BRILL
SCHÖNINGH

INTERDISCIPLINARY JOURNAL FOR RELIGION AND
TRANSFORMATION IN CONTEMPORARY SOCIETY
7 (2021) 303–334

JRaT
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Free Contributions

The Evolutionary Biology of Religious Behavior

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Abstract

In the following review article, we aim to summarize the current research progress in the field of evolutionary and behavior genetics studies on human religiousness and religious behavior. First, we provide a brief (and thus incomplete) overview of the historical discussions and explain the genetic basis of behavior in general and religious behavior in particular, from twin studies to molecular data analysis. In the second part of the paper, we discuss the potential evolutionary forces leading to human religiousness and human religious behavior, emphasizing the emergence of "axial age" and the so called "big gods" in the relatively recent history of humans.

Keywords

evolution – behavior genetics – religion

1 Preamble

It is important to state that the following article summarizes current research on "evolution and religions" and does not aim to relativize faith and belief but instead tries to understand how religion evolved. In our opinion, the study of evolution of religions and religious behavior does not preclude religious belief but adds an additional perspective to the understanding of human religiousness.

2 Introduction

At least since Galileo Galilei, religion and the natural sciences in the Western world have frequently been in an area of conflict, but presumably in an unnecessary area of conflict since, as brilliantly outlined by Steven Jay Gould, both disciplines represent a "magisterium of human understanding",[1] a fact already pre-empted by Galileo Galilei who stated "that the intention of the holy ghost is to teach us how one goes to heaven, not how heaven goes".[2]

Over the centuries, the conflict has been prolonged. Until nowadays, it has been kept alive by representatives of both sides, prominently, for instance, by Richard Dawkins in his "God Delusion"[3] which is somehow an "anti-religious book" with a religious touch of being "anti-religious". Long before Dawkins, the "Origin of Species"[4] published by Charles Darwin in 1859 led to severe tensions between Darwin[5] and his supporters (Darwin aimed at becoming a man of the church at a younger age) and representatives of the official Church of England. These tensions peaked in 1860 during a meeting of the British Association for Advancement of Science (in the absence of Charles Darwin) amongst the supporters of the evolutionary theory, represented eloquently by Thomas Huxley and the Bishop of Oxford, Samuel Wilberforce. Interestingly, Wilberforce was supported by the captain of the "Beagle" – the ship on which Darwin had travelled around the world some years before, on a journey that profoundly influenced Darwin's later theories on evolution. Darwin seemed to have avoided the direct confrontations more and more, as these conflicts presumably made him unwell. Maybe this was the reason why Darwin became increasingly interested in botany later in life – it was still evolutionary biology, but compared to human evolution, this field of research was less connected to emotions and

1 See Gould, *Rocks of ages*.
2 See Galilei, *Letter to Madame Christina of Lorraine*.
3 Dawkins/Ward, *The God Delusion*, pp. 40–45.
4 See Darwin, *Origin of Species*.
5 See Jensen, *Return to the Wilberforce-Huxley Debate*.

confrontations that Darwin wished to avoid.[6] One of the great ironies in the history of sciences is that, as far as we know, even though Darwin had been working in the field of botany and his cousin Francis Galton was presumably aware of the fundamental work on genetics by the monk Gregor Mendel, Darwin himself may not have gotten in closer touch with the work of Gregor Mendel,[7] which may have helped Darwin to "prove" his theory. Gregor Mendel, however, studied "The Origin of Species" in German as soon as the translation was available in 1863.[8]

What is lesser known is that Darwin not only avoided these confrontations, but also had a deep interest in religion. He aimed to understand how religion may have evolved and speculated that the moral aspects of religion may have been important for the evolution of human sociability.[9] Hence, the research of religion and religious behavior from an evolutionary point of view already started with Charles Darwin.

3 Behavioral Genetics and Inheritance

Before discussing particular evolutionary explanations of human religious behavior, an introduction to the evolutionary and genetic fundamentals is needed. Since the famous "pea experiments" carried out by Gregor Mendel at the monastery of the Order of Saint Augustine, St. Thomas in Brno, we understand the laws of inheritance.[10] For this paper, it is not necessary to go into much detail, but it is important to realize that offspring resemble their parents to some extent. Nonetheless, apart from phenomena like parthenogenesis (where no sexual partner is needed for reproduction), in sexually reproducing species, offspring are never identical copies of their parents but an "admixture" of both mother and father, with many genetic interdependencies such as genetic dominance and recessiveness forming a "new individual". Gregor Mendel actually did not know the "means of inheritance", the DNA (Deoxyribonucleic Acid), as it was only discovered in the year 1953 by Watson and Crick.[11] Since then, we not only understand the "Mendelian rules of inheritance", but have also learned about the complex encoding and regulation of the DNA, leading from the genotype to the phenotype. The genotype (from Greek "kind") is the sum of the genetic information of an organism. The phenotype

6 Reviewed in Desmond/Moore, *Darwin*.
7 See Galton, *Did Darwin read Mendel?*
8 See Galton, *Did Darwin read Mendel?*
9 See Darwin, *Descent of Men*.
10 See Mendel, *Versuche über Pflanzen-Hybriden*.
11 See Watson/Crick, *Molecular Structure of Nucleic Acids*.

(pheno from Greek "showing") is the composite of the observable characteristics of an organism, i.e. what the organism "shows", including morphology, physiology, but also behavior and attitudes.

Meanwhile we know that in humans the DNA consists of more than three billion base pairs. These "base pairs" consist of four chemical bases. The sequence of these bases, the so-called "code of life", encodes for the proteins that are forming our bodies and perform a vast array of functions, including regulating how these proteins are built up. From these three billion base pairs, we differ from each other in about five million base pairs. These roughly five million base pairs that make us individually different consist mostly of so-called "single nucleotide polymorphisms" (SNP) and are of highest interest in quantitative genetics, which deals with these individual differences to describe – in addition to epigenetics (see later) – the "path from the genotype to the phenotype".[12]

In the realm of genetics, usually diseases and physical characteristics such as body height or weight are in the focus of interest. Yet, it is much more than that: genetics (and epigenetics) are not only associated with physical characteristics, but also with our behavior, our attitudes and even with our moral values.[13] As Steven Pinker quoted: "We are no blank slate, also our behavior is hardwired" to some extent in our genes[14] and, interestingly, the influence of genetics on behavior, attitudes and values is often stronger than, for instance, the association between genes and diseases.[15]

Before the advent of molecular genetics and the large sequencing of DNA, twin studies were the "gold standard" of behavioral genetics to estimate the extent to which a behavior is influenced by genetics.[16] Twin studies are based on the simple genetic fact that monozygotic twins share 100% of their genome (i.e. they are genetically identical apart from the small number of mutations that each individual accumulates during life),[17] whereas dizygotic fraternal twins only share 50% of the genome, comparable with normal siblings. Although both monozygotic and dizygotic twins share the same parental environment, they usually do not share school, teachers, friends and peers. Accordingly, the influences on a child are divided into three parts: 1. additive genetics usually denoted as "heritability" – the sum of all genetic influences,

12 See Jobling et al., *Human Evolutionary Genetics*.
13 See Plomin et al., *Behavioral Genetics*.
14 See Pinker, *The Blank Slate*.
15 See Plomin, *Blueprint*.
16 See Plomin et al., *Behavioral Genetics*; Plomin, *Blueprint*.
17 See Kong et al., *Rate of De Novo Mutations and the Importance of Father's Age to Disease Risk*.

