

The God Allusion: Individual variation in Agency Detection, Mentalizing and
Schizotypy and their Association with Religious Beliefs & Behaviors

Rafael Wlodarski^{a*} and Eiluned Pearce^a

^a Department of Experimental Psychology, University of Oxford

* Corresponding author. Address: Department of Experimental Psychology, South Parks
Road, Oxford OX1 3UD, UK. Email: rafael.wlodarski@psy.ox.ac.uk. Phone: +44 (0) 01865
71367.

Abstract

It has previously been suggested that the historically and geographically widespread persistence of religious beliefs occurs because it is a by-product of normal cognitive processes, ones which first evolved to confer survival advantages in the social domain. If this theory holds, then it is likely that inter-individual variation in the same biases may predict corresponding inter-individual variation in religious thoughts and behaviors. Using an online questionnaire, 298 participants answered questions regarding their tendency to detect agency, the degree to which they displayed schizotypal traits, their ability to understand the emotions and motivations of others ('mentalizing'), and their religious beliefs and behaviors. Path analysis suggested that mentalizing, agency detection and schizotypal thinking were each independently related to religiosity. Furthermore, schizotypal thinking and agency detection were highly interrelated with one another, while mentalizing was not. Although the degree to which an individual engages with religious or spiritual beliefs will be influenced by their cultural and historical context, this paper helps to elucidate the interplay between various cognitive processes that might predispose some individuals but not others towards holding such beliefs in the first place.

Key Words: religious belief; agency detection; agency; schizotypy; theory of mind; mentalizing; empathy.

Introduction

Religious beliefs and practices are both historically and cross-culturally widespread, found in some form in every known human society (Norenzayan, 2013). It is estimated that there currently exist at least 10,000 distinct religions, each with their own set of beliefs, rituals and portrayals of supernatural beings (D. B. Barrett, Kurian, & Johnson, 1998). Even individuals who do not partake in organized religion may identify with having ‘spiritual’ beliefs that are considered religious in the widest sense (Saucier & Skrzypińska, 2006). The apparent universality of religiosity implies that these diverse sets of distinctive beliefs might come quite naturally to humans, and that actually an atheistic mind-set is the oddity (Boyer, 2008; McCauley, 2000). Consequently, the prevalence of personal and institutionalized religious beliefs both across time and geography has led some researchers to examine the kinds of cognitive mechanisms which might both underlie, and help promulgate, this near-universal phenomenon.

An increasingly popular approach to explaining the pervasive existence of religious tendencies is the suggestion that such beliefs piggyback on everyday cognitive processes, processes that primarily evolved because they confer certain survival advantages (Atran & Norenzayan, 2005; J. L. Barrett, 2000; Bering, 2002). For instance, religious beings in the form of gods or spiritual deities oftentimes combine non-human traits, such as omnipresence or the ability to fly, with human-like properties, such as humanoid shapes, a physical presence, and mental states. Indeed, it may be these minimally counter-intuitive amalgamations of normal human features and minimal violations of category characteristics that make such conceptual beings so attractive (J. L. Barrett, 2000; Guthrie, 1993; Shtulman, 2008). Given that supernatural beings are considered to be agents with mind-states, it has been argued that belief in supernatural beings is likely to involve cognitive processes also relevant to dealing with social relationships with other humans, such as ascribing agency to

others and reasoning about their mental states. In other words, the cognitive processes that help individuals function in the types of complex social environments typically found in the ‘real world’, where members of the network are dispersed and therefore not physically present all the time, can also be applied to imagined or ‘virtual’ social interactions with supernatural entities even though they may never have a physical presence (Atran & Norenzayan, 2005; J. L. Barrett, 2000, 2007; Bering, 2002; Guthrie, 1980; Holt-Lunstad, Smith, & Layton, 2010; Pearce, 2014). Although cultural and personal context remain important, the general human predisposition to apply social cognitive processes beyond the sphere of face-to-face physical social interactions is likely to be a necessary pre-condition for many types of religious beliefs and cognitions to arise. Here, we build on previous work that has identified some of the specific social cognitive processes which may be associated with ‘religious thinking’, or religiosity, to examine whether individual variation in these cognitive abilities might be associated with corresponding individual variation in religiosity.

