, 1997; Zahavi, 1975), although parallel ideas have a long history in the social sciences (Mauss, 2000 [1924]; Spence, 1973; Veblen, 1994 [1899]). In the context of sexual selection, where it originated, costly signaling refers to ‘wasteful’ traits and behaviors that do not appear to aid survival. Such traits serve as advertisements of high genetic quality precisely because they are expensive to produce and maintain. Since genetic quality cannot be directly assessed, a costly trait or behavior can serve as a signal to females of the condition of possible mates. Because mating interactions have the potential for a conflict of interest between males and females, males may benefit from signaling high quality regardless of their condition. The honesty of the system is

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maintained because only individuals in truly good condition will be able to bear the costs of the signal without sacrificing other aspects of their fitness. Signalers benefit because their advertisements make them attractive as mates, while receivers stand to gain reliable information about the sender's quality.

While all signals aimed at obtaining a response from a receiver carry inherent costs to the sender, these can be characterized as efficacy and strategic costs (Dawkins, 1993; Guilford & Dawkins, 1991). The former refer to the energetic and opportunity costs endured by the sender to produce a signal that is discernible to a potential receiver and the increased predation risk associated with being more noticeable. Every signal carries some efficacy costs. Costly signals are different because they exceed this minimum threshold and require an additional investment (i.e., strategic cost) from the sender in order to produce an extravagant trait or behavior that is hard to fake. In a given population, individuals will be present in a continuum of lowest to highest quality signalers whose ability to afford strategic costs will result in a range of signal intensities. While these hard-to-fake signals can potentially be faked, the high costs involved in their production will deter free-riders from advertising falsely (this is in contrast to 'indices', signals which cannot be faked because they are the direct result of an underlying attribute; Maynard-Smith & Harper, 2003).

The logic of costly signaling theory has been extended to various aspects of human behavior, including cooperation (Gintis, Smith & Bowles, 2001), conspicuous consumption (e.g., Griskevicius et al., 2007; Miller, 2009; Nelissen & Meijers, 2011), hunting (Smith & Bliege-Bird, 2000) and fishing (Sosis, 2000; see also Bliege-Bird & Smith, 2005). In the case of religion, Irons (1996, 2001) has proposed that costly rituals may be understood as hard-to-fake signals that reliably indicate commitment to the group. Irons argues that religion represents a "cultural commitment" that binds participants to a set of ideas related to a community of believers. Since group members cannot directly evaluate each other's commitment, rituals that involve extensive time, effort or resources ensure that only those individuals who are truly devoted to the community and its shared ideas (that is, high-quality signalers) will find that benefits of group-belonging outweigh the costs of participation. Irons argues that throughout human evolution, intragroup cooperation represented an important selective advantage. Individuals in groups who were able to work together more efficiently had a better chance of survival than those who did not. Hard-to-fake rituals that advertised commitment to the religious group increased trust among members, facilitating the emergence of cooperation and collective action.

An analogous theory has been advanced by economist Larry Iannaccone, who argues that "stricter" churches are more successful precisely because they weed out free-riders not willing to comply with the sacrifices that are required to be part of the community (Iannaccone, 1992, 1994). Other theorists have advanced similar formulations (e.g., Alcorta & Sosis,

2005; Atran, 2002; Boyer, 2001; Bulbulia, 2004b; Cronk, 1994; Henrich, 2009; Sosis & Alcorta, 2003; Sosis, 2003) and provided empirical support (e.g., Ruffle & Sosis, 2007; Sosis & Bressler, 2003; Sosis, Kress & Boster, 2007). Like Irons, these researchers argue that ritual increases cooperation by providing an advertisement system that communicates the intensity of members' faith and thus solidarity toward the group. Since group enterprises are vulnerable to free-riding, professions of commitment can be reliable only if they are accompanied by "credible signals of cooperative intentions that are costly-to-fake" (Sosis, 2003, p. 93).

However, in order for ritual (or any other trait or behavior) to fit the characteristics of a costly signal that is evolutionarily stable, certain conditions must be satisfied. Bliege-Bird & Smith (2005; see also Gintis et al., 2001; Grafen, 1990; Johnstone, 1997) advance the following four criteria: one, members of a population vary with regard to an attribute that cannot be directly assessed but can be otherwise signaled; two, it is advantageous for others to obtain reliable information about variation in attribute quality; three, there is a conflict of interest between signalers and receivers so that deception (i.e., signaling higher-than-actual quality) benefits signalers at the expense of receivers; and four, the costs of producing or performing the signal are condition-dependent (low-quality individuals pay higher costs to produce the signal, or, *ceteris paribus*, the benefits of signaling are greater for high-quality individuals).

Sosis et al. (Sosis et al., 2007; Sosis, 2003; Sosis, 2005) have argued that ritual meets these conditions. One, intensity of religious faith is a variable trait among members of a population that cannot be directly assessed but can be potentially signaled through ritual participation; two, observers benefit from gaining information about this variation because religious faith is tied to group commitment and thus willingness to participate in cooperative exchanges with other group members; three, religious groups offer benefits in the form of intragroup cooperation which can be exploited by nonbelievers (i.e., low-quality signalers) who deceptively advertise religious faith; and four, the opportunity costs of religious participation will be lower for believers (i.e., high-quality signalers) than for nonbelievers because the former have willingly changed or abandoned behaviors in order to comply with the religious doctrine, while the latter have not. Alternatively, if the benefits of group belonging are delayed, only true believers will be willing to engage in ritual participation long enough to receive them (see Sosis et al., 2007).