2. the common environment – usually the family the children grow up in, and 3. the external, so-called non-common environment.[18]

Comparing a sufficiently large number of monozygotic versus dizygotic twins allows to determine the proportion to which genetics, the family environment as well as the external environment contribute to the trait in question such as, for instance, behavior or attitude. This approach has been developed and refined in the last decades so that the international twin data base has grown to a number of roughly 400,000 twins worldwide.[19] Some of the databases like the Brisbane Twin Study[20] and the Swedish Twin registry[21] not only surveyed at any one point in time but intended to cover the life course of participants by surveying them at certain time intervals from adolescence until older ages.

In practice, twin studies are carried out as follows: after ethic approval, twin-pairs are identified as early in life as possible, for instance, via the selection of a representative sample from a birth register. Twin studies are time-consuming and the statistical methods are demanding for larger sample sizes. Therefore, the aim is to identify at least several hundred up to, if possible, several thousand twin pairs. Twin status (monozygotic versus dizygotic) is determined by DNA comparison of certain genomic regions: monozygotic twins are expected to have 100% DNA sequence concordance, whereas dizygotic twins only have approximately 50% DNA sequence concordance (as is the case in siblings). As twin studies usually aim to follow the life course of the participating twins, both twins are surveyed in regular time intervals, ideally from early life until older ages. Survey questions include a wide range of various traits, from morphological measures (e.g. weight and height), physiological measures (such as blood pressure) to attitudes, habits and behavior. Thus, the twin data set includes the genetic relatedness (50% versus 100%) together with the same questions surveyed at the same time for both twins. This information is usually enough to describe any trait as a combination of the influence of genetics/epigenetics (i.e. heritability), the common environment, and the unique environment and calculate the respective contribution in percent by an advanced statistical tool called "path modelling".[22]

A rather surprising research example of discoveries obtained through twin studies is the finding that individual political attitude also has a genetic

18 See Martin et al., *The Power of the Classical Twin Study*; Boomsma et al., *Classical Twin Studies and Beyond*; Neale/Cardon, *Methodology for Genetic Studies of Twins and Families*.

19 See International Society for Twin Studies, *Twin Registers and Research*.

20 See Mitchell et al., *Twenty-Five and Up*.

21 See Karolinska Institutet, *The Swedish Twin Registry*.

22 A detailed description of the statistical tools can be found in Plomin et al., *Behavioral Genetics*; Neale/Cardon, *Methodology for Genetic Studies of Twins and Families*; Bates et al., *umx: Twin and Path-based Structural Equation Modelling*.

basis.[23] Thus, the prevailing opinion that our political attitudes are only the results of free will together with some influence of parents, teachers, friends and partners is only partly true. Twin data meanwhile show that this is not the case. Rather, whether we have a politically "more right wing" or a "more left wing" attitude is up to 60% influenced by our genes.[24] Hence, discussions on politics are always also discussions on individual genetic predispositions and political attitudes may have been an evolutionary adaptive.[25] Very important, however, is the fact that the ratio of the genetic influence depends on the trait that is surveyed: if individuals are asked about their political orientation, up to 60% of the variance is explained by genetics (which means that it is heritable in a narrow sense) whereas only 10% of the actual voting behavior is explained by genetics.[26]

Individual political attitude is an impressive and, for most people, an unexpected trait that has a rather strong genetic basis, yet it is only one of many examples discovered by twin studies within the last decades. Indeed, twin data facilitated the discovery of the genetic basis of many traits, leading to the formulation of the first law of behavioral genetics by Eric Turkheimer: "All human behavioral traits are heritable to some extent".[27] Thus, from the perspective of behavioral genetics the discussion "nature versus nurture" is obsolete as it always needs both genetics and environment, at different quantities, depending on the trait. The following table gives an up-to-date overview over the heritability of several traits:

TABLE 1 Heritability of selected traits[a]

Trait	**Estimated heritability**
Eye colour	95%
Height	80%
Weight	70%
Reading disability	60%
General intelligence	50%
Personality	40%

a See Plomin, *Blueprint*.

23 See Eaves/Eysenck, *Genetics and the Development of Social Attitudes*; Hatemi/McDermott, *The Genetics of Politics*; Hatemi/McDermott, *Give Me Attitudes*.

24 See Lockyer/Hatemi, *Genetics and Politics*; Hatemi/McDermott, *The Genetics of Politics*.

25 See Fieder/Huber, *Political Attitude and Fertility*.

26 See Hatemi/McDermott, *The Genetics of Politics*.

27 See Turkheimer, *Three Laws of Behavior Genetics and What They Mean*.

In addition to political attitude, physical traits, cognitive abilities and personality, heritability has also been estimated for many other traits and a partially genetic basis has been discovered for these traits. Accordingly, the "age of sociogenomics" has been recently proposed.[28] For instance, education and educational achievement have been found to be highly heritable, showing an estimated twin heritability of ~ 60% and a SNP heritability of ~ 30%.[29] In recent years, heritability estimates are no longer based only on twin studies but increasingly also on genome wide association studies (see below).[30] Heritability has also been estimated for psychiatric disorders such as major depressive disorder (~ 32%), schizophrenia (~ 70%) as well as bipolar disorder (~ 62%).[31] Even our moral intuitions seem to have a substantial genetic basis as it has been shown for the case of moral dilemmas (heritability ~ 54%),[32] supporting the view of Jonathan Haidt that we make "moral decisions" unconsciously due to our predisposition.[33] Also individual differences of "in-group vs. out-group" preferences may to some extent be explained by inheritance although heritability varies highly from 18% to 79% depending on the specific trait analyzed.[34] The question of heritability of in-group vs. out-group attitudes may also shed light on the emotional debate of migration. Accordingly, being in favor of migration, or rejecting migration, respectively, seems to have a partially genetic and thus evolutionary basis.[35] A profound overview of heritability estimates can be found at MaTCH.[36]