Three candidate cognitive processes, or biases, that have been posited to underlie the human tendency towards religious thinking are (i) attribution of agency and the ascription of human-like mental states to non-human life-forms or objects (a form of anthropomorphizing), (ii) identifying and reasoning about the content of those mental states, or ‘mentalizing’ and (iii) schizotypal personality traits associated with ‘odd’ thinking and novel perceptual experiences (here referred to as ‘schizotypal thinking’ and representing a subcomponent of schizotypy) (Atran & Norenzayan, 2005; J. L. Barrett, 2000; Bentall, Claridge, & Slade, 1989). The ‘cognitive science of religion’ approach argues that humans are generally attracted to religious thought because these underlying biases predispose them to such thinking. Although these cognitive biases have been proposed to explain the existence of religious tendencies in general, the question of whether individuals who show greater levels of these biases would be *more* susceptible or responsive to religious thinking than individuals

who display lower levels of these biases has not yet been tackled in depth. For instance, individuals who are more disposed (i) to seeing agency in the natural world, (ii) to ruminate on the mind-states of such ‘imagined’ agents, and (iii) who experience schizotypal cognitions and sensations may find religious concepts easier to intuit and accept than other individuals.

Humans are known to display considerable inter-individual variation in many cognitive abilities and traits, including those associated with sociality (i.e. Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Stiller & Dunbar, 2007; Willard & Norenzayan, 2013). Inter-individual variation in many domains (such as personality traits or mating strategies) arises from a combination of genetic and environmental influences, and is thought to be adaptive as differential fitness payoffs may accrue to various traits/strategies depending on their relative frequency in a population (e.g. Dall, Houston, & McNamara, 2004; Maynard Smith, 1984; Wlodarski, Manning, & Dunbar, 2015). By examining such inter-individual variation in agency detection, mentalizing and schizotypal thinking and any corresponding variation in religiosity, the assumptions made by theories in the cognitive sciences of religion, namely that these cognitive thinking styles underlie religious thinking, can be empirically tested: individual with stronger cognitive biases should be more likely to express greater religiosity. Moreover, by exploring these cognitive biases simultaneously, a clearer picture, of both the relationship between these cognitive processes, and their direct and indirect relationships with religiosity, can be elucidated.

Agency Detection

The first cognitive bias thought to underlie religious beliefs is the tendency to detect agency, or ‘intentions,’ in individuals and objects in the environment. Ascribing such agency aids in attributing purpose to external events – in the case of religion purpose arising from the intentioned activities of supernatural agents (Michotte, 1963). Agency detection may have arisen as an evolved survival strategy which allows for ‘erring on the side of caution’ when

presented with an ambiguous or unpredictable stimuli, since the cost for failing to detect agents (e.g. a predator) may be much higher than for incorrectly assuming the presence of agents where none exist (J. L. Barrett, 2000; Guthrie, 1993). Attribution of agency can also be referred to as a specific type of anthropomorphism: attributing human-like traits to non-human beings or objects, traits that include mental states.

In general, humans have such hyperactive agency detection tendencies that almost any object can be viewed as possessing human-like traits, including animals, forces of nature, technological tools, and even the simplest of geometric shapes (Epley, Waytz, & Cacioppo, 2007; Guthrie, 1993). Studies have previously suggested that a link exists between religious thinking and agency detection by finding that religious individuals are more likely to detect faces in semi-ambiguous stimuli, irrespective of the actual presence of a face-like stimulus (Riekkki, Lindeman, Aleneff, Halme, & Nuortimo, 2013). Interestingly, individuals are typically more likely to attribute psychological mind-state features, rather than human physical or biological features, to religious or fictive supernatural beings (Shtulman, 2008).

