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RESEARCH ARTICLE

The Mutant Says in His Heart, "There Is No God": the Rejection of Collective Religiosity Centred Around the Worship of Moral Gods Is Associated with High Mutational Load

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Abstract
Industrialisation leads to relaxed selection and thus the accumulation of fitness-damaging genetic mutations. We argue that religion is a selected trait that would be highly sensitive to mutational load. We further argue that a specific form of religiousness was selected for in complex societies up until industrialisation based around the collective worship of moral gods. With the relaxation of selection, we predict the degeneration of this form of religion and diverse deviations from it. These deviations, however, would correlate with the same indicators because they would all be underpinned by mutational load. We test this hypothesis using two very different deviations: atheism and paranormal belief. We examine associations between these deviations and four indicators of mutational load: (1) poor general health, (2) autism, (3) fluctuating asymmetry, and (4) left-handedness. A systematic literature review combined with primary research on handedness demonstrates that atheism and/or paranormal belief is associated with all of these indicators of high mutational load.

Keywords Social epistasis model · Mutational load · Developmental stability · Religion · Health · Handedness

Introduction

There seems to be a stereotype that religious people, and especially religious women, are particularly attractive and healthy. A number of popular articles and social media pages discussing this observation can be found online (Malloy, 2017; Hewitt, 2010, p. 99) including threads beginning with questions such as "Why are Mormon girls so hot?" (*Yahoo Answers*, 2008) and "OMG … why are Christian woman so extremely (physically) attractive?" (*Yelp*, 2010). Several passages in the Bible seem to suggest that those who intensely fear Yahweh are more disease-resistant (Deut. 7:15) and are more physically attractive (e.g. I Samuel 16:18). Those inspired by other gods or by Satan are, in contrast, autistic (Mark 9:25) and even left-handed (Matt 25: 41). Why should the authors of these books believe this to be the case? It could, of course, be a way of idealising the virtuous, but it is not clear that all of these features were the most pertinent for that purpose.

The recently proposed social epistasis model (Woodley of Menie et al., 2017) may be in line with some of these observations. Specifically, the authors demonstrate that there has been deleterious mutation accumulation since the Industrial Revolution, as a function of relaxed selection on many health- and fitness-related dimensions. This relaxation has been caused by reduced environmental harshness. In particular, Woodley of Menie et al. argue that throughout history child mortality has been strongly associated with genetic mutational load and that reduced mortality therefore leads to an accumulation of genetic mutations in the population. This is, in turn, reflected in increasing levels of medical and neurodevelopmental disorders, such as autism (Blaxill, 2004), fluctuating asymmetry (Woodley of Menie & Fernandes, 2016), and left-handedness (McManus et al., 2010). Noting that 84% of our genes relate to the brain, Woodley of Menie et al. propose that the human mind would be particularly

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sensitive to this mutational accumulation, which would have been selected against under conditions of natural selection. They argue that these "behaviour-altering 'spiteful' mutations" (p. 181) are maladaptive and would include pathological altruism, for example, where people are altruistic to the degree that it damages their individual genetic interests. They would also include any thought process that leads to a group's sub-replacement fertility. Woodley of Menie et al. maintain that such "spiteful mutations" can significantly negatively impact even those who do not carry them, by inspiring ways of thinking which undermine the ability of the society to create an environment conducive to maximum fitness.

Accordingly, behavioural tendencies and worldviews that were widespread before industrialisation are very likely to have been selected for, because they benefitted genetic fitness. Woodley of Menie et al. aver that religiosity, with a heritability of roughly 0.4 for belief (Koenig et al., 2005) and 0.3 for ritual attendance (Bradshaw & Ellison, 2008), is an example of such a trait. Indeed, several strains of evidence suggest that religiosity may be selected for in itself: it is a human universal, it is associated with increased fertility, it is partly genetic, it has clear physical manifestations in terms of brain changes specifically associated with religious experiences, for example, and it is arguably adaptive, by way of promoting health and health-related behaviours (see Vaas, 2009). These consistent health benefits refer specifically to such forms of religiosity wherein there is both religious belief and religious practice via group rituals (see Koenig, 2012).

Religiosity has been selected for on a number of levels. It is group-selected for, because religious groups tend to be higher in ethnocentrism (e.g. Dutton et al., 2016) meaning that they have a higher probability of triumphing in battles of group selection, as shown in computer models (e.g. Hammond & Axelrod, 2006). We recognise that there is considerable debate over the utility of group selection. Wilson and Sober (1994) have advocated the "Multi-Level Selection Theory". They argue that once cooperative groups develop within a species, then selection will act to promote those groups which possess the optimum level of certain qualities which permit them to outcompete other groups. Thus, selection will still operate on individuals within a group but can also be seen to operate on groups themselves, as collections of individuals, in some circumstances, can shift away from individual and towards group selection. This model helps to explain, for example, the development of altruistic tendencies. Kin selection involves making sacrifices for your kin and group selection is a logical extension of this, as ethnic groups are extended kinship groups. "Group selection" has been criticised in depth by Pinker (2012). His key criticisms are that (1) group selection deviates from the "random mutation" model inherent in evolution; (2) we are clearly not going to be selected to damage our individual interests, as group selection implies; and (3) human altruism is self-interested and does not involve the kind of self-sacrifice engaged in by sterile bees. Each of these points can be answered. Firstly, if the group selection model is building on the individual selection model, then it is bound to present a slightly different metaphor. To dismiss it on these grounds seems to betoken a fervent attachment to the original idea. Secondly, the group selection model merely suggests that a group will be more successful if there is genetic diversity, meaning that an optimum percentage of its members are inclined to sacrifice themselves for their group. Thirdly, it is clearly the case that a small percentage, in many groups, is indeed prepared to sacrifice itself for the group. So, it seems to us that it is reasonable to accept multi-level selection and to regard religion as group selected.