Thus, the costly signaling theory of religion proposes that costly rituals function as hard-to-fake signals of commitment to the group and the ideas it represents and that such advertisements promote trust and solidarity among group members. While it is not possible to directly measure feelings of commitment or solidarity, it is possible to assess levels of cooperation among group members. Empirical evidence supports the link between hard-to-fake ritual and intragroup cooperation. Sosis and Bressler (2003; see also Sosis, 2000)

compared the longevity of religious and secular communes that existed in North America in the 19th and early 20th century. Their analyses show that religious communes lasted longer and were less likely to dissolve than secular ones due to collective action failures (i.e., internal disputes or economic collapse). In addition, religious communes imposed almost twice the number of costly requirements on members than secular ones, and increased number of costly requirements was positively correlated with commune longevity among religious communities. Sosis and Ruffle (2003) further tested the relationship between hard-to-fake ritual and intragroup cooperation among members of religious and secular Israeli kibbutzim. They found that religious males, the only group required to engage in public ritual, cooperated more in an economic game than religious females and secular participants of both genders. Moreover, only males who attended synagogue daily cooperated more than religious females and no differences were found between religious males who did not attend synagogue daily and religious females nor between secular males and females. The authors conclude that cooperation levels are related to frequency of ritual participation rather than to gender.

Although costly signaling has become a central tenet of neo-Darwinian accounts of religion, with the exception of the work of Sosis et al. cited above (Sosis, 200; Sosis and Bressler, 2003; Sosis and Ruffle, 2003), empirical studies are scarce. Here, I present results from a 14-month long ethnographic investigation of costly signaling. The work was carried out in the city of Salvador da Bahia in northeastern Brazil from July 2005 to October 2006 (Salvador and Bahia are both terms used to refer to the city; here, Salvador will be used). The study focused on communities of Candomblé, an Afro-Brazilian religion that originated in the region in the 19th century and which has been the subject of considerable ethnographic work (e.g., Bastide, 2001 [1958]; Capone, 2004; Landes, 1994 [1947]; Lima, 2003 [1977]; Matory, 2005; Prandi, 1996; Rodrigues, 1935; Wafer, 1991). Salvador and its immediate surroundings remain the center of Candomblé, but the religion has spread to other major cities like São Paulo and Rio de Janeiro (see Prandi, 1991).

2. Research setting

Salvador has a population of almost 3 million, making it the third largest metropolitan area in Brazil. Traces of its past as a main port of entry for the slave trade remain evident in its population, which is approximately 75% Afro-Brazilian. The urban landscape is a mosaic of commercial thoroughfares, luxurious high rises and modest residential neighborhoods, all interspersed with numerous slums and shantytowns. Candomblé religious centers, most commonly called *terreiros* (other terms are *axé*, *roça*, *casa*, and simply *candomblé*) are usually located in low-income areas where Afro-Brazilians are overwhelmingly represented. Estimates for the total number of terreiros in Salvador range from 2000

(Mott & Cerqueira, 1998) to 3000 (Pedro S., personal communication), although a recent survey by the Center for Afro-Oriental Studies of the Federal University of Bahia places the number at 1155.

Worship is centered on the cult of the *orixás*, deities that embody *axé*, the life force of the universe. Uniquely Brazilian figures have also become part of the pantheon, such as the *caboclo* and *boiadero* spirits that represent Amerindians and backland cowboys. Communication with these entities takes place through divination rituals and possession trance, an aspect of the religion that has received considerable attention (see Cohen, 2007, for a recent cognitive account).

Candomblé has a pragmatic orientation, centrally concerned with solving the problems of domestic existence and with helping adherents achieve health, prosperity and happiness. Like other African diasporic religions of Brazil and the Caribbean, it has often been described as amoral (e.g., Chestnut, 2003). Neither fixed ethical rules nor ideas of a rewarding afterlife are features of the religion. Rather than vigilant deities that enforce moral norms and mete out punishment for ethical transgressions, *orixás* can be swayed to advance one's interests through offerings and exchanges. The *exús*, for example, are trickster spirits that can be invoked for either helping or harming others, what is referred to as "opening or closing roads". Thus, the idea of moral gods that encourage prosociality through the threat of constant vigilance and punishment (e.g., Johnson & Bering, 2006; Roes & Raymond, 2003; Rossano, 2007) does not seem to apply in this context. Punishment from the *orixás* is more likely to occur because of failure to perform the appropriate offering or ritual rather than for violating a moral norm. As Amaral (2002) states, in Candomblé, "the only 'sin', the only unforgivable error is not properly worshipping the *orixás*" (p. 63) (my translation).