What about the heritability of religiousness? Is, for instance, individual spirituality heritable as well? Although in the case of religiousness not as many studies have been conducted as in the case of other traits such as political orientation, the twin studies carried out so far reveal compelling results: for adult twins, the heritability of religiousness ranges from 35% to 55% depending on the actual measured "phenotype of religion". For instance, heritability differs somewhat (43% versus 39%) – between intrinsic religiousness (i.e. feeling of affiliation, spirituality) and extrinsic religiousness

28 See Mills et al., *An Introduction to Statistical Genetic Data Analysis*.
29 See Rimfeld et al., *The Stability of Educational Achievement Across School Years is Largely Explained by Genetic Factors*.
30 Reviewed in Mills & Tropf, *Sociology, Genetics, and the Coming of Age of Sociogenomics*.
31 See Wray/Gottesman, *Using Summary Data from the Danish National Registers*.
32 See Smith/Hatemi, *Are Moral Intuitions Heritable?*
33 See Haidt, *The Righteous Mind*.
34 See Kandler et al., *The Genetic and Environmental Roots of Variance in Negativity Toward Foreign Nationals*; Lewis et al., *Distinct Heritable Influences Underpin In-group Love and Out-group Derogation*; Loehlin, *Nature, Nurture, and Conservatism in the Australian Twin Study*.
35 See Schahbasi et al., *Factors Affecting Attitudes Toward Migrants*.
36 See MaTCH: *Meta-Analysis of Twin Correlations and Heritability*.

(i.e. more social religiousness such as going to church).[37] Additionally, Truett et al. found stronger signs of heritability of religiousness in women compared to men (34% versus 26%).[38] Koening et al. further showed that genetic factors influencing religiousness are weaker in adolescence compared to adulthood.[39]

We also found (article in preparation), on the basis of the MIDUS twin data set[40] which includes 370 men, 482 women, 340 monozygotic twin pairs, 292 dizygotic same sex twin pairs and 220 dizygotic different sex twin pairs, who were surveyed from 1995 to 1996, that the heritability of religious behavior ranges from 23% for "importance to marry someone of the same religion" up to 53% for "seek comfort in religion" (Table 2). As expected, and also found in other studies,[41] the importance of spirituality emerged as the "religious phenotype" with the second highest heritability, confirming that "intrinsic religiousness" may have a particularly high heritable component. However, one twin study alone may have shortcomings and also the sample size is only moderate; the results found so far should be confirmed by other data sets and research groups. Nonetheless, the magnitude of effects is pretty much in line with what has been found so far.[42]

It is important to mention that heritability calculated on basis of twin studies always includes both genetics and epigenetics. In its essence, epigenetics includes all mechanisms of gene regulation (i.e. which genes are expressed, that is, translated into proteins) that are not based on DNA sequence. Epigenetic markings are modifications of the DNA or its protein scaffolding, as for instance DNA methylation (the addition of a methyl group on the DNA). Intriguingly, such epigenetic modifications are sensitive to environmental influences. Moreover, if such environmentally induced epigenetic alterations occur in the germline, they can be transferred from one generation to the next. Thus, "experiences" of one generation can be directly transmitted to the next generation. One renowned example is the heritability of fear: Dias et al. demonstrated in mice that fear conditioning of the father (i.e. male mice were conditioned to fear the odor acetophenone) was transmitted to the following

37 See Bouchard et al., *Intrinsic and Extrinsic Religiousness*; Ludeke et al., *Obedience to Traditional Authority*.

38 See Truett et al., *Religion and Education as Mediators of Attitudes*.

39 See Koening et al., *Genetic and Environmental Influences on Religiousness*.

40 See Ryff et al., *Midlife in the United States*.

41 See Bouchard et al., *Intrinsic and Extrinsic Religiousness*.

42 See Bouchard et al., *Intrinsic and Extrinsic Religiousness*; Ludeke et al., *Obedience to Traditional Authority*; Truett et al., *Religion and Education as Mediators of Attitudes*; Koenig et al., *Genetic and Environmental Influences on Religiousness*.

TABLE 2 Heritability of certain "religious phenotypes"[a]

	Heritability	Common environment	Unique environment
seek comfort in religion	53.1%	0.0%	46.9%
spirituality important	44.6%	0.0%	55.4%
identify with own religious group	43.8%	6.0%	50.3%
prefer people same religion	34.7%	9.1%	56.1%
religion important in life	32.5%	14.0%	53.4%
religion important for decisions	27.1%	18.8%	54.0%
explore different religions	26.1%	0.0%	74.0%
how religious you are	25.7%	17.0%	57.3%
frequency of religious services	24.2%	26.6%	49.1%
important to marry same religion	22.9%	24.0%	53.0%

a See Ryff et al., *Midlife in the United States; Heritability means all the genetic predispositions of items surveyed. Common environment means the environment in which twins have grown up (i.e., to a very large extent the family). Unique environment is the environment that each twin experiences individually (i.e., school, teachers, friends). Interestingly, as often observed for other phenotypes, family upbringing has no influence on seeking comfort in religion and spirituality in later life.*

generation so that naïve sons (and also grandsons), which had never before been exposed to acetophenone, showed increased sensitivity and reactivity to acetophenone. The underlying mechanism was that the fear conditioning of the father caused epigenetic modifications of the sperm and was thereby transferred to the next generation.[43]

For a long time, twin studies have been the most important research tool for the estimation of heritability. 18 years ago and beginning in Japan, a new powerful tool for estimating the heritability of a phenotype was established, the so called "genome wide association study" (GWA), which enables the identification of the association of genotypes with one or more phenotypes.[44] Phenotypes include everything that can be measured, ranging from physical measures such as height, weight, the occurrence of diseases, to complex behaviors and attitudes. GWAs investigate the association of the genotype characterized by up to

43 See Dias et al., *Parental Olfactory Experience Influences Behavior And Neural Structure In Subsequent Generations*.

44 See Ozaki et al., *Functional SNPs in the Lymphotoxin-alpha Gene*; Ikegawa, *A Short History of the Genome-wide Association Study*.