Religiosity is sexually selected for, because it functions as a marker of socially desirable traits (Dunkel et al., 2015a), for example that a person follows moral rules and has access to a useful network of co-religionists (Blume, 2009; Figueredo et al., 2006). It is also individually selected for because it renders adherents more pro-social due to the belief that they are being watched, meaning they are less likely to be cast out of the band or killed. It also reduces anxiety in the face of difficulties (Norenzayan & Shariff, 2008) and tends to provide God-mandated justifications for fitness-improving behaviour, including prescriptions for procreation and parental investment (Sela et al., 2015). This being the case, we would expect that most people in a pre-industrial context would be relatively religious because it is selected for thanks to its associated fitness benefits on multiple levels.

However, complex pre-industrial societies developed a very specific form of religiosity. Norenzayen and Shariff (2008) argue that the development of agricultural societies and then city states helped to cause selection for a more universalist form of religiousness, focused around a moral God, and that this in turn helped to hold together increasingly larger and genetically diverse societies composed increasingly of strangers and non-kin. Similarly, Cofnas (2012) has argued that general intelligence evolved with universalist religions, because as more intelligent groups expanded they needed universal religion to hold them together. As Norenzayan and Shariff (2008) have observed, hunter-gatherer societies do not generally have moral gods, but rather a large number of spirits who are appeased in various ways. So, we can conclude that complex pre-industrial societies were strongly selected not merely to be religious in a general sense, but to revere and believe in moral gods who were concerned with people's moral behaviour and to engage in collective rituals to worship these gods. Insomuch as selection continued up until the Industrial Revolution, we would expect people to have become increasingly religious in this specific way across time. Indeed, Dutton and Madison (2017) have shown that England became more religious, more fervent in dedication to God, across the Middle Ages. By the eighteenth century, God was strongly believed in while genuine belief in spirits—

comparable to those of hunter-gatherer societies—had gradually died off, increasingly dismissed as superstition (Broomhill, 2016). We appreciate that this model raises potential questions. Buddhism, in theory, involves no personal God. However, in practice, Buddha is either worshipped as a god or the religion is adhered to alongside another one where there are personal gods (see Faure, 2011). Similarly, it has been argued that atheistic ideologies, such as Marxism, have many religious dimensions (Eliade, 1957), to the extent that they are, to some extent, "replacement religions" (see Dutton, 2014). However, in practice, their leaders are often accorded transcendental powers and ultimately literal god-like status, as in the Soviet Union with Lenin and Stalin (Froese, 2008, p. 64).

Accordingly, the relaxation of selection would lead to deviation from this very carefully selected religious norm. These deviations would be diverse and might appear to be superficially very different. However as they are underpinned by the same process—increasing genetic mutation affecting the mind—we hypothesise that they would be associated with the same genetic correlates. In the present study, we will test this hypothesis by examining the genetic associations of two examples of these deviations. The first is atheism. Obviously, we would expect atheism to be selected against due to the adaptive nature of religiousness. It must be stressed that there are many different kinds of atheism. Some atheists may be highly moral and may develop relatively systematic worldviews even involving collective ritual, such as Marxism. Others may simply be selfish and nihilistic with an aversion to religion. But they have in common their rejection of a way of thinking and behaving that would have been selected for under pre-industrial conditions: they reject the belief in and collective worship of moral deities. The second belief which we will explore is belief in the paranormal. This is clearly a deviation from the belief in a moral god and will usually be a deviation from the regular participation in religious ritual, though there may be exceptions, such as Spiritualist churches (see Walliss, 2010). We would expect that the belief in a world influenced by ghosts would have been selected against because it is, in fact, comparable to the kinds of beliefs held by hunter-gatherer societies, and does not involve a moral god.

We would expect that, as selection ceases to weed out mutations, the prevalence of these kinds of beliefs would increase. This is very clearly the case for atheism in the UK. Participation in religious rituals and church membership has plummeted over the last century. In 1900, 27% of the British population attended church once a week or were members of a church, but this had fallen to 11% by 2010 (Brierley, 2010) and continues to fall. In a 1957 Gallup POLL, 6% of British people did not believe in God, but this had increased to 14% in 1993 (Dutton, 2014) and 46% in 2015 (Gallup, 2003). However, this apparent decline in religious belief is much less pronounced when other forms of religion are considered, such as when people are asked if they believe in "God or a Life Force". At the same time, paranormal belief has been increasing. According to YouGov Polls in 2009 and 2005, 40% of British people claimed to believe in the supernatural. By 2013, this had risen to 52% (reported in Copping 2013), and a poll by UK TV in 2014 found that 49% of Britons believed in God but 55% believed in the supernatural (Field 2014). According to YouGov, 7% of British people claimed to have experienced a ghost in 1950, a figure that had increased to 14% in 1990, 19% in 2003, and 25% in 2011 (Daily Mail Reporter 2011). Belief in ghosts in the USA was 25% in 1990 and 32% in 2005 (Kim et al., 2015).