As in many religions (see Qirko, 2004), membership in the Candomblé terreiro is characterized by a hierarchy that resembles a family in terminology and organization. Each terreiro is essentially an autonomous community led by the *mãe-de-santo* or *ialorixá* ("mother of the saint") in the case of a woman or the *pai-de-santo* or *babalorixá* ("father of the saint") in the less common case of a man. The *mãe-de-santo* or *pai-de-santo* is the undisputed authority in both spiritual and secular matters. The physical space functions simultaneously as the private home of the leader and her family and as a temple for a community of followers, called *filhos-de-santo* ("children of the saint").

Traditionally, initiation into Candomblé is an arduous process that requires periods of total seclusion and takes years to fully complete. From my observations, however, the duration and intensity of initiation are highly dependent on the idiosyncrasy of the *mãe-de-santo* or *pai-de-santo*, size of the community, characteristics of the potential initiate and other factors. In addition, a large part of the following of every terreiro is composed of uninitiated affiliates, neighbors, friends and occasional visitors. In some terreiros, individuals who have never completed the initiation process may still play a central role in the terreiro, especially if they

have been members for a long time or are close relatives of the leader. The distinctions between initiates and external members are often hazy because individuals at all membership levels may vary greatly in their involvement with the religion and with any particular terreiro.

Many individuals first come to the terreiro seeking last-resort solutions to specific personal problems, including financial difficulties, troubled relationships, illnesses and addictions. The *mãe-de-santo* or *pai-de-santo* provides a consultation followed by a ritual course of treatment. Fees from these activities constitute the main source of revenue for the terreiro (recently, tourist attendance at large public feasts has also become a source of income). Recurrent “clients” often come to depend on the religious community for emotional as well as material aid and represent the terreiro’s main pool of potential initiates.

All who “belong” to a terreiro are expected to comply with numerous demands, including frequent internal rituals, weekly periods of sexual abstinence, total obedience to the *mãe-de-santo* or *pai-de-santo*, and adherence to a variety of taboos. In addition, all members must participate in the large public feasts that terreiros regularly celebrate which are expensive to produce and take weeks to prepare. On the other hand, terreiros have historically provided a haven of social support for otherwise marginalized individuals (Harding, 2000). Even today, many Candomblé adherents face the double challenge of urban poverty and racial discrimination. For many, the terreiro provides services otherwise not available to them, such as medical care or a space to socialize. The independent nature of each terreiro, the potential benefits that members can derive and the high levels of dedication required make Candomblé an ideal setting to explore the relationship between costly religious signaling and cooperation.

3. Hypotheses

Costly rituals can be characterized as behaviors and behavioral restrictions required by the religious group that represent “time, energetic and/or financial costs that are not directed toward accomplishing somatic or reproductive goals efficiently or that limit an individual’s ability to achieve these benefits from nongroup members” (Sosis & Bressler, 2003, p. 219). Only those who are truly committed to the group and its shared values will be willing to forgo otherwise pleasant or productive activities and engage in the required sacrifices. While feelings of commitment cannot be directly assessed, it is possible to evaluate cooperativeness among group members. If ritual is indeed a hard-to-fake signal of commitment to the group, individuals that signal more intensely should also be more cooperative. High-intensity signalers benefit because they are perceived as more reliable and thus may be more likely to be the recipients of cooperative exchanges. On the other hand, signaling is beneficial to receivers because it provides information about the sender’s cooperative intentions.

To test these ideas, costly religious signaling was evaluated through the Candomblé Religious Signaling Scale (CRSS), while cooperation was assessed through a Public Goods economic game (PGG) and a questionnaire that evaluated past instances of given and received cooperation (these instruments are described in detail below). From this framework, the following predictions arise: (1) that Candomblé followers who score higher in the CRSS will cooperate more in the PGG and report higher instances of given cooperation toward other terreiro members; (2) that participants who score higher in the CRSS will report more instances of received cooperation from others in their group; and (3) because high levels of signaling are predicted to motivate others to direct cooperation toward the signaler, that individuals who have potentially more to gain from belonging to the terreiro because of greater social or economic need will report higher scores in the CRSS (see Irons, 2001).

4. Methodology

A preliminary database of 55 terreiros was constructed using a combination of random sampling from an existing catalogue (Mott & Cerqueira, 1998) and snowball sampling. This preliminary database was used to understand the variability present in the population of terreiros and to begin to identify potential sites for further research. From this general database, a subsample of 14 terreiros was created for more detailed investigation. To ensure that participating terreiros were active, only those that had organized at least one public feast that I attended during the research period were considered.

Terreiros were chosen to reflect diversity in terms of wealth, size and location in the city. Three were located in distant suburbs and the others in the city proper. Eight were led by women and the remaining six by men. Roughly half of the terreiros were located on paved streets in urbanized neighborhoods and the rest in alleyways and hillsides of surrounding shantytowns or favelas. The size of the houses themselves, a clear indicator of wealth, ranged from a three-story compound to a two-room shed with metal sheets for a roof. In Candomblé, each terreiro identifies with a *nação*, a “nation” or ethnic group that represents the ancestry of its ritual practice. Eight terreiros identified as Keto or Ketu, one as Alaketo, two as Angola, one as Jeje, one as Gege Savalu and another did not provide an answer. These differences, however, are more due to strategic manipulation of notions of tradition and authenticity rather than to consistent ritual differences (see Lima, 2003, [1977], for a fuller discussion).