Mentalizing

While one of the outcomes of agency detection may be attribution of mental states to non-human entities, another necessary step underlying religious belief entails the more involved ability to reason about the actual content of those mental states, referred to as mentalizing or ‘Theory of Mind’ (Apperly, 2012; Premack & Woodruff, 1978). This ability allows an individual to understand that others may hold different beliefs, desires, and intentions to their own, and to reason about the content of such beliefs. One fundamental component of reasoning about the content of others’ mind states includes the ability to understand the emotional states of others, which is aided by the ability to put oneself in the place of another, that is, to empathize.

Identifying and understanding mental states ('mentalizing') is a necessary prerequisite for the creation of the kinds of complex mental representations typically ascribed to supernatural beings and gods found in most religious belief systems (J. L. Barrett, 2000; Dunbar, 2003; Norenzayan, Gervais, & Trzesniewski, 2012). Indeed, studies which have looked at brain activations in individuals who are thinking about god or praying find activations in regions typically also associated with 'mentalizing' (Kapogiannis et al., 2009; Schjoedt, Stødtkilde-Jørgensen, Geertz, & Roepstorff, 2009), and children begin to reason about the mental states of supernatural agents at around the same time as they develop the ability to reason about what other humans are thinking (around the age of four – though some studies have suggested that it may be present in some form in infants as young as 12-18 months (U. Frith & Frith, 2003; Lane, Wellman, & Evans, 2010)). Further evidence that mentalizing may be a pre-requisite for holding religious beliefs comes from research with individuals who show deficits in their ability to mentalize about the mental states of others, i.e. individuals diagnosed with autism-spectrum disorders (Baron-Cohen, Leslie, & Frith, 1985; Korkmaz, 2011). Several studies have shown that those on the autism spectrum are more likely to self-identify as atheist and are less likely to believe in god, with mentalizing abilities (as indexed by empathizing) thought to be a key mediating variable: the less able individuals are to empathize (i.e. understand others' emotional mind-states), the less likely they are to be religious (Caldwell-harris, Murphy, & Velazquez, 2011; Norenzayan et al., 2012).

Schizotypal Thinking

As well as links between religiosity and agency attribution, and religiosity and mentalizing, previous research also supports a link between religiosity and schizotypal cognitions and sensations. Schizotypy is a set of traits found in non-clinical populations which include unusual perceptual experiences and cognitive disorganization (Bentall et al.,

1989). In its extreme form, namely the clinical diagnosis of schizophrenia, schizotypal traits have been associated with agency and perceptual misattribution – whereupon individuals wrongly attribute their own thoughts or perceptions to others, or attribute other's thoughts and perceptions to themselves (Dein & Littlewood, 2011; C. D. Frith, 1992). Research has found that individuals scoring highly on scales assessing various delusional tendencies are more likely to display hyper-religious behavior, or to become members of new religious movements (Peters, Day, Mckenna, & Orbach, 1999; Previc, 2006). Furthermore, some schizotypal traits found in normal populations have also been associated with certain religious tendencies, particularly among men (Diduca & Joseph, 1997; Maltby & Day, 2002).

The presence of these cognitive biases, namely the tendency to detect agency, the ability to mentalize, and schizotypal thinking, is thought to be a necessary pre-prerequisite for various types of religious thoughts and beliefs (religiosity). It has also been previously found that individual variation in these abilities may be independently related to variation in religiosity. However, these cognitive biases share a in common and are all closely tied to general social cognition, and thus may have strong associations to not only religiosity, but also with one another. The aim of the current study was to examine these cognitive processes and their implications for religiosity in parallel, looking at both their relative impact on religiosity, as well the interrelationships between them. Only by examining the relationships between these cognitive abilities simultaneously can we begin to speculate about which of them might be the primary drivers of religiosity, and which may in fact just be different facets of common underlying cognitive processes.

