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Alloparenting and religious fertility: A test of the religious alloparenting hypothesis

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ABSTRACT

Life history theory anticipates that organisms trade offspring quantity for offspring quality. In modern human societies this tradeoff is particularly acute because of increased returns on investments in embodied capital. Religious people, however, despite having more children than their secular counterparts, do not appear to suffer lower quality offspring. To explain this apparent *paradox of religious fertility,* we propose a *religious alloparenting hypothesis,* which hypothesizes that higher levels of alloparenting in religious communities enable religious individuals to support larger families without reducing offspring quality. Using data from a large national sample whose population is roughly half religious and half secular (N = 12,980; New Zealand), we demonstrate that, after adjust for denominational, environmental ethnic and other demographic differences, religious identification is associated with an increased likelihood of having at least one child, and religious identification and ritual frequency are positively related to offspring number among people with at least one child. Consistent with the *religious alloparenting hypothesis*, religious identification and ritual frequency are also positively associated with alloparenting among community members who do not currently have young children of their own. These are the first findings to reveal that religious cooperation extends to alloparenting; however, whether or not the levels of alloparenting in religious communities are sufficient to mitigate the costs of higher relative fertility remains a critical consideration for future research.

1. Introduction

Despite prolonged investment in children, human females exhibit shorter interbirth intervals and have more offspring than our closest great ape relatives (Hill & Kaplan, 1999; Kramer, 2010; Walker, Gurven, Burger, & Hamilton, 2008). High fertility is accomplished, in part, by substantial energetic contributions to children by alloparents (Bell, Hinde, & Newson, 2013; Hawkes, O'Connell, & Blurton Jones, 1997; Hrdy, 2005, 2009; Kaplan, Hill, Lancaster, & Hurtado, 2000). Cross-cultural studies of natural fertility populations find that, under diverse ecological conditions, older siblings (Kramer, 2010), fathers (Hewlett, 2004), and adult kin (Sear & Coall, 2011; Sear & Mace, 2008) make substantial investments to children. Alloparental investments are critical to child survival and child well-being (Sear & Coall, 2011; Sear & Mace, 2008), and have contributed to the demographic success of humans over the long course of human evolutionary history (Bell et al., 2013; Kramer, 2010).

Notably, human ecologies have undergone rapid change in recent centuries, with marked effects on human reproductive trends. Beginning about 300 years ago, industrialization in European societies led to the dispersal of individuals over greater geographical ranges (Chesnais, 1992; Mason, 1997). As a result, kin network size and alloparental resources available to mothers diminished (Draper, 1989; Sear & Mace, 2008; Turke, 1989). Indeed, cross-cultural studies find that, when compared to natural fertility populations, children in modern societies receive less investment from kin, particularly older siblings, cousins, aunts, and uncles (Sear & Coall, 2011). It has been argued that the lower levels of alloparental resources in modern environments contribute to reduced fertility because the costs, real and/or perceived, of rearing successful children in modern environments are greater than under ancestral conditions (Draper, 1989; Kaplan, 1996; Kaplan et al., 2000; Sear, Lawson, Kaplan, & Shenk, 2016; Sear & Mace, 2008; Turke, 1989). Despite having fewer offspring, however, parents living in modern environments invest more in each child than parents in pre-

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modern environments (Kaplan, 1996; Kaplan, Lancaster, Tucker, & Anderson, 2002).

Modernization is associated with increased levels of parental investment because the returns on investments to offspring skill, education, and health are greater than under the conditions that characterized most of human evolutionary history (Kaplan, 1996; Kaplan et al., 2002). Human parents, in other words, face a tradeoff between offspring quantity and offspring quality, and this relationship is intensified in modern environments (Lawson & Mace, 2009, 2011).

Although in modern environments increased investment in fewer offspring is positively related to measures of quality, such as education and/or wealth, it remains unclear whether low offspring number/high investment strategies are associated with offspring reproductive success. Using extensive data from Icelandic genealogical records over two centuries (1700 CE–1919 CE), for example, Lynch (2016) found that parental resource contributions to offspring were more important to offspring reproductive success than genetic contributions and that falling population-wide fertility corresponded to increased investment in each offspring (see also, Boone & Kessler, 1999). Other studies, however, fail to find an association between a low offspring number/high investment strategy and downstream reproductive success, even though these strategies are associated with increased proximate measures of offspring quality such as education (e.g., Goodman, Koupil, & Lawson, 2012; Kaplan, Lancaster, Johnson, & Bock, 1995). Although it is unclear whether low fertility in modernized societies increases offspring reproductive success, child number is consistently found to be negatively related to valuable and rival resources, including education, intelligence, physical size, and wealth (Kaplan et al., 1995; Lawson & Mace, 2011).