4.1. Data collection

4.1.1. General procedure

Data collection for each of the 14 terreiros was scheduled for a date when most regular members could be present. All terreiros participated on different days, except in the case of

two communities that often celebrated feasts and ceremonies together and decided to take part as one. On the appointed day, participants gathered in the largest room in the house, usually the *barracão* (a ceremonial room for feasts). I explained that participants would complete a three-part written questionnaire and then participate in an economic game played with real money. In one case, only 11 members of one of Salvador's largest terreiros completed the written questionnaires but did not participate in the economic game.

For all other terreiros, a questionnaire packet was given to each participant. I verbally reviewed the instructions for filling out the questionnaire and explained that the game would take place when everyone had completed their responses. After two field assistants collected the finished questionnaire packets, instructions for the economic game were given following a pre-rehearsed script modeled after Gurven (2004). Sample rounds of the game with varying outcomes were used to ensure comprehension by all participants. After the game, a small party was sponsored at each terreiro as compensation for participation. All explanations and instructions were given in Portuguese.

4.1.2. Individual questionnaire and intragroup cooperation

The first part of the questionnaire focused on demographic variables and questions that assessed various aspects of individual involvement with the terreiro. Categorical variables (living or having lived at the terreiro, having relatives as fellow members of the terreiro, and marital status) were coded as dummy variables. The second part collected data on acts of cooperation among the terreiro community. This section was formulated through observations and interviews and consisted of a list of eight commonly occurring cooperative instances with yes/no responses. For example, the first set of items included "Have you ever lent money to someone in your terreiro?" and "Have you ever taken care of someone in your terreiro who was sick?" Positive responses to the first eight items were added to create the variable "given cooperation" (GCoop). The variable "received cooperation" (RCoop) was created in the same way, but the questions were reversed to determine whether the respondent had ever received those same services. Thus, the questions became "Has someone from your terreiro ever lent you money?" or "Has someone from your terreiro ever taken care of you when you were sick?"

4.1.3. Candomblé Religious Signaling Scale

The third part of the questionnaire consisted of a scale created to measure costly signals of religiosity. Because existing measures of religiosity focus on Christianity and other world religions, a Candomblé-specific Likert scale was formulated. Interviews were used to reveal aspects of the religion that participants deemed as costly or difficult. These data were collected on three dimensions commonly used in religiosity scales (see Mockabee et al., 2001): attendance, giving and participation. A fourth commonly used dimension (salience) was not included because it refers to the impact of

belief in one's everyday decisions rather than to observable behaviors open to monitoring by others (i.e., signals).

Material for a 37-item preliminary scale was gathered from progressively more detailed interviews and observations. The preliminary scale was tested in the nearby town of Cachoeira over the course of three weeks ($n=52$). Cachoeira was chosen because it is a small town where sufficient Candomblé adherents who would not be part of the final sample could be found within a reasonable time frame. Subsequently, interviews with respondents in Cachoeira were used to determine the wording clarity of items and eliminate confusing questions. Principal component analyses (varimax rotation) were used on the remaining items to determine which would be included in the final version of the scale. Items with loadings over .550 on a single factor were chosen for further consideration. Of those items, only those with means close to the center and high standard deviations were chosen. High variation is desirable because an item that is answered uniformly by most respondents will not reflect the differences in religiosity that the scale is intended to capture.

The final version of the CRSS presented to study participants consisted of a 14-item scale ($n=252$). Reliability analysis of completed responses revealed high internal validity (Cronbach's $\alpha=.875$). For the following analyses, completed scales with one missing response ($n=21$) were recoded using the person mean substitution method described by Downey and King (1998), where the mean of a person's completed responses substitutes the missing value. Items "I never miss a feast at my terreiro" or "I come to the terreiro at least once a week" referred to the costliness of attendance since most devotees depend on public transportation which is expensive and inefficient. Participation, which requires both time and energy, was captured in items such as "I have spent a whole month at my terreiro because of an obrigação" (literally, "obligation", meaning a compulsory religious event) or "Whenever my terreiro has a feast, I come at the beginning and stay until the end" (feasts can last several hours). Other items included "There are foods I cannot eat because of my orixá", "I always have a candle lit for my orixá" (candles were often cited as a significant expense) and "I keep two or more days of resguardo a week" (*resguardo* refers to abstinence from alcohol, secular entertainment and sexual relationships) (full scale available on the journal's website at www.ehbonline.org).

Candomblé adherents perform numerous activities in a religious context that involve costs but nevertheless benefit the entire group (e.g., donating money or staying after a feast to clean the terreiro). These may be understood as provisioning of a public good or "costly cooperation" (Gintis et al., 2001) rather than religious signals. Since expressions of religiosity are hypothesized to indicate cooperative intent, the inclusion in the scale of items that represent altruistic activities represents a tautology, even if they commonly occur in a religious context. To take this problem into account, analyses were performed using the full version of the scale and a shortened 11-item version ($n=252$).

in which items representing any kind of group provisioning were removed (Cronbach's $\alpha = .837$). Excluded items were "I always give money to my terreiro to help with a feast", "I always help in the preparation of a feast" and "I always help clean up after a feast". Results from the complete and shortened scale were very similar. The present analyses used the shortened version to avoid biasing the result in favor of cooperation hypotheses. However, results from the complete scale are also shown for comparison.