We would expect these separate beliefs—atheism and paranormal belief—to be associated with indicators of mutational load, with mutational load being reflected in developmental instability. Developmental stability relates to the ability of an organism to produce a phenotype from the genotype. Suboptimal genetic or environmental conditions (e.g. mutations and ecological stress) will cause development to deviate from the optimum and lead to suboptimal physical and mental development. As such, optimal physical and mental development serve as honesty signals for the organism's genetic fitness, on which sexual selection can then operate (Woodley of Menie et al., 2017). Examples include health (Penke et al., 2007) and physical attractiveness: Symmetrical faces and other anatomical structures are regarded as attractive because they evidence the ability to maintain a symmetrical phenotype in the face of environmental stressors, which also implies low mutational load (Markow, 1992). Accordingly, our hypothesis predicts that high developmental stability is associated with the very specific kind of religiousness which we have argued that humans in complex societies were selected to have until industrialisation. As deviations from this, atheism and belief in the paranormal will be associated with indicators of developmental instability, which betoken high mutational load.

Literature Review

In order to test these two predictions, we conducted a systematic literature review in order to unearth studies revealing a relationship between religiousness and developmental stability, following the PRISMA guidelines (http://www.prisma-statement.org/). We decided to use the following eligibility criteria for including studies in the review:

(1) The study relates to an accepted measure of developmental stability as laid out by Woodley of Menie et al. (2017). These measures were established as general mental and physical health, autism, fluctuating asymmetry (physical attractiveness), and left-handedness. We only employed these specific measures because it is accepted that they reflect developmental stability.
(2) The study tested whether there was (a) a correlation between atheism and the measure of developmental

instability and (b) strongly implied the presence or absence of such a relationship.

(3) The study had to report original data and not be based on data reported elsewhere. Based on these criteria, we searched for the literature using the following PRISMA procedure. We conducted the literature search using Google Scholar and then repeated it using Web of Science.

The next step was to copy all titles into a Word document, numbered and marked with the grounds for including or excluding them, according to the "Data Management" part of the PRISMA procedure.

Finally, we decided, based on the above-described criteria and on further analyses of the content of the articles (e.g. title, abstract, text), which papers to include, according to the PRISMA selection process.

Our literature search process is now described in line with the PRISMA guidelines. We combined each measure of developmental instability with the keywords "atheism" or "religiousness" and "correlation", for example "fluctuating asymmetry AND atheism AND correlation". Various forms of the search terms were tested, and the number of hits indicated that the following keywords yielded large but still manageable amounts of literature.

In the case of health and religion, as will be discussed below, we relied on the relatively recent systematic literature review conducted by Koenig (2012). We could not find any formal meta-analysis of the relationship between health and paranormal belief. An in-depth review of the association between mental health and paranormal has already been conducted (Dein, 2012) indicating a robust relationship.

Google Scholar Starting with autism, autism AND atheism revealed 2300 studies of which three were relevant. "Fluctuating asymmetry" produced 38 hits of which none were relevant. "Left handed" produced 1120 hits of which one was germane.

Continuing with religiousness, autism unearthed 4570 hits of which 5 were relevant and 4 were new: left-handedness (which automatically included permutations of this term) unearthed 2230 hits but none were relevant. Fluctuating asymmetry provided 412 hits of which one was relevant, on the paranormal. Accordingly, we repeated the searches using the keyword "paranormal". This unearthed 3 further articles in relation to left-handedness. Finally, we searched the reference lists of articles we had found and asked colleagues who might know of relevant research. This revealed two further relevant hits.

Web of Science Repeating the autism-religiousness search, we found 107 hits, of which 1 was both new and relevant. For fluctuating asymmetry, there were 4 hits of which 0 were relevant. For left-handedness, there were 14 hits and none was relevant. Repeating the search with paranormal, we found 10 hits (0 relevant) for left-handed etcetera and 4 hits (2 relevant) for fluctuating asymmetry. Trawling the reference lists in these articles did not unearth any further relevant studies.

The Relationship Between Religiousness and Health

Harold Koenig is an authority in the field of the religion-health nexus. A meta-analysis of 100 studies on different measures found a correlation of 0.29–0.38 between religiousness and physical and mental health (see Koenig et al., 2012). In addition, Koenig (2012) conducted a meta-analysis of studies of this relationship published between 1872 and 2010. Using this method, Koenig and his team identified over 1200 "quantitative original data-based publications during the period 1872 to 2000 and 2,100 studies examining the R/S-health *(Religion-Spirituality-Health)* relationship from 2000 to 2010" (Koenig, 2012). By comparing with other reviews conducted around the same time, they concluded that they had captured about 75% of the published research on this nexus. Koenig and his team found that 80% of the religion-health nexus studies were on the relationship between religion and mental health, with only 20% on physical health. They analysed those studies which reached statistical significance, finding that on the overwhelming majority of measures of physical health, mental health, and healthy behaviour, religious belief and participation were positively associated with health. Exceptions included certain mood disorders which were positively correlated with religiousness, because hyper-religiosity is a symptom of them. These were schizophrenia and bipolar disorder.