Methods

Participant Recruitment

An online questionnaire was distributed to U.S. based participants using the Mechanical Turk micro-task crowdsourcing platform. Participants were over 18 years old and were informed that their responses were completely voluntary and anonymous. Participants provided informed consent, and were remunerated the standard Mechanical Turk payment amount for their time. The study was approved by Oxford University's Research Ethics Committee (CUREC).

In total, 298 participants completed the survey, of whom 141 were male and 157 were female, ranging in age from 19 to 65 ($M = 37.1$, $SD = 11.9$). The most common self-reported 'primary religious affiliations' reported by participants were Atheist (22.1%), Catholic (16.8%), Agnostic (16.8%), Christian (Other) (14.8%) and Protestant (13.8%).

Questionnaire Design

Several standardized scales were used in the questionnaire to assess individuals' tendency to ascribe agency, their mentalizing abilities, presence of schizotypal traits, and their religious beliefs and practices.

To assess individual tendency to ascribe agency, the Individual Differences in Anthropomorphism Questionnaire (IDAQ, Waytz, Cacioppo, & Epley, 2010) was used. This psychometrically validated measure assesses an individual's tendency to ascribe free will, emotions, intentions and consciousness (i.e. agency) to a variety of non-human objects, including animals, the natural environment, and technological items. Questions included items such as "*To what extent does a tree have free will?*," with answers to all questions recorded on 10-point Likert-type scales ranging from "Not at all" to "Very Much."

A key component of mentalizing, or the ability to infer the content of the mental states of others, involves the ability to empathize with other individuals so as to better ascertain the content of their mental states (Baron-Cohen et al., 1985; Baron-Cohen, 2009). To that end, a

short-version of the Empathy Quotient (EQ, Loewen, Lyle, & Nachshen, 2010; Wakabayashi et al., 2006) scale was used as a proxy measure of mentalizing abilities. This 8-item scale included questions such as *“I am good at predicting how someone will feel”* and *“It is hard for me to see why some things upset people so much”*, with responses measured on a 4-point Likert-type scale ranging from *“Strongly Disagree”* to *“Strongly Agree”*. The EQ has been successfully used in past studies as a proxy for mentalizing and has been shown to have an independent association with religious beliefs (Norenzayan et al., 2012).

The presence of a relevant Schizotypal thinking style was assessed using the ‘Odd Beliefs / Magical Thinking’ and ‘Unusual Perceptual Experiences’ subscales of the Schizotypal Personality Questionnaire (SPQ, Raine, 1991). Questions included items such as *“Can other people feel your feelings when they are not there?”* and *“Have you often mistaken objects or shadows for people, or noises for voices?”* with responses measured on a 4-point scale: “Yes,” “Maybe,” “No,” “Unsure,” and with any “Yes” responses scoring one point on the standard scale. These particular subscales were used as they most closely assess cognitions related to mis-ascription of mind-states and perceptual experiences between self and others, cognitions which have been shown in past research to be related to certain types of religious beliefs (i.e. Farias, Claridge, & Lalljee, 2005).

Religious beliefs were assessed using two established scales of religiosity. The Short Santa Clara Strength of Religious Faith Questionnaire (SCSRFQ, Plante, Vallaey, Sherman, & Wallston, 2002) includes five items such as *“My faith impacts many of my decisions,”* with responses collected on a 4-point Likert-type scale ranging from *“Strongly Disagree”* to *“Strongly Agree”*. The Duke University Religion Index (DUREL, Koenig & Büssing, 2010) contains five items, with three questions relating to religious beliefs (i.e. *“In my life, I experience the presence of the Divine”*) and measured on a 5-point Likert-type scale ranging from *“Definitely not true”* to *“Definitely True,”* and two questions relating to frequency of

religious practice and attendance (i.e. “*How often do you attend church/synagogue/mosque or any other religious meetings (outside of weddings/funeral services)?*”) with responses measured on a 6-point Likert-type scale ranging from “*Never*” to “*More than once a week.*” Since responses to individual items across both scales were found to be very highly inter-related (*Cronbach’s* $\alpha = .96$), the mean of the responses to items on both scales was used to create a general ‘religiosity’ score to be used in further analysis.