4.1.4. Public Goods Game

The PGG consists of dividing participants into random and anonymous n -person groups. Players receive equal monetary endowments. Players must decide how much of this endowment they will donate to the common pool of their n -person group and how much to keep for themselves. After these decisions are made, the investigator adds up the total donations of each pool, doubles the amount and divides it in equal parts to all players in the same group. A larger common pool means more money to double and increased winnings to all players. On the other hand, there is a strong temptation to donate less because players receive equal amounts from the final common pool regardless of how much they initially hold back.

In each terreiro, participants were divided into groups of four players. When the number was not divisible by 4, groups of four and five were composed to avoid excluding people already on site. Players had no way of knowing whether they were part of a four- or five-person group. At the beginning of each session, numbered pieces of paper were placed in a plastic container and randomly selected and assigned to a group of four or five, depending on the total number of participants. Duplicate numbered tickets were then randomly distributed to players along with corresponding numbered envelopes containing an amount roughly equivalent to a day's wages [10 Brazilian reais (R\$), equivalent to about US \$5 at the time]. Players were instructed to remove from the envelope the amount they wished to retain and to return their donation to the common pool inside the envelope. The numbered envelopes tracked the donations of each person while maintaining anonymity. Participants were specifically instructed to prevent others from seeing how much money they took out of the envelope. Two field assistants were on hand to ensure they complied with these instructions. Players themselves were anxious to avoid prying eyes and generally refused to discuss their offers with others even after the game was over. After all envelopes were returned, calculations were made to determine how much each person would ultimately receive and players used their numbered ticket to claim their final winnings.

5. Results

Two-hundred and fifty-three subjects (138 female, 115 males) from 14 terreiros participated. Additional information

on participants is provided in Table 1. The 13 terreiros that provided group-level information ranged from 4 to 37 in years since foundation (mean \pm S.D.=19.33 \pm 10.8). Number of participants at each terreiro ranged from 11 to 30 (mean \pm S.D.=20.17 \pm 6.33). Household income for each participant was measured as seven categories related to monthly minimum wage (R\$350 or US\$165 at the time). The median amount of each category was calculated and that number was used for subsequent analyses. Approximately half of participants (47.6%) earned less than one minimum wage and almost a third were unemployed (30%). Those employed described a wide array of occupations, including housemaid, cook, security guard, cashier, policeman, fisherman, administrative assistant, salesperson, street food vendor, nurse and government employee. With the use of standard census categories, participants were asked to choose the race (the words *raça* and *cor* were used) they most identified with. Over 90% chose categories associated with Afro-Brazilian ancestry (*negro*, *preto*, *moreno* and *pardo*). Because of this homogeneity, race was not included in further analyses.

Responses to items in the modified CRSS were added to produce a single score for each individual (mean \pm S.D.=53.39 \pm 16.26; min, 11; max, 77). Results from the PGG were quantified as the offer (amount left in the envelope for donation to the four-person group) (Fig. 1). However, it is likely that game endowment will have different significance for individuals if there are wide economic disparities. For many subjects in this sample, 10 Reais was a significant amount. On the other hand, for individuals in the highest income brackets the same amount was negligible. To take this into consideration, game offer was recalculated as a percentage of income (mean \pm S.D.=1.88 \pm 2.51; $n=239$). Fig. 2 summarizes the results of the PGG recalculated in this manner.

Table 1
Selected descriptive statistics (means and percentages) of participants by gender^a

	Males	Females	All participants
Age	30.94 \pm 11.83	36.50 \pm 14.53	34.51 \pm 13.74
Income	634.16 \pm 544.25	517.18 \pm 478.47	541.80 \pm 498.03
Unemployed (%)	46.7	35.9	41.2
Single (%)	60.7	57.7	59
Married or living with someone (%)	30.4	26.3	28.2
Separated, widowed or divorced (%)	6.3	14.6	10.8
Years as a member of Candomblé	12.59 \pm 10.59	15.89 \pm 12.99	14.82 \pm 12.23
Years as a member of the terreiro	9.09 \pm 7.95	9.68 \pm 9.16	9.62 \pm 8.94
Lives or has lived at the terreiro (%)	17.6	18.8	36.4
Has "blood" relatives in the terreiro (%)	20.7	34.7	55.4

^a Percentages for males and females calculated within gender.

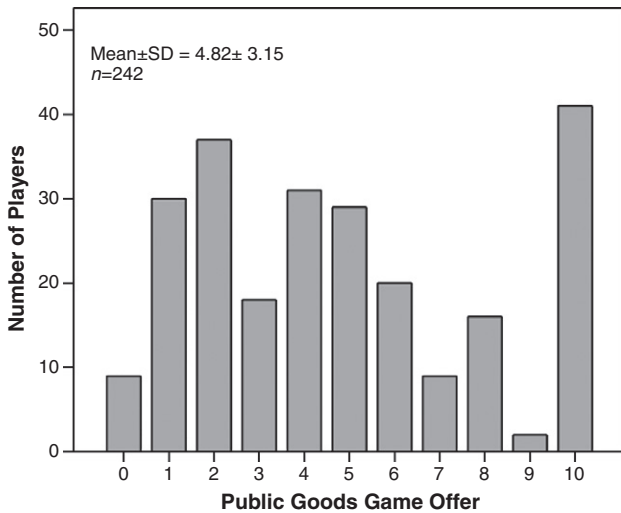


Fig. 1. Results from the PGG were quantified as the offer (amount left in the envelope for donation to the four-person group).