Overall, Koenig (2012) argues that his findings can be explained by the following: (1) the ways in which religion provides emotional resources for coping with stress by giving eternal meaning to life and providing a God who will ultimately look after you; (2) its pro-social doctrines, helping one to avoid stresses which induce poor mental health (e.g. social conflict); and (3) the social dimension of religion, meaning a social support network will exist to help alleviate stress when it arises. Further, the religious engage in more healthy behaviour, partly inspired by religious teachings to do so, such as to avoid excessive (or any) alcohol, meat, and sexual promiscuity, for example. It should be emphasised that not all religious people are healthy. For example, the southern states of the USA are highly religious but also have high levels of obesity. But it can certainly be argued that even in these areas the devoted will be encouraged by their churches to eschew alcohol, sexual promiscuity, and smoking, using Biblical justifications. Moreover, the southern states differ from less religious states in many ways which co-vary with religiosity—such as in terms of education level and average income. These would need to be controlled for in order to examine the relationship

between religion and health (Myers, 2014, p. 90). The physical health-religion nexus, argues Koenig (2012), is thus a consequence of the positive psychology of the religious and their strong social support network, which increases physical health mainly through decreasing stress levels. Koenig briefly mentions the possibility that genetics may be relevant—due to the significantly heritable nature of religion and personality—but he does not pursue this. However, many traits that are heritable are also influenced by the same genes through pleiotropy, so there is a strong case that genetics may play a significant part in the religion-health relationship.

The Heritability of Koenig's Measures

All of the measures employed by Koenig (2012) for which we could find heritability estimates have a non-trivial genetic influence, as seen in Table 1. Where relevant, we draw upon Polderman et al.'s (2015) meta-analysis. On this basis, we have strong grounds for suspecting that the religion-health nexus may be partly genetic.

We wrote to Dr. Koenig to ask whether any studies led towards the conclusion of a genetic influence over the religion-health nexus. He was aware of three such studies, all of which he was involved in, none of which allowed the case to be directly proven. Koenig et al. (1997) found a positive correlation between religious service attendance and plasma interleukin-6 (IL-6) levels and between religious service attendance and other immune-system regulators and inflammatory substances. Interleukin-6 is known to stimulate immune response. Controlling for confounding variables, including chronic illnesses, the authors found that in 1992 those who regularly attended church in 1989 were significantly healthier than non-attenders in 1989. Specifically, they seemed to have better immune systems. There was no environmental variable that appeared to explain this association, the authors reported. By implication, the simplest explanation is that genetic differences may explain the association. In addition, two studies looking at candidate genes (Dew & Koenig, 2014 and Koenig et al., 2015) imply that the religious are genetically less anxious. However, it should be noted that such literature can be problematic, involving failures to replicate and similar issues. So, as our model would predict, religiousness of the specific kind we have identified is associated with physical and mental health, and the simplest and most likely explanation for this seems to be common genetic influences.

By contrast, belief in the paranormal is associated with poor mental health (Dein, 2012). Schizophrenia is associated with belief in the paranormal (e.g. Thalbourne, 1994; Schofield & Claridge, 2007), as is manic depression (Thalbourne & French 1995), as our hypothesis would predict. Neuroticism, a predictor of depression, has been shown to correlate with paranormal belief at 0.27 ($p < 0.001$) (Williams et al., 2010b, cited in Holt et al., 2012) while a mental health scale on depression and anxiety correlated with paranormal experience at 0.17 ($p < 0.001$) (Rabeyron & Watt, 2010). Schizotypy personality has been shown to correlate with paranormal belief at 0.29 ($p < 0.001$) (Kelley, 2011). It has also been found to correlate with being "spiritual but not religious" (0.22, $p < 0.04$), to a greater extent than with religious or with non-religiousness (Willard & Norezayan, 2017).

We have already observed that there is a positive association between schizophrenia and paranormal belief. This is consistent with our interpretation of the social epistasis model. Autism and schizophrenia are often understood to be the two opposite points of a spectrum, with "normality" somewhere in the middle (Crespi & Badcock, 2008, cf. Gervais, 2014). Schizophrenia, like autism, is understood to betoken developmental instability (Yeo et al., 1999).

The Positive Atheism-Autism Nexus

Woodley of Menie et al. (2017) highlight autism as being a particularly useful measure of developmental instability and thus of higher mutational load. They argue that autism is such a good example because it is linked to advanced paternal age (Blaxill, 2004), implying that it arises due to mutations in increasingly poor-quality sperm. Accordingly, if autism were negatively associated with religiousness, this would substantially strengthen the case for arguing that religiousness in industrial societies may be partly a function of low mutational load.