millions of SNPs (see above) with one or more phenotypes, thereby identifying certain SNPs that are particularly strongly associated with the investigated phenotype (i.e. which explains comparably much of the variance of the phenotype). Thus, GWAs help to entangle the link between genetics and a phenotype, hence the link "from genes to the organism". As most of the phenotypes are complex, usually not only one genetic locus (SNP) is associated with the trait, but many – a so called polygenic association. In addition, not only may several thousand SNPs influence a phenotype but any one SNP may also be associated with many different phenotypes (so called pleiotropy). Both polygenic associations and pleiotropy are the rule, not the exception. Beyond identifying genotype-phenotype associations, GWAs are also suitable tools to estimate the heritability of a phenotype: in statistical terms, this means "how much of the variance of a phenotype can be explained by the individual variation (SNPs) in the DNA sequence" (the so-called SNP heritability). In the last decade, GWA studies have confirmed the heritability estimates by twin studies as heritability estimated by GWA studies correlates with the heritability estimated by twin studies.[45] Though heritability estimated by twin studies is usually higher compared to the heritability estimated by GWA studies, a phenomenon called "missing heritability".[46] As epigenetics is commonly not covered in GWA studies (which mostly rely on SNPs only), epigenetics may to some extent explain this "missing heritability". Nonetheless, GWA studies based on a totally different method have become the strongest confirmation of twin studies. A good overview of GWA studies on "social phenotypes" can be found at the website of the Social Science Genetics Association Consortium.[47]

Beyond the identification of genetic loci and the estimation of the heritability, GWA studies are also used to generate the so-called Polygenic Risk Score (or only Polygenic Score PGS). The Polygenic Score is a summarized indicator summing up the estimates of additive genetic influences on a certain phenotype.[48] This score is then applied to the individual genome data of a target sample, thereby enabling the calculation of the individual underlying genetic predisposition for a certain phenotype. What sounds somehow technical is indeed a revolution. The reason is that the polygenic score enables an estimation solely on the basis of the genomic data, for instance, an individual's probability to develop a certain disease or the probability to achieve a certain educational

45 See Yang et al., *Common SNPs Explain a Large Proportion of the Heritability for Human Height*; Yang et al., *GCTA: A Tool for Genome-wide Complex Trait Analysis*.

46 See Manolio, *Finding the Missing Heritability of Complex Diseases*; Eichler, *Missing Heritability and Strategies for Finding the Underlying Causes of Complex Disease*.

47 See SSGAC, *Social Science Genetic Association Consortium*.

48 See Harden/Koellinger, *Using Genetics for Social Science*.

level.[49] Even though the polygenic risk score only provides probabilities, it certainly will pose serious ethical and legal questions.[50]

As GWA studies need a very large sample size (> 100.000 completely sequenced individuals),[51] it is difficult to carry out a GWA study on religiousness and religious behavior. However, we tried to carry out such a study on the basis of two data sets[52] – the Health and Retirement Study and the Wisconsin Longitudinal Study (together approx. 20.000 individuals). We found that particularly SNPs on the X-chromosome are associated with religious intensity (measured by church attendance, questions on spirituality and importance of religion). The association of SNPs on the X-chromosome is interesting, as women usually score higher on spirituality compared to men. This led us to the speculation that some women may be homozygous for spirituality on the X-chromosome and thus more inclined towards spirituality. As we all have two DNA strands for all autosomes but only women also have two X-chromosomes (men have XY-chromosomes), only women can be homozygous on the X-chromosome [i.e. have the same alleles (SNPs on the same DNA positions on both X-chromosomes)]. Thus, it could be the case that in women, but not in men, the same alleles on both X-chromosomes that may be associated with religiousness are activated together so that, possibly, a kind of "amplification" for the phenotype "spirituality" may happen.

However, on the basis of our data, this view remains speculative for the moment as associations on the X-chromosome are technically non-trivial, demanding an even higher number of cases. Interestingly, we also found a positive genetic correlation between religiousness and fertility, a potential case of pleiotropy. The same SNPs that influence religiousness also seem to influence fertility. This finding suggests that being religious and having more children not only has a "social link", indicating a potential coevolution of fertility and religiousness (thus a genetic-cultural co-evolution, see below).

To sum up, as any other trait, religiousness and religious behavior have a heritable basis, but the magnitude of heritability depends on the behavior and attitude measured. However, it is important to state that whenever we measure religiousness (by surveys, frequency of religious attendance, or whatever else), we can only measure certain aspects of a complex trait – the complex

49 See Selzam et al., *Predicting Educational Achievement from DNA*; von Stumm et al., *Predicting Educational Achievement from Genomic Measures and Socioeconomic Status*.

50 See Mills et al., *An Introduction to Statistical Genetic Data Analysis*; Harden/Koellinger, *Using Genetics for Social Science*; Mills et al., *An Introduction to Statistical Genetic Data Analysis*.

51 See Lee et al., *Gene Discovery and Polygenic Prediction*; Barban et al., *Genome-wide Analysis*.

52 See Primes et al., *A Genome Wide Association Study on Religiousness*.

trait itself represents some sort of "hidden variable" and can thus only be measured indirectly.

4 Religiousness and Fertility

Everything stated so far about genetics (and epigenetics) is important in order to understand the evolution of religiousness and religious behavior. The reason is that the "physical base of evolution", the DNA, its variation (genetics) and regulation (epigenetics) contribute to our individual differences, enabling biological selection. Accordingly, if a trait is heritable and the trait is beneficial to its bearer in terms of higher fitness (i.e. the bearer of the trait has on average more children), the DNA sequences associated with this trait will spread in a population. This is exactly what seemed to happen with religion. Religion appears to have been beneficial to individual fitness as individuals who were religious had more children (and therefore more grandchildren and great-grandchildren and so forth). As a result, religiousness spread in human populations – not only due to cultural inheritance but also due to genetic inheritance. Nevertheless, cultural inheritance is of particular importance as we will see later. As commanded in Genesis 1,1–2,25: "*be fruitful and multiply*".

The pro-fertile effects of religions are so powerful that the spread of some religions is characterized by an increase in their number of adherents, due to the sheer number of children their members have.[53] The Mormons, whose average family size clearly outnumbers the average amount of children in any other US family, are an impressive example of these pro-fertile characteristics of religions.[54] Furthermore, many studies in different cultures demonstrated that, on an individual level, more deeply affiliated individuals (measured for instance by the frequency of attendance of religious services) have, on average, more children than less deeply affiliated ones.[55]

Interestingly, in terms of fitness benefits, rules to only marry within a religious community can be found in the bible and the Quran, such as: Deuteronomy 7,3: *Do not take wives or husbands from among them* (*the disbelieving*)*; do not give your daughters to their sons or take their daughters for your sons.* Or Quran 2,221:

53 See Blume, *The Reproductive Benefits of Religious Affiliation*.

54 See Mosher et al., *Religion and Fertility in the United States*.

55 See Adsera, *Marital Fertility and Religion in Spain*; Newman/Hugo, *Women's Fertility, Religion and Education in a Low-fertility Population*; Mosher/Hendershot, *Religion and Fertility*; Neuman/Ziderman, *How does Fertility Relate to Religiosity*; Branas-Garza/Neuman, *Parental Religiosity and Daughters' Fertility*; Fieder/Huber, *The Association Between Religious Homogamy and Reproduction*.