Questions were also asked about general demographic information, including age, sex, level of education and primary religious affiliation.

Results

The correlations between each of the four variables of interest in this study are presented in Table 1. As can be seen in this table, religiosity was significantly correlated with all three variables of interest, agency detection, mentalizing and schizotypal thinking, as well as with sex (with females being significantly more religious than males). Schizotypal thinking and agency detection were also strongly positively correlated with each other, and females were found to be significantly better at mentalizing than males. The relationship between these variables and age was also examined, however since no significant associations were found (all *Pearson’s* r s < .071, all p s > .308), age was dropped from further analysis.

Table 1. Correlation matrix between mentalizing, schizotypal thinking, agency detection and religiosity

	Sex	Mentalizing	Schizotypal Thinking	Agency Detection	Religiosity
Sex	1	.243**	.097	.082	.134*

Mentalizing	1	-.015	-.006	.175*
Schizotypal thinking		1	.505**	.256**
Agency detection			1	.240**
Religiosity				1

*Note: For sex, males = 0, females = 1; * $p < .01$, ** $p < .001$*

To examine the direct independent contributions of mentalizing, schizotypal thinking and agency detection towards participants' religiosity scores, the three predictor variables of interest plus sex were regressed onto religiosity in a linear regression analysis, the results of which are presented in Table 2. The regression analysis suggests that while both schizotypal thinking and mentalizing are predictors of religiosity, agency detection is not a significant predictor once the effects of schizotypal thinking and mentalizing are taken into account. Furthermore, this analysis suggests that when the effect of all the variables of interest on religiosity was taken into account at the same time, the independent effect of sex on religiosity was no longer significant. Since the subtraction of sex from this analysis was found to make no differences to the model fit ($\Delta r^2 < 0.001$) or the significance of the other predictor variables, sex was dropped as a predictor variable from further analysis.

Table 2. Regression of sex, mentalizing, schizotypal thinking, agency detection onto religiosity

	<i>B</i>	<i>SE B</i>	<i>β</i>
Constant	5.79	4.65	
Sex	0.92	1.60	.037
Mentalizing	0.29	0.11	.178*
Schizotypal thinking	0.74	0.26	.208*
Agency detection	0.05	0.03	.129

Note: For sex, males = 0, females = 1; $r^2 = .121$, * $p < .01$

In order to examine the inter-relationships between mentalizing, schizotypal thinking, and agency detection tendencies in more detail, and their mediating effects on religiosity, a path analysis (using standardized scores) was conducted using the Ω nyx analysis package (version 0.9-729, von Oertzen, Brandmaier, & Tsang, 2014). This analysis examines the relationships between each of these predictor variables, as well as their direct and mediated effects on religiosity, using Maximum Likelihood Estimation (MLE) of parameters. The results of the path analysis displayed in Figure 1 and Table 3.