Caldwell-Harris et al. (2011) studied discussions by 387 different contributors on an autism website, from which they were able to discern the views on religion held by the contributors. High-functioning autistic (HFA) individuals demonstrated significantly the highest rates of "non-belief identities" such as atheism (26%) and agnosticism (17%). In the neurotypical (NT) group (non-autistic controls) which they analysed as a control, 17% were atheists and 10% were agnostic ($X^2(12, N = 387) = 43.69$, $p < 0.01$). Thus, high-functioning autistics are significantly more likely to be atheists than the neurotypical individuals who should logically have lower mutational load than autistics. The same authors conducted a survey with a sample of 61 people who self-identified as autistic. They found that those who regarded themselves as "atheists" scored significantly higher on the autism quotient scale, a means of quantifying the extent of autism, than those who were Christians (M = 22.98, 95% CI [19.91, 26.04]). Consistent with this, Barnes and Gibson (2013) found that those who had undergone religious experiences had elevated empathy (a quality lacking in autistics). In addition, Jack et al. (2016) found that "moral concern" (also lacking in autistics) predicted religious belief ($r = 0.28$, $p < 0.001$, $N = 159$). Norenzayan et al. (2012) also found that autism predicted reduced religious belief, based on Canadian samples. They note that "In a logistic regression model with autism diagnosis and IQ predicting belief in God, autistic participants were only

Table 1 Heritability estimates for the health measures in Koenig (2012)

Measure	Heritability	Reference
Mental health		
Depression	60%	Polderman et al. (2015)
Anxiety	29%	Polderman et al. (2015)
Psychoticism	36–50%	Heath and Martin (1990, p. 117)
Schizophrenia	50–80%	Gejman et al. (2010)
Criminality	56–70%	Barnes et al. (2011)
Divorce	40%	Jerksey et al. (2010)
Suicide	55%	Zai et al. (2012)
Bipolar disorder	70%	Smoller and Finn (2003)
Healthy behaviour		
Diet	32%	Van den Berg et al. (2013)
Cholesterol	32–50%	De Miranda Chagas et al. (2011).
Smoking	60%	Lesov-Schlaggar et al. (2008)
Alcoholism	50%	Verhulst et al. (2015)
Regular exercise	27–84%	De Geuss et al. (2014)
Obesity	40–70%	Wilyard (2014)
Risky sexual behaviour	14–72%	Harden (2014)
Physical health		
Alzheimer's	58–79%	Gatz et al. (2006)
Hypertension	30%	Aqarwal et al. (2005)
Stroke (cerebral vascular disease)	37%	Bevan et al. (2012)
Endocrine function	69%	Polderman et al. (2015)
Longevity	26%	Herskind et al. (1996)
Chronic pain	46%	Williams et al. (2010a)
Subjective health	32.5%	Romeis et al. (2000)

11% as likely as neuro-typical controls to strongly endorse God, OR = .11, 95% CI = .01, .96, *Wald* = 3.98, $p = .046$". Lowicki and Zajenkowski (2017) found that religiosity correlated with psychopathology at − 0.32 ($p < 0.001$) and was mediated by "empathy". Vonk and Pitzen (2017, p. 72) found that emotional intelligence was positively associated with intrinsic religiosity, meaning genuine religious belief ($\beta = 0.22$, $p = 0.003$). Reddish et al. (2016) found no significant difference between autistics and controls on religious cognition, but theirs was a sample of just 21 participants.

The Positive Fluctuating Asymmetry-Paranormal Nexus

Fluctuating asymmetry (FA) is an important measure of developmental stability, as mentioned in the introduction. Consistent with the social epistasis model, FA is increasing over time, as indicated by measurements of skulls (Woodley of Menie & Fernandes, 2016). This being the case, we would predict that religious people would have lower fluctuating asymmetry than atheists or believers in the paranormal. We did not find any previous research on FA with regard to atheism. However, Schulter and Papousek (2008) found that FA of finger length was associated with paranormal belief ($r = 0.36$, $p \leq 0.0001$). Following up on Voracek (2009), who found no such associations at all, Rogers et al. (2017) found small and non-significant correlations between FA and belief in life after death, extrasensory perception, and psycho-kinesis, with the exception of a significant correlation between psycho-kinesis for women (but not men) and self-rated (but not experimenter-measured) finger lengths ($r = 0.10$, $p < 0.05$). Thus, we may cautiously conclude that there may be a weak association between fluctuating asymmetry and paranormal belief.

The Negative Religiousness-Left-Handedness Nexus

Markow (1992) proposed that left-handedness is a product of developmental instability. The heritability of handedness has been estimated to be around 0.25 (e.g. Medland et al., 2009) and might therefore also be associated with mutation load. Left-handed people have a small cognitive disadvantage compared to the right-handed, which translates into lower average earnings and lower socioeconomic status (Goodman, 2014). Left-handedness is associated with higher incidence of autism (Soper et al., 1986), schizophrenia (Dragovic & Hammond, 2005), and immunological disorders (Geschwind & Behan, 1982). It is also associated with psychosexual aberrations (Rahman et al., 2007), such as paedophilia and homosexuality (Blanchard, 2008), reduced life expectancy (Marks & Williamson, 1991), low birth weight (Searleman et al., 1989), and premature birth (Behrman & Butler, 2007, Ch. 11). It has been suggested that the simplest interpretation of these results is that left-handedness is a reflection of an atypical brain. It reflects a brain that undergoes developmental instability due to a combination of elevated numbers of deleterious mutations and an acutely inauspicious environment. Naturally, either factor may sufficient to lead to sinistrality in some cases. According to experts in the field of sinistrality, left-handedness may result when damage occurs to the left cerebral hemisphere, leading to transfer of various specialised functions into the opposing hemisphere. This would lead to an atypical organisation of the brain, which tends to be associated with a range of atypical behaviours (Satz et al., 1985). The association between left-handedness and schizophrenia, as well as the potential association with creativity, has hence been widely speculated on (see Graham & Bachman, 2004). In other words, left-handedness is a reflection of mutations which under conditions of natural selection would be damaging and would likely be selected against. Our hypothesis

predicts that religious people would be more right-handed than atheists or believers in the paranormal. The latter would be more likely to be left-handed or ambidextrous.