5.1. Hypothesis 1: Individuals with higher scores on the CRSS will be more cooperative in the PGG and report more instances of past given cooperation to other terreiro members

Religious signaling was assessed through the CRSS, while cooperation was measured by the PGG and the variable GCoop described earlier. Preliminary analyses indicated that the original version of the CRSS significantly predicted performance in the PGG (Soler, 2008). Here, the data from the PGG were reanalyzed to account for the wide income disparities in the sample of participants and the CRSS was modified to deal with circularity concerns. Multivariate linear regression analyses were used to determine significant predictors of the cooperative measures. Control variables included age, sex, marital status and other

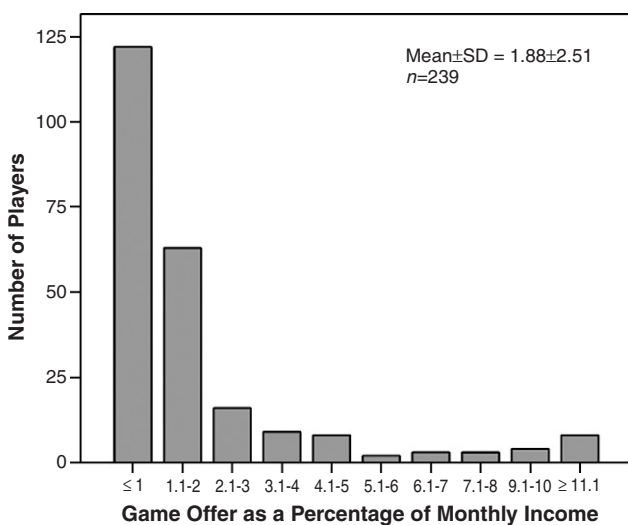


Fig. 2. Results of the PGG recalculated as a percentage of income.

Table 2
Multivariate regression of “GivCoop” on CRCS and other variables (n=206)

	Standardized coefficients	p values
(Constant)		.000
Sex	.026	.649
Age	.081	.228
Income	.205	.000
Married or living with someone	-.049	.411
Separated, widowed or divorced	.028	.659
Lives or lived at the terreiro	.297	.000
Has relatives in the terreiro	.011	.860
Years in the terreiro	.270	.000
Candomblé Religious Commitment Scale (CRCS)	.312	.000

Adjusted R²=.392, p<.001.

variables related to involvement with the terreiro which may be expected to have an effect on cooperation.

When GCoop is used as the dependent variable, significant predictors include income, lived or having lived at the terreiro, years as a member of the terreiro, and the modified version of the CRSS excluding provisioning items (Table 2). The same model using the original version of the CRSS yields almost identical results with the only significant variables being income ($\beta=.211, p<.001$), lives or has lived at the terreiro ($\beta=.303, p<.001$), years in the terreiro ($\beta=.250, p<.001$) and CRSS ($\beta=.293, p<.001$) (adjusted R²=.429, p<.001). Surprisingly, having relatives in the terreiro did not have an effect on instances of cooperation toward others.

The same covariates, except income, were used in a model with game offer as a proportion of income (the other measure of cooperation) as the dependent variable. Income was not included because it is already taken into account in the re-calculation of game offer. In this case, age and the modified CRSS score are significant predictors, but having lived at the terreiro, having relatives as members of the terreiro and years as a member of the terreiro have no effect (Table 3). Using the full version of the CRSS as a covariate results in age ($\beta=.300, p=.001$), married or living with someone ($\beta=-.167, p=.029$) and CRSS ($\beta=.257, p=.001$)

Table 3
Multivariate regression of “game offer as a percentage of income” on CRSS and other variables (n=199)

	Standardized coefficients	p values
(Constant)		.056
Sex	.023	.751
Age	.277	.001
Married or living with someone	-.190	.010
Separated, widowed or divorced	-.095	.227
Lives or lived at the terreiro	.097	.219
Has relatives in the terreiro	.016	.840
Years in the terreiro	-.148	.064
Candomblé Religious Commitment Scale (CRCS)	.224	.003

Adjusted R²=.096, p=.001.

being the only significant predictors of PGG offer (adjusted $R^2=.092$, $p=.002$).

5.2. Hypothesis 2: Individuals with higher scores on the CRSS will report having received more cooperation from their fellow terreiro members

The costly signaling theory of religion depends on the idea that more intense signalers will receive benefits from their displays. To test this idea, the variable RCoop was used to collect data on received instances of help from others. These examples were drawn from ethnographic observations and interviews with Candomblé adherents and included financial and nonmonetary forms of aid. It is expected that among members of the same terreiro there will be a significant relationship between high scores on the religious signaling measure and the variable RCoop. Controlling for years as a member of the terreiro, having relatives in the terreiro, and living or having lived at the terreiro, it was found that individuals with higher scores on the CRSS reported receiving more past instances of cooperation from others in the same terreiro (partial $r=.131$, $n=214$, $p=.055$, two-tailed).