And do not marry polytheistic women until they believe and Quran 60,10: *And hold not to marriage bonds with disbelieving women*; they may make sense from an evolutionary point of view. Because with some exceptions (interestingly in countries such as Brazil with newly emerging syncretic religions), couples who marry within their own religious denomination have on average more children and remain childless less frequently than couples marrying outside their own denomination.[56] On a proximate level, we interpret this as a result of better understanding and thus a greater harmony among spouses. On an ultimate (evolutionary) level, this finding suggests that religious homogamy may have provided an additional opportunity for selection (please see also later).

However, religion is not always associated with a higher number of children; extreme examples are the Shakers, who marry, but live in celibacy,[57] as well as ancient sects such as the cult of the Cybele of which some members performed self-castration.[58] Certainly, both in evolutionary as well as in cultural terms, such religious communities refusing reproduction are not very successful as apparent in the example of the Shakers – according to Wikipedia, only a community of three individuals has survived until 2017.[59] Thus, "in numbers", those communities do not play any significant role and overall, adherence to one of the great world religions is associated with an increase in the number of descendants. Accordingly, the worldwide percentage of the unaffiliated will decrease from 16.4% in the year 2010 to 13.2% in the year 2050.[60]

Education and development may have contributed to secularization particularly in the West,[61] which are both associated with a decrease in fertility. Though the actual association might be more complicated and intervened,[62] as for instance due to migration, the trend of secularization in Western Europe may be gradually reversed by the mid-twenty-first century.[63] Furthermore, from an evolutionary perspective, selection pressures within populations do depend more on the relative numbers of descendants in a population than on the absolute number of descendants.[64] Thus, also in a regime of overall low fertility, as currently in western societies, if religious individuals have on average more children, there will be an ongoing selection pressure on religiousness.

56 See Fieder & Huber, *The Association Between Religious Homogamy and Reproduction*.
57 See Blume, *The Reproductive Benefits of Religious Affiliation*.
58 See Norenzayan et al., *The Cultural Evolution of Prosocial Religions*.
59 See *Shakers*.
60 See Hackett et al., *The Future of World Religions*.
61 See Albrecht/Heaton, *Secularization, Higher Education, and Religiosity*.
62 See Becker et al., *Education Promoted Secularization*.
63 See Kaufmann et al., *The End of Secularization in Europe?*
64 See Relethford, *Human Population Genetics*.

For example, as in the US, the interaction of conservative attitudes, religiousness and fertility leads to a reproductive advantage for the more conservative;[65] in the long run, this association will lead to a shift towards more conservative and religious individuals in the US.[66]

5 The Evolution of Religiousness

The question thus is: why was religion so successful in terms of fitness gains? From an evolutionary point of view, it is important to investigate why religiousness has evolved at all. David Sloan Wilson posed this question as follows: "perhaps the most basic question is whether the trait is an adaptation that evolved by a process of selection".[67] Does a given element of religion exist because it helps an entity (such as an individual or a group) survive and reproduce better than competing entities? Alternatively, a trait such as religion may have arisen at first as a nonadaptive evolutionary by-product of some cognitive functions.[68] Lately, the view that the primary evolutionary force towards religiousness in humans is a by-product of our cognition has grown in importance as a lot of evidence for this by-product hypothesis has been gathered. Beyond that first step, however, later on during the formation of the first larger settlements, religiousness was probably directly selected in a process of cultural genetic co-evolution (see below) as, for instance, religiousness helped to increase prosocial behavior among non-kin.[69]

We first explain the so-called by-product theory: most of the religions in traditional hunter gatherer, pastoralists and early farmer societies do not know any "big moralizing gods". They usually have many "small gods" who do not really interfere with their lives. Often ancestors and gods are ascribed to the nature that surrounds the people.[70] The development of these "small gods" may have happened during the evolution of our cognition and particularly during the process of mentalizing, the development of a theory of mind,

65 See Fieder/Huber, *Political Attitude and Fertility*; Vogl/Freese, *Differential Fertility Makes Society More Conservative on Family Values*.

66 See Vogl/Freese, *Differential Fertility Makes Society More Conservative on Family Values*.

67 See Wilson/Green, *Evolutionary Religious Studies* (*ERS*).

68 See Atran/Henrich, *The Evolution of Religion*; Bering, *The Belief Instinct*, reviewed in Norenzayan et al., *The Cultural Evolution of Prosocial Religions*, and Norenzayan, *Big Gods*.

69 See Norenzayan, *Big Gods*.

70 See Norenzayan, *Big Gods*.

which became very common during human history.[71] Thus, in turn we started to ascribe consciousness not only to our human fellows but also to animals, plants and even things. In ascribing mental states to humans, animals, plants and almost everything around us, we also started to imagine what would happen to an individual after death: will the mind of an individual really disappear after death?[72] Mentalizing has also been very important in the context of prosociality: if an individual may feel and suffer as I do, I should not harm it in any way, but act pro-socially.[73]

Taking this into account, religion has presumably evolved as a by-product of increased sociality necessary for human group formation, in a process of natural selection on the subcortical and neocortical regions of the human brain. Evolution certainly did not generate a "god-gene" as frequently speculated, but as with any complex trait has a polygenic and pleiotropic genetic basis.[74] That is, religiousness is influenced by many genetic loci which, in turn, also influence other traits. This view is in line with the by-product theory of Maryanski and Turner, who emphasize that the common ancestor of monkeys and apes already may have bequeathed a suite of neurological adaptions that have evolved during a stage of only weak social ties within animal groups, but may have proven adaptive at later evolutionary stages involving stronger social ties. Maryanski and Turner assume on the basis of cladistic analyses that this neurological adaption may have started approximately 20 million years ago, "rewiring" hominine brains and leading to a much bigger and much more convoluted neocortex, indicating an increased connectivity of the human brain. Accordingly, selection may have increased regions and connectivity in the brain responsible for emotions as well as for logical reasoning.[75] These adaptions in the brain, enabling for instance emotion enhancing rituals, morality, reciprocity and feeling of justice, are not only important for group living but may also have provided the basis for the capacity to conceive the sacred and the supernatural. Accordingly, with an increasing cohesion among group members it may also have become much more important to relate to "others" and also to imagined "supernatural others".

In line with this view, Boyer and Bergstrom conclude that religion is not a process sui generis. Thus, no specific organ or specific "genes" are needed to

71 See Bering, *The Belief Instinct*; Frith/Frith, *Development and Neurophysiology of Mentalizing*; Waytz et al., *Causes and Consequences of Mind Perception*.