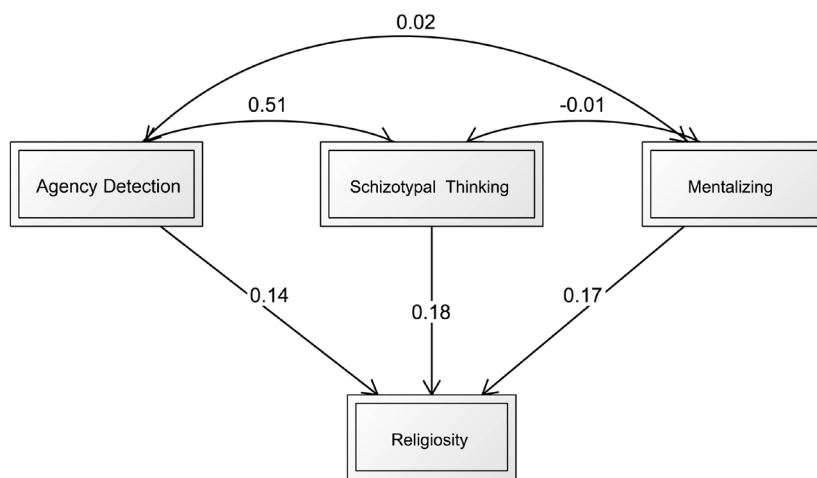


Fig 1. Path analysis of Agency detection, Schizotypal Thinking, Mentalizing, and Religiosity

Note: * $p < .01$, ** $p < .001$

Table 3. Path analysis covariate estimates

	Estimate	SE	z	P
Agency Detection – Religiosity	0.145	0.048	2.998	.003
Mentalizing – Agency Detection	0.018	0.045	0.415	.678
Mentalizing – Schizotypal thinking	-0.014	0.043	-0.324	.746
Schizotypal thinking – Agency Detection	0.514	0.049	10.487	.001
Mentalizing – Religiosity	0.171	0.040	4.264	.001
Schizotypy – Religiosity	0.184	0.047	3.875	.001

The path analysis model suggests that among the predictor variables, significant positive direct relationships exist between agency detection and religiosity, schizotypal thinking and religiosity, and mentalizing and religiosity. Additionally, a positive inter-relationship exists between agency detection and schizotypal thinking, with schizotypal thinking and agency detection both having indirect effects via each other on religiosity.

Discussion

The findings presented here suggest that mentalizing, agency detection, and schizotypal thinking are independently related to how religious individuals report themselves to be. Furthermore, as well as these direct relationships, the schizotypal pattern of thinking (as measured via subscales of the schizotypy scale) and agency ascription were also highly interrelated, meaning that they also have indirect relationships to religiosity via each other. Together, these results support the claim of Dein and Littlewood (2011) that there is a relationship between the schizotypal thinking style and religiosity as a consequence of the human tendency to detect agency. However, contra Dein and Littlewood, this relationship does not seem to be mediated by mentalizing ability. Instead, mentalizing ability seems to lie on a separate independent related to religiosity, as previously suggested by the finding that

reduced mentalizing ability (as indexed by autistic-like thinking styles) is associated with reduced religiosity (Norenzayan et al., 2012).

Some initial sex differences were found in this study, with females being better at mentalizing than males, and more likely to be religious than males. These findings are in line with past research which has found that not only are females more likely to be religious than males (i.e. Walter & Davie, 1998), but that this effect may be mediated by mentalizing ability (as assessed by empathizing) (Norenzayan et al., 2012), since females are sometimes found to show better mentalizing abilities than males (e.g. Baron-Cohen et al., 2001; Stiller & Dunbar, 2007). However, when sex was examined in conjunction with the other variables of interest, the effect of sex on religiosity was negated, suggesting that mentalizing, schizotypal thinking and agency detection are more relevant predictors of religiosity. A possible explanation for the sex difference found in mentalizing ability revolves around the question of whether females are actually better than males at mentalizing abilities, or if this observations is a by-product of the methodology used. Sex differences in mentalizing seem to only crop up when self-report measures are used, but disappear when more direct assessments of mentalizing are utilized instead (see Eisenberg & Lennon, 1984), suggesting the possibility of demand characteristics driving self-report differences. If this is the case, then sex differences in real-world mentalizing ability might be non-existent, calling into question the possibility that mentalizing mediates the relationship between sex and religious thinking.