A number of studies have found that paranormal belief is associated with being not right-handed. Barnett and Corballis (2002) found that the most ambidextrous were the most likely to believe in magic, with the overall correlation between the laterality quotient and magical ideation at 0.213 ($p \leq 0.001$). Christman et al. (2008) found that mixed-handers were, in effect, more gullible and easily indoctrinated than either right- or left-handers, across two experiments ($d = 0.38$ and 0.44, both $p \leq 0.05$). For magical ideation, Nicholls et al. (2005) found a correlation with mixed-handedness ($r = -0.138$, $p \leq 0.001$) and Jaspers-Feyer and Peters (2005) with left-right confusion, but only in females ($r = 0.191$, $p \leq 0.003$). Niebauer et al. (2004) found that those who were "strongly handed" in either their left or right hand were more likely to believe in creationism than those who were more ambidextrous. This is actually consistent with our model because it has been shown that both left-handedness and *extreme right-handedness* betoken developmental instability (Yeo & Gangestad, 1994, p. 286). However, to our knowledge, nobody has tested the association between religiousness in general and handedness and this, therefore, will be the focus of the next section.

Method

Data from the Midlife Development in the United States (MIDUS) were used to examine the relationship between religiosity and handedness. MIDUS is an extensive longitudinal examination of development in middle adulthood, and the data used in the current investigation were from the second wave of data collection (Ryff et al., 2004a–2006), which includes five projects. Data concerning religiosity and religious orientation were obtained from project 1, also known as MIDUS II—the primary follow-up to the original data collection. Data concerning handedness was obtained from Project Four, also called the Biomarker Project (Ryff et al., 2004b–2009). The purpose of the Biomarker Project was to gather more detailed health information using a subsample of the larger MIDUS participant pool.

Participants After merging the files from the two MIDUS II projects, there were 612 participants for whom there were data on both religiosity and handedness. The age of these participants ranged from 35 to 86 (M = 58.74, SD = 11.93). There were 245 males (40%), 349 females (57%), and 18 participants with missing data concerning sex (3%), and the sample included 568 Whites (92.8%), 16 Blacks (2.6%), five Native Americans (0.8%), three Asians (0.5%), and 20 (3.3%) participants who responded other or do not know, or who did not answer.

Handedness Handedness was measured using the Edinburgh Handedness Inventory (Oldfield, 1971). Participants are asked the degree to which they use their left hand, right hand, or both hands for 10 tasks (e.g. "opening a box"). Scores for left-handedness and right-handedness were calculated by the MIDUS administrators using formulas giving added weight to a greater degree of laterality. Ambidextrousness was quantified by the so-called laterality quotient ([right-handedness − left-handedness] / [right-handedness + left-handedness] × 100).

Religiosity MIDUS II includes eight scales related to religiosity, namely spirituality (sample item: How spiritual are you?), religious identification (sample item: How religious are you?), private religious practices (sample item: How often do you pray in private?), religious support (sample item: If you were ill, how much would people in your congregation help you?), religious/spiritual coping-A (sample item: When you have decisions to make in your daily life, how often do you ask yourself what your religious or spiritual beliefs suggest you should do?), religious/spiritual coping-B (sample item: I work together with God as partners), daily spiritual experiences (sample item: How often do you have a deep sense of appreciation?), and mindfulness (sample item: Because of your religion or spirituality, do you try to be a more patient person?).

Scale totals were factor analysed using principal axis factoring. The first factor was the only factor with an eigenvalue greater than one (EV = 3.83), explaining 47.91% of the variance among the measures. The factor loadings of each scale on this first factor were 0.74 for spirituality, 0.69 for religious identification, 0.76 for private religious practices, 0.43 for religious support, 0.78 for religious/spiritual coping-A, 0.82 for religious/spiritual coping-B, 0.65 for daily spiritual experiences, and 0.58 for mindfulness. The factor score was used as the measure of religiosity.

Religious Orientation MIDUS II includes an item about religious orientation. In response to the question, participants were given 46 options and allowed to supply their own answer. However, following previous research using the MIDUS II data (Dunkel & Dutton, 2016; Dunkel et al., 2015b), only six representative groups were examined in the current investigation. The six groups represented the three most numerous affiliations: Roman Catholic ($n = 216$), Baptist ($n = 90$), Methodist ($n = 66$), a Jewish group ($n = 19$), agnostics ($n = 30$), and atheists ($n = 16$). The Jewish group was a combination of five separate responses (Jewish Conservative = 6, Jewish Reform = 11, Jewish Reconstructionist = 1, and Jewish "other" = 1).