72 See Bloom, *Religion is Natural*.

73 See Epley/Waytz, *Mind Perception*; Frith/Frith, *Development and Neurophysiology of Mentalizing*.

74 Reviewed in Mills & Tropf, *Sociology, Genetics, and the Coming of Age of Sociogenomics*.

75 See Maryanski/Turner, *The Neurology of Religion*.

express religion in its manifoldness.[76] Accordingly, religions may be explained in reference to cognitive modules in the brain underlying an agent detection process including gods as agents and therefore religions use already existing adaptations or existing cognitive structures as well as already existing social structures.[77] Hence, religion is rather a by-product of already existing traits. Examples of preadaptation that helped religion to manifest are, for instance, the ability of costly signaling and thus to be able to detect who cooperates and who fakes.[78] For instance, if someone is practicing extensive and demanding religious rituals (in this case rituals are representing "a costly signal"), it can be assumed by the co-believers that he or she is really committed to beliefs and also to the group. Hence the risk of exploitation of a group by a cheater is lowered substantially. In addition, religion may also be based on the ability of humans to learn and to imagine things from early childhood on.[79] As human imagination tends to attribute human characteristics and person-like features to the non-human environment, this ability may also have helped to promote religious feelings[80] albeit it may have evolved for different reasons. Concepts of religions may also be described as being derived from evolved dispositions to represent existing objects and intentional agents.[81] Furthermore, already existing building blocks of religion may have exploited our interests in rituals and ritualized behavior. Also our moral attitudes enabling group living and leading to the formation of moral codes[82] may be a prerequisite for religiousness as many cultures ascribe moral codes to transcendent beings.[83] Accordingly, a nonphysical agency "has become" the origin of morality, which indeed often has a transcendental characteristic. Also, our social cognition, such as misfortune, is generally interpreted in transcendental terms – someone behaves badly and consequently bad things happen.[84] We have to keep in mind, however, that not every trait is an adaptation as also other forces, such as for instance genetic drift, are at work.[85]

The evolution of religiousness as a by-product is illustratively explained by the understanding of recognizing causalities linked closely to mentalizing.

76 See Boyer & Bergstrom, *Evolutionary Perspectives on Religion*.
77 See Boyer & Bergstrom, *Evolutionary Perspectives on Religion*; Boyer, *Religion Explained*.
78 See Zahavi/Zahavi, *The Handicap Principle*.
79 Reviewed in Boyer, *Religion Explained*.
80 See Boyer/Bergstrom, *Evolutionary Perspectives on Religion*.
81 See Boyer, *Religious Thought and Behaviour as By-products of Brain Function*.
82 See Boyer, *Religion Explained*.
83 See Boyer & Bergstrom, *Evolutionary Perspectives on Religion*.
84 See Boyer, *Religious Thought and Behaviour as By-products of Brain Function*; Boyer & Bergstrom, *Evolutionary Perspectives on Religion*.
85 See Relethford, *Human Population Genetics*.

Recognizing causalities may have led to a better understanding and thus to a better prediction of the world surrounding us. We recognized the seasonality of nature which helped us to prepare for times of need (such as winter, dry season, migration of prey etc.). We may have discovered the link between conception and birth and the link between poisonous plants and getting sick, and that special treatment with plants reduces the risk of getting sick.[86] Thus, thinking in causalities may have made us better adapted to the environment and also capable of adapting the environment to our needs. Thinking in causalities has been so beneficial for us that, as a result, we may have started to extend the concept of causality to all lifeless and living nature, and thereby developed "myths of causality" such as the well-known creation myths[87] – leading to a theory of the causality of "everything – the creation of a creator" and to a widespread teleological thinking – everything has a purpose.[88]

Accordingly, at first these prerequisites for religiousness may have been selected as a by-product, but later on a direct selection may have fostered the evolution of religiousness and religions. For example, pro-sociality among members of larger groups, and with pro-sociality, religiousness may have been selected directly. Thus, religiousness might represent an example of a genetic-cultural co-evolution: biological evolution and cultural evolution are not separated from each other, but closely linked by a kind of "feedback loop".[89] In the case of religion, this means that the cultural trait "religion" may create an "adaptive niche"[90] establishing certain rules within group cooperation on the one hand, and rules of punishment for anti-social behavior on the other.[91] These rules of pro-sociality enforced by religion may have provided reproductive benefits (more children) because those who show pro-sociality and help others more likely receive help from others themselves, thereby increasing access to resources. Due to increased fertility, in turn, the genetic information (alleles) that is associated with religiousness (and with pro-sociality) spreads in a population. Accordingly, the genetic predisposition of being religious eventually becomes more and more common in the population and, in turn, shapes the culture of a group which then acts as biological selection pressure etc. – i.e. establishing a feedback loop between culture and genetics and back to culture. This process may also be enforced by religious endogamy (please see later). Primarily in small populations, this feedback loop may have led to an

86 See Henrich, *The Secret of our Success*.
87 See Sproul, *Primal Myths*.
88 See Norenzayan, *Big Gods*.
89 See Richerson et al., *Gene-culture Coevolution in the Age of Genomics*.
90 See Laland et al., *An Introduction to Niche Construction Theory*.
91 See Fehr/Gächter, *Altruistic Punishment in Humans*.

acceleration of the biological evolution. These hypotheses are pretty much in line with recent findings of population genetics, showing that biological selection and adaptation may have been much faster than previously thought – not in tens of thousands of years, but in several hundred years.[92] Furthermore, couples adhering to the same belief and moral views may have a more harmonious marriage and less arguing, which in turn may foster having more children.[93] This may have been of particular importance in the case of marriage between different families and tribes as females moving to the family of their spouse may have been the rule.[94] Evidence that religiousness is associated with an increased pro-sociality can also be found in psychology, as being religious is associated with charitable giving and voluntarism.[95] Also, pro-sociality was found to be higher among religious kibbutzim than among secular kibbutzim.[96] Furthermore, religious utopian communities lasted longer compared to secular communities.[97]

Genetic, archaeological, historical and psychological evidence suggests that this acceleration of the evolution of pro-sociality started approx. 12,000 years ago during the first larger agglomerations of humans (for instance, Göbekli Tepe, a larger agglomeration of hunter-gatherers). Among these first larger settlements, the evolution of a common set of beliefs may have been of particular importance as it facilitates the commitment of all group members to a powerful, transcendent and almighty supernatural being (or beings in polytheistic religions) that represents the moral rules of the community and monitors all social interactions, rewarding or punishing behavior whenever it is or is not in line with the moral beliefs of the group. Such a "big god" (gods) is watching the behavior of adherents, rewarding, sanctioning and punishing even in afterlife, a god that demands for costly rituals to show commitment to him and to the group. These big gods ensured that people coming from different ethnic and cultural backgrounds into the first bigger settlements are committed to the same pro-social rules and do not violate the norms of the group that are important for survival – they impose rules of a pseudo kinship. But these "big gods" also punish the less committed and these "big gods" mark religious boundaries, leading to the separation of groups by religion, with all the problems up until nowadays, and to strict rules that are non-negotiable.