Cognitive theories of religion have suggested that religious beliefs, and particularly beliefs related to the existence of supernatural agents, rely on several forms of cognition typically utilized in other social domains (Atran & Norenzayan, 2005; J. L. Barrett, 2000, 2007; Bering, 2002; Boyer, 1994; Guthrie, 1980). In support of this supposition, past research has suggested that religious and non-religious people tend to anthropomorphize God during real-time inferential processing of information (J. L. Barrett & Keil, 1996), and that a

relationship exists between schizotypal thinking and an extrinsic religious orientation (Maltby & Day, 2002), and between mentalizing abilities and religious belief (Norenzayan et al., 2012). This study adds to this growing body of literature by finding individual variation in all of cognitive abilities is related to religious belief outcomes, but it further suggests that the causal pathways may more complex than previously appreciated: agency detection and schizotypy were found to be closely interrelated with each other, while mentalizing abilities showed no relationship with either agency detection or schizotypy.

The apparently separate pathways to religiosity from (i) agency detection and schizotypal thinking, and (ii) from mentalizing, arise because forms of agency detection involve deeply rooted biases which utilize low-level mental processing abilities, abilities possibly shared with other animals, while mentalizing involves higher level cognitive processes involving greater activation of pre-frontal cortices and evolutionarily recent social decision making circuits (Apperly, 2012). Assessing the actual content of others' minds requires vastly more elaborate cognitive processes than basal 'pattern recognition' cognitions involved in seeing faces in everyday objects (Dunbar, 2003). The schizotypal thinking traits assessed here seem to be closely tied to agency detection, whereby individuals not only ascribe human-like (cognitive) features to various items in their environment, but also mis-ascribe agency to aspects of the environment – even in the absence of tangible environmental cues (as assessed by SPQ questions like *“Have you ever had the sense that some person or force is around you, even though you cannot see any-one?”*). It may be that schizotypal thinking relies on similar low-level processes to agency detection, and hence is similarly unrelated to 'high-level' mentalizing activities, as suggested by the lack of relationship in the path analysis found here. However, the question remains whether any one of these three processes is a primary driver of religiosity, or whether all of these processes are required to support religious thinking.

The fact that the regression analysis in this study showed relationships between (i) schizotypal thinking and religiosity and (ii) mentalizing and religiosity, but not between agency detection and religiosity, suggests that agency detection may in fact be a form of schizotypal thinking. It may be that the kind of miss-attribution of mental states found in some schizophrenic disorders also leads to greater levels of general agency detection, and once the effect of schizotypal thinking is partialled out, then agency detection behaviors on their own are not significant predictors of religious cognition. This finding implies that looking at agency detection as the sole predictor of religiosity (i.e. Riekkari et al., 2013) may be misleading, since it misses the important contribution of ‘unusual perceptual experiences’ and ‘odd beliefs/magical thinking,’ which might be the underlying cognitions leading to both agency detection and religious belief. Furthermore, the path analysis conducted here shows that not only is agency detection closely interrelated to schizotypal thinking, but that it is a weaker independent predictor of religiosity than either schizotypal thinking or mentalizing.

It is interesting to note that mentalizing ability does not appear to be as closely related to either agency detection or schizotypal thinking as past literature implies. It makes intuitive sense that in ascribing a mental state to a non-human object, or miss-ascribing the presence of a mental state to an unusual perceptual experience (as in the case of schizotypal thinking) an individual might need to also infer something about the content of that mental state. After all, a mental state can hardly be said to exist if it has no content. However, the Empathy Quotient used to index mentalizing ability in this study examined the ability to *accurately* infer the mental and emotional states of other individuals throughout daily life (using questions such as “*I often find it hard to judge if something is rude or polite*”). It may be that while merely ascribing the presence of mental states or agency to a non-human object is an important underlying factor associated with religiosity, the ability to interpret and identify *what* those

mental states might be is also important, and may be a separate (more involved) cognitive process to either basic agency detection or schizotypal thinking.