5.3. Hypothesis 3: Individuals who have a greater need of belonging to the religious group will score higher on the CRSS

Individuals in a position of greater social vulnerability may be expected to display higher religiosity in order to secure the social support that the religious group can provide. Consistent with this hypothesis, there is a marginally significant relationship between CRSS score and income (partial $r=-.117$, $n=249$, $p=.066$, two-tailed) and this is strengthened if the full scale is used (partial $r=-.137$, $n=228$, $p=.039$, two-tailed). Women may also be expected to demonstrate higher religiosity because they are often the sole caretakers of children and elderly relatives and thus in more need of support. In contrast to numerous studies that suggest females are more religious than men (e.g., Francis, 1997; Stark, 2002), there was no significant gender difference in CRSS score (53.12 for women vs. 53.59 for men; $t_{251}=-.226$, $p=.821$, two-tailed). There was no significant difference either in CRSS score when single parents were compared to all other participants (53.46 vs. 53.53; $t_{250}=-.034$, $p=.973$, two-tailed), although the former reported being part of the religion longer (18.35 vs. 13.13; $t_{238}=3.108$, $p=.002$, two-tailed). Employment status (employed vs. unemployed) had no impact on CRSS score (51.43 vs. 54.55; $t_{182}=1.28$, $p=.204$, two-tailed).

The intensity of religious signaling may be expected to depend not solely on financial or social needs but also on individual circumstances. For example, new terreiro members may feel a greater compulsion to prove their alliance to the group by demonstrating higher religiosity. Similarly, those with relatives in the same group may need to signal less because they already have a source of support in the community. Both these relationships are significant but in the opposite direction: years in the terreiro and CRSS score

are positively correlated (.258, $n=224$, $p<.001$, two-tailed), while those with relatives in the same terreiro scored higher in the CRSS than those without (73.66 vs. 64.83; $t_{228}=3.403$, $p=.001$, two-tailed).

6. Discussion

Consistent with a costly signaling interpretation of religious ritual, results show that hard-to-fake expressions of religiosity are related to measures of intragroup cooperation among Candomblé adherents. Controlling for various other variables, higher scores on a religiosity scale specifically designed for Candomblé, the CRSS, significantly predict game offer in an economic game and self-reported acts of cooperation toward other group members. In the case of the game, the amount of variation explained by the model is modest. However, it is notable that while CRSS score had a significant effect, other variables that may be expected to predict game offer did not (i.e., having relatives at the terreiro, years as a member of the terreiro, living or having lived at the terreiro).

With regard to past instances of given cooperation (GCoop), significant predictors include income, years as a member of the terreiro and living or having lived at the terreiro in addition to CRSS. The first two relationships are unsurprising: individuals in a better financial position will have greater ability to provide some forms of aid, while the longer an individual is part of a community, the more occasions for cooperation that will arise. In Candomblé, it is not unusual for adherents to make a temporary (and sometimes permanent) home with their *mãe-de-santo* or *pai-de-santo*. In this sample, non-kin lived in about half of the terreiros at the time of the research. Such individuals often move to the terreiro as a result of distressing personal circumstances and tend to become heavily involved in its religious activities. In addition to having more opportunities of cooperating because they are on the spot, these individuals may feel a sense of obligation toward the community that translates into increased cooperation.

Costly religious signaling is advantageous to observers who will gain valuable information from these displays. Senders, on the other hand, are predicted to receive more cooperation from others because they will be perceived as more reliable. Indeed, results show that individuals who score higher on the CRSS report more cooperation directed towards them from fellow terreiro members. It can be argued that highly religious individuals help each other selectively because they are the primary participants of religious life. Without data that reflect specific patterns of cooperation between individuals within each group, it is not possible to determine the role that tit-for-tat or indirect reciprocity play in the results, but it is likely that these mechanisms operate in conjunction with costly signaling (Milinski, Semmann & Krambeck, 2002; Panchanathan & Boyd, 2004).

Since high levels of costly signaling are related to received cooperation, there is a possibility of individuals

taking part in religious signaling in order to reap cooperative benefits and exiting the group when demands for reciprocity are made. A potential free-rider must perceive the potential benefits as compensating the considerable time, effort and economic investments that are required to be part of the community. While a terreiro can become a crucial resource in moments of crisis (e.g., providing a temporary home, care during serious illness), these events do not occur often nor do they affect all individuals in equal measure. More common advantages of belonging consist of socialization, occasional child care or a small loan, all of which can be procured from family or friends in most cases. In contrast, costly demonstrations of faith are ongoing and required from every member. A low-quality signaler (i.e., someone who is not truly committed to the group) may find that future advantages are either too trivial or too uncertain to compensate for the exacting demands of the terreiro.