Results

The bivariate correlations between religiosity and the measures of handedness were as follows: left-handedness, $r(612) = -0.12$, $p < 0.01$; right-handedness, $r(612) = 0.10$, $p < 0.05$; and laterality, $r(612) = 0.11$, $p < 0.01$. When the

demographic variables of age and sex were controlled for, the results changed little: left-handedness, $r(590) = -0.12$, $p < 0.01$; right-handedness, $r(590) = 0.09$, $p < 0.05$; and laterality, $r(590) = 0.11$, $p < 0.01$. It can be seen from the results that we have found a weak but significant negative correlation between left-handedness and all measures of religiousness. Put simply, left-handed people are less religious than right-handed people, as our hypothesis predicts.

To test the differences between religious orientation groups, a one-way analysis of variance was calculated each for left-handedness, right-handedness, and laterality. Table 2 lists the descriptive statistics for each group and each of the three variables. It should be noted that the assumption of homogeneity of variance for each test was violated. To adjust for the violation, alpha was adjusted to $p < 0.01$. With this adjustment, only the test for left-handedness remained significant, $F(1, 431) = 3.26$, $p = 0.007$, partial $\eta^2 = 0.04$; the tests for right-handedness, $F(1, 431) = 2.22$, $p = .051$, and laterality, $F(1, 431) = 2.99$, $p = 0.012$, were not significant. Post hoc Tukey's tests revealed that the Jewish group had higher left-handedness scores than both the Methodist and Roman Catholic participants.

Discussion

The results largely support our hypothesis that atheism and belief in the paranormal are positively associated with a variety of markers of developmental instability. This is consistent with the idea that they are both reflections of mutational load, because they would have been selected against under pre-industrial conditions of strong selection.

First, let us consider some implications that these findings may have for the future. Developed countries will continue to become less religious in the traditional sense, at least in the short term. Furthermore, this will cause even those who do not carry the mutations associated with low religiousness to become less religious, according to the social epistasis model (Woodley of Menie et al., 2017). This is because those who do carry them will be inclined to counter traditional religiousness and to undermine the structures which promote it, including organised religion within important institutions such as schools. In addition, it has been shown that religiousness is positively associated with both positive and negative ethnocentrism (Dutton et al., 2016). As such, we would expect ethnocentric feeling and behaviour to continue to decline in developed countries in tandem with the decline of traditional religiousness. In effect, increasing proportions of the populations in developed countries can be expected to espouse ideologies such as multiculturalism, which encourages immigration from different ethnic groups and promotes their culture and interests, as Woodley of Menie et al. argue. In most circumstances, this would be at variance with the interests of the ethnic group as an extended genetic family because it would decrease the portion of the population that was from this ethnic group (see Salter 2007). Concomitantly, as traditional religiousness and ethnocentrism decline, we would expect a continuing growth in forms of religiousness that deviate from that practiced in developed countries at the point of industrialisation. In other words, religious belief and practice will become increasingly diverse and anomic. More and more people will claim, for example, that they do not believe in God but they "believe in something", or they "believe in a force behind the universe", they "believe life has meaning", or "they worship God in their own way". This kind of belief—as well as advocacy of ideologies such as multiculturalism and even religious pluralism (see Dutton, 2012, p. 149)—can already be observed within established churches. In December 2017, it was reported that the Very Rev. Kelvin Holdsworth, provost of St Mary's Cathedral in Glasgow, had implored Christians to pray for Prince George to be homosexual, because if he were homosexual it would supposedly force the Church of England to be more "inclusive" (Greenfield, 1st December 2017). Even some Church of England priests do not believe in God in any literal sense. The Rev'd Anthony Freeman (1993) espouses "Christian Humanism" while the Rev'd Don Cupitt (2002) advocates "Christian Non-Realism".

However, in terms of using our finding to prognosticate the collapse of traditional religion, there is an important caveat. Traditional religiousness predicts both the desire to have children and actually having children in developed countries, even when controlling for socioeconomic factors (e.g. Rowthorn, 2011). This would be consistent with our findings because the desire to have children would have been strongly selected for and the ability to have them would reflect sound health, so both should be associated with religiousness. Thus, if we aver that traditional religiousness has declined due to accumulating mutational load and its impact on religious structures, as well as due to decreasing stress due the more stable environment produced by industrialisation, then traditional religiousness would decline if the magnitude of the impact of these factors outweighed the magnitude of the impact of the higher fertility of the traditionally religious. It is quite possible, however, that the situation could

Table 2 Mean left-handedness, right-handedness, and laterality scores by religious orientation

	Left-handedness	Right-handedness	Laterality
Agnostic	2.57 (5.57)	15.40 (6.30)	70.99 (58.56)
Atheist	4.13 (6.93)	13.50 (7.27)	54.86 (72.93)
Baptist	3.49 (5.73)	13.66 (6.50)	59.31 (63.09)
Jewish	6.00 (7.33)	13.05 (7.79)	35.42 (79.15)
Methodist	2.00 (3.73)	15.30 (5.10)	74.62 (44.88)
Roman Catholic	2.08 (4.55)	15.74 (5.69)	76.01 (51.33)

Standard deviations are in parentheses

be reversed. A number of researchers have argued that intelligence, in developed countries, is in decline and that this will ultimately lead to reversal of civilisation (e.g. Lynn, 2011; Dutton and Charlton, 2015). This reversal of civilisation would eventually elevate stress and negatively impact medical science, increasing the intensity of selection and decreasing mutational load. Accordingly, religiousness would increase.