Mentalizing likely involves higher-level processes that are quite distinct and a more involved form of cognition than simple agency detection. Cognitively demanding processes such as mentalizing, or Theory of Mind, seem to only develop in humans at around the age of five, which is about the time that children also begin to reason about the mental states of various supernatural agents (Lane et al., 2010), whereas agency attribution (without understanding the content of mental states) occurs much earlier in development (U. Frith & Frith, 2003). This suggests that religion may only have been possible once the ability to mentalize evolved in addition to basic agency attribution (or in the case of schizotypal thinking, miss-attribution). In other words, it is likely that religion depends not only on understanding that other individuals have minds, but also on ascertaining what those mind-states might be. While basic agency detection may bias individuals to detect the presence of some form of agency, it may be this particular ability to assess the *content* of an agent's mind which led to the formation of religious thinking, which in turn would be reinforced as individuals come to have a *shared* understanding of the intentions of the kinds of supernatural beings which form the basis of most forms of religion.

Although chimpanzees and orangutans show some indication of understanding that other individuals have minds and perhaps even the contents of those minds (Cartmill & Byrne, 2007; O'Connell & Dunbar, 2003), it is likely that non-human primates do not possess 'higher order' mentalizing capabilities. Such capabilities would allow an individual to incorporate the mind-states of multiple individuals in a recursive fashion (e.g. I think that he thinks that god has a purpose for us) (Dunbar, 2003, 2008; Launay et al., 2015), and it may this unique ability which is the prerequisite for the rise of the kinds of pervasive religions found in human cultures. Through being able to track the mind-state of fellow individuals, as

well as of a supernatural being, and further realizing that others also hold mental representations of supernatural beings, ‘social’ religions with shared belief systems can arise once enough individuals develop such capabilities. How these more complex social cognitive abilities, namely higher-order mentalizing at multiple levels of recursion (keeping track of what others’ think about what others’ think about what other’s think) fit into the model presented here remains to be investigated.

It should be noted that the nature of a cross-sectional study such as this one limits the ability to make causal inferences about the data. It may well be that inter-individual differences in mentalizing ability, schizotypal thinking and agency detection predispose an individual to religious thinking to different degrees, but it is also possible that more frequent religious thoughts and practices lead to improved mentalizing, more sensitivity to agency detection and greater frequency of schizotypal thought. To examine the directionality of these effects, future experimental or intervention studies could attempt to manipulate these predictive traits, perhaps by providing training in mentalizing ability or in agency detection accuracy, and then measure effects of such interventions on the frequency and intensity of various religious cognitions.

This study found that inter-individual variation in the tendency to detect agency in the environment, variation in schizotypal thinking patterns, and the ability to understand the emotions and motivations of others (mentalizing) were all related to variation in religious beliefs and behaviors. Furthermore, it was found that schizotypal thinking and agency detection were highly interrelated with one another, while mentalizing ability was relatively independent of these two cognitive systems. These results support previous conjectures that religiosity may rely on, and possibly be a by-product of, normal cognitive processes which likely evolved to solve challenges in the social domain. Although the degree to which an individual holds spiritual beliefs will most certainly be influenced by cultural and historical

contexts, this paper also lends support to the notion that the human tendency towards religious thinking is associated, to some extent, with common cognitive biases.

Acknowledgements: We thank our colleagues at the Social and Evolutionary Neuroscience Research Group (SENRG) for their valuable input, particularly Jacques Launay and Robin IM Dunbar. RW and EP are supported by a European Research Council Advanced Grant.

The authors declare no conflict of interest.

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Biographical Sketches

Rafael Wlodarski, BBus, BA(Hon), DPhil, is a post-doctoral researcher at Oxford University's Department of Experimental Psychology. His research interests revolve around evolutionary approaches to the study of human behaviour, particularly human sociality, courtship and pair-bonding.

Eiluned Pearce, MA, MSc, DPhil, is a post-doctoral researcher at Oxford University's Department of Experimental Psychology. Her interests revolve around different aspects of social bonding, and she is currently looking at the bonding effects of group singing, and the role of genetics on inter-individual differences in sociality.