Psychological mechanisms may also contribute to an individual's commitment to continued participation with a religious group. Sosis (2003) argues that internalization of belief plays a crucial role in minimizing the risk of free-riding. Believers will perceive the opportunity costs of constant ritual participation as lower because they interpret their actions as important and meaningful, while skeptics will constantly struggle with the inconsistency between their beliefs and their required behavior. Sosis proposes that the resulting cognitive dissonance will result in the skeptic either abandoning the group or, alternatively, adopting its beliefs.

In any case, the existence of free-riding does not mean that costly signaling is ineffective at promoting cooperation. Rather, the system will remain stable as long as free-riders are relatively rare in a population of costly signalers (Johnstone, 1997). Religious communities, as other groups, may consist of constantly shifting systems where honest and deceptive signals compete against each other (Cronk, 1994; Johnstone & Grafen, 1993). Those that find the optimal balance of requirements and rewards and are able to prevent free-riding will thrive, while others will disappear. Thus, the implementation of costly signals may be a necessary but not sufficient condition of successful groups (Sosis & Bressler, 2003).

A different challenge to the costly signaling hypothesis of religion is the difficulty in drawing a clear distinction between religious and cooperative behaviors. Candomblé members participate in numerous activities that produce public goods, such as cooking or cleaning the terreiro. It can be argued that these activities are not religious signals but rather forms of conspicuous cooperation that advertise underlying qualities (Gintis et al., 2001). To avoid this problem, such activities were removed from the measure of religious signaling (CRSS). In Candomblé, however, seemingly secular activities are an integral part of the religious experience. The community itself is an embodiment of the *axé*, the life force of the universe, which is why members refer to their Candomblé group as “my *axé*”. The distinction between religion and community that is common in psychology of religion (dating to Allport's classic

characterization of intrinsic and extrinsic religiosity) may be somewhat artificial in this case and in the context of other religions with comparable characteristics.

The third hypothesis predicts that individuals who occupy marginalized social positions will be especially motivated to advertise their commitment and obtain higher scores on the CRSS. Candomblé terreiros have always been a source of support for vulnerable populations, from freed slaves in the 19th century (Harding, 2000) to women (Landes, 1994 [1947]) and homosexuals (Fry, 1986) in more recent times. Here, the data show a marginally significant negative relationship between income and CRSS. For individuals who are economically or socially vulnerable, motivation to join a religious community may come from the necessity of creating a buffer or insurance against an unpredictable future. In these cases, even the smaller rewards of group belonging may offset the sacrifices of religious participation. Alternatively, because these individuals are by definition less likely to have socialization or work alternatives, the opportunity costs of joining a religious group will be lower.

In addition to social vulnerability, other individual circumstances may also predict increased signaling. Newer terreiro members, predicted to be in greater need of demonstrating commitment, actually score lower in the CRSS. A possible explanation consistent with the internalization of belief mentioned earlier may be that those who remain in the group longer do so because they become increasingly devoted to the group and its ideas. Members without relatives in the terreiro were also hypothesized to signal more because they have fewer avenues of support from fellow members, but the opposite was the case. This may be explained by the role that kin occupy in these communities. For the *mãe-de-santo* and her family, the terreiro is not only a spiritual center but also a source of income. For this reason, close relatives often occupy positions in the hierarchy that require intensive participation in religious activities.

Terreiro members will accrue different benefits from ritual participation, but individuals will also perceive each requirement or restriction as entailing different costs. For example, a female over reproductive age will not find a taboo on sexual relations as costly as a younger individual. On the other hand, the older woman may find the physical demands of chanting and dancing more exacting than her younger counterpart. Thus, to minimize costs while obtaining the rewards of signaling some individuals may participate in ritual performances that exaggerate their involvement (Cronk, 1994). Possession trance, a highly visible and dramatic event, might be a possible arena to investigate this idea. In Candomblé as in other religions, possession does not affect all individuals equally and it can occur in different contexts. It may be that possession episodes and other dramatic aspects of ritual are strategic signals intended to amplify audience effects. Life-history events, changes in social or economic status, and political instability may also alter individual circumstances and give rise to manipulative strategies. The roles of receiver psychology and exploitation

have not yet received much attention in the area of religion, but signaling approaches provide an opportunity to incorporate these elements in future research.

While the idea that religion fosters group cohesion has been a long-standing assumption in the social sciences, costly signaling provides a mechanism as to how this might occur. This study focused exclusively on variation in religious signaling among Candomblé adherents, but the question of why costly signaling appears to be effective in religious but not in secular communities remains open (see Sosis & Bressler, 2003). As many others have noted, belief in a supernatural reality renders the actions and emotions of adherents uniquely real and meaningful. The unverifiable nature of religious ideas may make religious organizations immune to the practical problems that face secular authority. Another related possibility is that supernatural beings provide an unseen but effective deterrent for would-be free-riders (e.g., Johnson & Bering, 2006; Roes & Raymond, 2003; Rossano, 2007), although, as mentioned earlier, this trait does not seem to fit Candomblé. Empirical investigations of what makes religious ritual “special” remains an important next step in neo-Darwinian accounts of religion.

Supplementary Materials

Supplementary data to this article can be found online at [doi:10.1016/j.evolhumbehav.2011.11.004](https://doi.org/10.1016/j.evolhumbehav.2011.11.004).

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