92 See Field et al., *Detection of Human Adaptation During the Past 2000 Years*.
93 See Fieder/Huber, *The Association Between Religious Homogamy and Reproduction*.
94 See Huber et al., *Living with Own or Husband's Mother in the Household is Associated with Lower Number of Children*.
95 See Putnam/Campbell, *American Grace*.
96 See Sosis/Ruffle, *Religious Ritual and Cooperation*.
97 See Sosis, *Religion and Intragroup Cooperation*.

Building up boundaries between religions and setting of group specific rules often includes the generation of rituals. Accordingly, Marshal proposes that the best way to understand religions is by their rituals' epistemic and integrative functioning beginning with the practice of rituals and how ritual practices are transformed to knowledge into belief membership and further into belonging.[98] Important elements of the proposed model are effects of co-presence. In line with this, group members already share the relevant beliefs so that co-presence produces both identification among believers and polarization between believers and non-believers, which in turn leads to a stronger in-group cohesion among believers. Co-presence also leads to the liking and sharing of emotions and thoughts of believers, and increases the sense of unity and, thus, social cohesion within a group. This process is combined with the generation of rituals typical to a group of believers, further leading to a certain amount of conformity among group members. Furthermore, rituals affect subjective states of mind and facilitate more intense and more prolonged activities and thus improve the performance of the ritual. Accordingly, rituals are "costly" and therefore "honest" signals.[99] Marshal further proposed a theory of evolution of religious behavior and attitudes due to a duplex system: an evolutionary older non-conscious system and a newer conscious system that accounts for external experiences.[100] Accounting for these external experiences may have led to tensions among these two systems and, in turn, humans may have started to collectively confabulate corresponding external, coercive, and moral entities, their "Gods". Accordingly, due to these tensions among an unconsciousness and a conscious system we may have developed concepts of spirituality and transcendence to overcome an arising cognitive dissonance.

Anyhow, there is a lot of evidence that a cultural-genetic co-evolution took place: beliefs in big gods became increasingly common over the last several thousand years; archaeological and historical evidence demonstrates that rituals became more organized and regular. For example, in Middle America, 6,000 years ago, hunter gatherers had less formal, not strictly planned rituals; but with the later establishment of larger kingdoms that ruled many small villages, rituals became more regular and a class of priests who were "in contact" with the gods emerged. A comparable scenario happened in Mesopotamia and Egypt, eventually leading to the god of the Hebrew and the Christian bible as well as to the almighty god of the Quran.[101] Impressively, in the farewell

98 See Marshal, *Behavior, Belonging, and Belief*.
99 See Zahavi & Zahvai, *The Handicap Principle*.
100 See Marshal, *Behavior, Belonging, and Belief*.
101 Reviewed in Norenzayan, *Big Gods*.

sermon of the Quran, Muhamad emphasized the universality of belief and cooperation beyond ethnic and tribal borders in the sense of a newly emerging brotherhood among non-kin.[102]

Furthermore, according to Withmeyer, homogamy may play an important role in the forming of ethnic identities as it helps possible co-progenitors in a minimal endogamous set to which people belong, acting in their "genetic interest".[103] In minimal endogamous sets, people typically know through myths, for instance, what the unit of endogamy is (e. g. extended family, tribe, larger community of religious communities). This knowledge may lead to the definition of "latent ethnic groups" fostering pro-ethnic behavior as well as within group marriage and thus ensuring rules of genetic relatedness and increasing genetic relatedness within a group. This is a process of "ethnic group forming" that can be recognized, for instance, in the US, by marriage according to the same ancestry.[104] Also, the recently emerging homogamous marriages within the same educational strata may lead to a pseudo-ethnic stratification of a society by education.[105] Accordingly, "a kind" of homogamy may be substituted by another kind of homogamy; nowadays educational homogamy may substitute other forms of homogamy. Hence homogamy may always be of certain importance but the kind of homogamy may change. Correspondingly, ethnic and cultural entities may have emerged from small scale societies as we have evolved in rather small groups not much larger than 150 individuals.[106] These groups represented minimal endogamous groups forming the basic unit of "ethnicity". These small groups, however, may have implied the problem of inbreeding[107] so that in addition rules of "outbreeding" evolved (demonstrated for instance for paleolithic foragers).[108] Mainly young females accounted for outbreeding by moving to other groups for marriage. This more "outgroup orientation" of young females might be echoed nowadays by the more xenophile attitude found in young women.[109] Through this so-called "female dispersal",[110]

102 See Muhammad, *The Last Sermon*.

103 See Withmeyer, *Endogamy as a Basis for Ethnic Behavior*.

104 See Schahbasi et al., *Marriage in the Melting Pot*.

105 See Huber/Fieder, *Educational Homogamy Lowers the Odds of Reproductive Failure*; van Bavel, *The Reversal of Gender Inequality in Education, Union Formation and Fertility in Europe*.

106 See Dunbar, *Coevolution of Neocortical Size, Group Size and Language in Humans*.

107 See Clark et al., *Associations of Autozygosity with a Broad Range of Human Phenotypes*; Fieder et al., in press.

108 See Sikora et al., *Ancient Genomes Show Social and Reproductive Behavior of Early Upper Paleolithic Foragers*.

109 See Schahbasi et al., *Factors Affecting Attitudes Toward Migrants*.

110 See Huber et al., *Living with Own or Husband's Mother in the Household is Associated with Lower Number of Children*.

not only genes may have been transmitted among groups, but also attitudes, imaginations, culture and religious concepts. Thus, larger ethnic groups with a common culture and religion beyond tribes did emerge. Later on, during the agricultural revolution, even larger cultural groups were formed on this basis. In these larger groups, individuals of different ethnicities came together in the first city states. In addition, the unifying nature of religion led to an overcoming of "ethnic marriage barriers" and thus to the forming of much larger cultural, religious and also larger genetic entities. Thus, the concept of ethnic, cultural and religious nations did emerge. Ethnicity and religion may have always been overlapping to some extent. But religion may have helped to form new and larger entities beyond tribes and the simple agglomeration of tribes, leading to the "myth" of nations and states.[111]