In extending this research, it would be useful to turn to other measures of developmental instability. There is evidence that paraphilia and transsexuality are associated with many neurological disorders and other markers of developmental instability (Blanchard, 2008). According to the Pew Research Centre, 50% of lesbian, gay, bisexual, and transsexual (LGBT) Americans identified as being "atheist" as compared to only 20% of the general population of the USA (Pew Research Centre, 2013). Consistent with this, Foster et al. (2017) found, using an LGB sample, "that greater religious belief correlated positively and significantly with internalized heterosexism and outness as LGB" (abstract). In other words, the more religious a self-identified LGB was, the more likely he or she was to not actually be LGB. However, these results are hard to interpret as historical negative attitudes to homosexuality by the highly religious may have influenced how religious homosexuals profess to be. In addition, there is some dispute over whether homosexuality specifically is a marker of developmental instability. It has been argued that homosexuality is a group-selected trait, because females with homosexual brothers—who would thus invest in their nephews and nieces—would have more surviving offspring (Kirby, 2003).

Mindful of this complication, we chose not to consider homosexuality in the present study. Transsexuality and sexual fetishes, such as sadism and masochism, are highlighted by Blanchard (2008) as a manifestation of developmental instability. Ahrold et al. (2010) report several relevant correlations in this regard. They found that fantasising about being a different sex is positively correlated with paranormal belief for both men and women. Among women, fantasies of sadism and masochism were positively correlated with paranormal belief and negatively correlated with intrinsic religiousness, and masochistic fantasies negatively associated with fundamentalism. In each case, the correlations were significant but weak, in the region of 0.1 to 0.2, while homosexuality was not found to significantly correlate with religiousness for men or women.

It would also be useful to directly test the extent to which ethnocentrism—independent of religiousness—is associated with low mutational load. We would predict that ethnocentrism would have been selected for under conditions of selection. Certainly, there is evidence that the inclination to preferentially aid those who are more genetically similar to oneself is around 0.3 heritable (Rushton, 2005). This would be a fascinating area for future research. Consistent with this hypothesis, Neduva et al. (2012) found that extreme advocates of political correctness were characterised by being "narcissistic" and highly emotional. This would imply mental instability, which would possibly be a reflection of developmental instability.

We found no direct evidence of a relationship between atheism and fluctuating asymmetry. This would be a very useful piece of future primary research, as it does not appear to have been tested. However, it has been found that the general factor of personality (GFP)—a social effectiveness measure combining the socially positive aspects of each of the Big 5 personality traits—is positively associated with physical attractiveness (Dunkel et al., 2016). GFP is also positively associated with religiousness (Dunkel et al., 2015a, p. 65).

In terms of limitations, there is, however, one line of evidence that seems to be inconsistent with our findings. There is a large body of evidence indicating that religiousness is weakly negatively associated with intelligence, about −0.2 in population samples (e.g. Dutton, 2014). Intelligence would have been selected for in pre-industrial conditions (see Dutton and Charlton, 2015), so it should be negatively associated with mutational load and thus positively associated with religiousness. There are, however, a number of solutions to this paradox. Firstly, intelligence has been found to be only extremely weakly influenced by mutational load (Woodley of Menie and Fernandes, 2016), so this would potentially explain the paradox. In addition, religiousness is generally understood to be a robust marker of slow life history strategy at the group level (Figueredo et al., 2006) but intelligence does not correlate with LHS at the individual level (Woodley of Menie and Madison, 2015). Secondly, it could be argued that we would expect an optimum level of religiousness and intelligence to be selected for. It has been averred that it would be possible to be too intelligent for a particular ecology because, as Dutton and Van der Linden (2017) have shown, intelligence is negatively correlated not just with religiousness but also with many other evolved instincts, such as the desire to have children and to be ethnocentric. This means that in certain ecologies being too intelligent would be maladaptive. In addition, Karpinski et al. (in press) have shown that people with outlier high intelligence are prone to autism spectrum disorders, anxiety, depression, and even immune disorders, such as allergies. They argue that the reason for this association is that extreme intelligence involves an incredible ability to take in and analyse information and thus a kind of heightened and intense way of experiencing reality. In effect, the highly intelligent have elevated sensory perception and heightened intellectual and aesthetic awareness. Their intensely high and narrow cognitive ability leads to intense worry, being easily overwhelmed, obsessive interests, and an inability to engage in social interaction or relate to ordinary people. Similarly, Terman's research found that high IQ predicted being maladjusted (Towers, 1987). This would potentially imply that very high intelligence can be regarded as a maladaptive mutation, and this would explain why intelligence is weakly negatively associated with religiousness, which is adaptive. Indeed, it could be proposed that, with the reduction in stress brought about by industrialisation, a level of intelligence

which was once associated with religiousness is now associated with atheism. In other words, the environment has changed, rendering intelligence less adaptive than it once was.

But, overall, it would appear that the relationship between religion and health is not necessarily causal. Religious people in Western societies—religious in the sense that complex societies were before the Industrial Revolution—are a remnant, selected population that likely would have survived in preindustrial conditions. By contrast, atheists and believers in the paranormal would, disproportionately, never have reached adulthood or never have been born, because these beliefs, though very different, are partly an expression of the breakdown of selection and thus of rising mutational load.

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