This view is supported by an analysis on the basis of recent census data from ten countries worldwide. We found that individuals who marry across ethnic borders have, on average, a lower number of children. If, however, ethnically heterogamous spouses share the same religion, in terms of number of children, religious homogamy compensates for ethnic heterogamy. Accordingly, ethnically mixed marriages do not have fewer kids if spouses adhere to the same religion. Possibly, religion and the emergence of "big gods" may have led in general to more harmonious relationships and trust and thus also may have fostered fertility.[112] Interestingly, "mixing" of ethnic and religious groups by inter-marriage still seems to be the key to integration and social cohesion[113] – thus, religion may separate individuals but may also bring them together. Furthermore, as homogamy is prescribed by many religions and as homogamy increases the number of descendants, this may have provided a positive evolutionary "feedback loop" – increasing the prevalence of individuals with a predisposition for "homogamy" as well as for an increased fertility – indicating a genetic correlation and thus a co-evolution of both.[114]

However, the big god theory has to some extent a precursor, the so-called "Axial Age" theory developed by the philosopher Karl Jasper who claimed a historical axis during a rather short historical period of time.[115] The "Axial Age" religions include Judaism, Christianity, Hinduism, Buddhism, Confucianism and Daoism. These religions and philosophies are distinct from early pagan cultures which had been devoted to gods that are part of "this world" and had human characteristics, human strengths and weaknesses. This kind of god is

111 See Harari, *Homo Deus*.

112 See Huber/Fieder, *Mutual Compensation of the Effects of Religious and Ethnic Homogamy on Reproduction*.

113 See Fieder et al., *Do Birds of a Feather Flock Together?*

114 Fieder/Huber, in preparation.

115 See Jaspers, *The Origin and Goal of History*.

different from the gods or transcendental entities of the later axial age, which are always supernatural creatures "outside" of this world. These transcendent identities do not have needs and weaknesses of humans – they are the so-called "uncaused cause". These entities are moral instances, often offering an afterlife and a salvation from this world and a concept of a soul, and thus these religions are world "salvation religions".[116] According to Sanderson, these religions may have developed due to the increasing insecurity during the axial age, as during this time age, warfare and epidemics may have increased to an extent never seen before in the course of urbanization and state formation.[117] In line with this view, Basava et al. found on basis of historical data from Islamic sects and applying phylogenetic methods that apocalyptic beliefs had been co-evolving with revolutionary violence, whereas beliefs in reincarnation are found in peaceful stable groups. In both cases, Basava et al. found that violence did precede the emergence of beliefs, persisting in groups adhering to apocalyptical beliefs, but vanishing in groups adhering to beliefs in reincarnation.[118] In accordance with Sanderson,[119] occurring respectively persisting violence might be causal for the evolution of certain beliefs.

6 Further Cooperation

In the future, we believe a more intensified cooperation with religious studies in a very broad sense would bring mutual benefits to all involved fields as without the profound theological, historical, and cultural knowledge on religions, biologists will be at risk of interpreting things wrongly. We suppose that the complex interplay between religion and biology in the process of biocultural co-evolution can only be understood if the complexity of religions is understood. On the other hand, also religious studies may benefit from the integration of "biology", providing another complementary model to understand how religion in general and the great cultural variety in religions have emerged. Beyond these rather scientific questions, evolutionary biology and genetics will pose new fundamental ethical as well as religious questions. To answer these questions, a joint effort across the borders of these fields is urgently needed. Furthermore, the integration of evolutionary approaches may not only help to better understand the "emergence of religions", but may

116 Reviewed in Sanderson, *From Paganism to World Transcendence*.
117 See Sanderson, *From Paganism to World Transcendence*.
118 See Basava et al., *A Phylogenetic Analysis of Revolution and Afterlife Beliefs*.
119 See Sanderson, *From Paganism to World Transcendence*.

also provide additional knowledge on the differences and commonalities of religions. It may thus allow for a new approach for a better understanding of different religions which is utterly important – not emphasizing what divides religions but what they have in common.

7 Conclusion

Of course, it is not possible to cover the complexity and manifoldness of the evolution of religions in one article. Nonetheless, more and more evidence has been gathered that "being religious" is deeply rooted within us, much deeper than it could be explained by environmental influences and education only. Religion may have evolved not "per-se", but as a by-product of our cognitive functions, using already existing adaptations or existing cognitive structures as well as already existing social structures. This may involve for instance the distinction of costly honest signals from "fake signaling". Albeit today we recognize secularization in modern industrialized societies, religion is far from dying out. This is especially the case as religious attitudes and behaviors do have a reasonable genetic predisposition ranging from 20% up to over 50%, depending on the attitude or behavior investigated. Albeit the exact genetic basis for religiousness has not yet been discovered on a profound basis of cases, we can be sure that there is not only one "religious gene", but as any other complex trait, that religiousness has a polygenic basis. This is also in line with assumptions of multi factorial evolution of religiousness as a by-product of our various cognitive abilities. Furthermore, as religion is to some extent heritable and in almost all cultural settings affiliated people do have more children compared to the non-affiliated, we can expect that the "genetic predisposition for religiousness" will further proliferate. Accordingly, on the contrary to suggestions that religiousness may shrink, we have to expect an increasing share of believers world-wide within the next 50 years or so. Also, the highly polarized discussions we have recently experienced in Western secularized societies which really "rock", such as pros and cons of migration, are conducted on the "moral borders" echoing past discussions on religion. The high moral attitudes with which some of these discussions are held, are to some extent "pseudo religious". However, these discussions usually miss the unifying element of "big religions" merging different attitudes to "one system" of common beliefs, morals and values. Maybe this merging of different moral attitudes and values under "one system of beliefs" is one of the most important contributions of religion to our very recent evolution, fostering strong cooperation among unrelated individuals. Hence, discussions merely on moral issues often fail as

moral values differ strongly according to the respective political attitude: what is the moral demand? One side of the political spectrum is morally rejected by the other side[120] – thus contrary to "big religions", discussions on moral issues may lead to separation. There is no doubt that also the "big religions" generated considerable problems by enforcing strong conformism and punishment upon the non-conforming as well as upon the well-known (often violent) conflicts at the borders of religions. Thus, religion may have helped to overcome and widen ethnic borders, but on the other hand, borders of religions often "behave" like ethnic borders. A good example is the pressure by nearly all religions for "marriages within religious communities". As religious homogamy and fertility are usually positively associated, this may indicate a potential coevolution of both. However, concerning for instance the fierce discussions on migration and integration, from an evolutionary point of view, mate choice and marriage across ethnic, cultural and religious borders are the key to a successful integration in the long run.

From an evolutionary point of view, it would also be interesting to speculate if we (humanity) are able to establish a worldwide norm of "living together peacefully", respecting that others have different values and customs without the need for "a punishing big god".

Acknowledgements

The Midlife in the United States (MIDUS) Series. The original MIDUS study was supported by the MacArthur Foundation Research Network on Successful Midlife Development. Data had been accessed from ICPSR (https://www.icpsr.umich.edu/web/ICPSR/series/203).

Biography

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120 See Haidt, *The Righteous Mind*.

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