1.1. Religious fertility and child success in modern environments: A paradox?

Modernization entails major transitions in social organization, medicine, and technology. It also witnesses steady declines in organized religion. A diminishing importance of organized religion inspired classical sociologists, such as Comte, Engels, Freud, Marx, Voltaire, and Weber to forecast the imminent demise of religion (Stark, 2015). Despite their other intellectual insights, however, these thinkers were mostly wrong about the future of religion. Not only is a global majority religious, demographers predict the world will become even more religious. This is partly because the fertility rates of religious individuals outpace those of secular individuals (Blume, 2009; Hackett et al., 2015; Kaufmann, 2010; McQuillan, 2004).

For evolutionary ecologists, the higher fertility of religious individuals in modern environments presents what appears to be a puzzle, which we tentatively call *the paradox of religious fertility*. Among humans, higher fertility is associated with reduced offspring quality, and this relationship is intensified in modern environments (Lawson & Mace, 2008, 2009, 2011; Lynch, 2016). Yet in these same environments, and despite higher fertility, children born to religious parents do not appear to exhibit reduced quality relative to secular children, at least in terms of proximate measures of fitness, such as health, wealth and education (Bartkowski, Xu, & Levin, 2008; Ellison & Xu, 2014; and see below). Indeed, these findings suggest that religious people living in modern environments may be partially buffered from trading offspring quality for quantity (Shaver, 2017).

Few studies compare secular and religious child success (Bartowski et al., 2008); however, despite generally having more children, religiously affiliated children show a higher level of educational achievement at high school and university than do non-religious children (Glanville, Sikkink, & Hernández, 2008; Lee, Puig, & Clark, 2007; Massengill, 2008; Massengill & MacGregor, 2012; McFarland, Wright, & Weakliem, 2011; Regnerus, 2000; Schwadel, 2014). Consistent with these findings, there is a positive correlation between parental religiosity and wealth in the United States (Gruber, 2005; Keister, 2003). Physical health and health habits also exhibit a positive correlation with parental religiosity (Rew & Wong, 2006; Varon and Riley, 1999; Wallace & Forman, 1998).

It is possible that the positive outcomes found for religious children are the result of greater wealth accumulated to these families; however, in the United Sates at least, there is denominational level variance in adult accumulation of wealth to individuals born to religious parents, after adjusting for sibling number (Keister, 2003). Moreover, other studies conducted in the United States find that although sibling number is negatively associated with several forms of wealth accumulation, as adults, those individuals born to Catholic and Protestant (but not Jewish) parents achieve greater wealth than individuals born to secular parents (Keister, 2007). Although these findings suggest that the paradox of religious fertility may hold in many modern contexts, we stress that there are not yet conclusive tests of whether or not children born to religious parents are to any extent buffered from the costs of high fertility. Nonetheless, the high fertility of religious communities begs evolutionary investigation.

Here we begin to address the evolutionary puzzle of religious fertility by focusing on those mechanisms that may be responsible for motivating the high fertility of many religious communities. Although demographers have long known that religious individuals have higher fertility rates than secular individuals, and evolutionary anthropologists find that in modern environments larger family size is associated with a reduction in offspring quality, researchers have yet to ask the question: How might religious parents mitigate the costs of high fertility typically faced by modern human populations?

1.2. The religious alloparenting hypothesis

We propose the religious alloparenting hypothesis which claims that religious cooperation enables the high fertility characteristic of religious communities (Shaver, 2017). The hypothesis builds on evidence that religious people exhibit high within-group cooperation (Johnson, 2005; Norenzayan et al., 2016; Purzycki et al., 2016; Ruffle & Sosis, 2007; Sosis & Ruffle, 2003; Wilson, 2005) and suggests that this cooperation (e.g., running errands, sharing clothing) indirectly affects fertility by freeing religious parents to invest more in their children than secular parents with equivalent offspring number. The religious alloparenting hypothesis further predicts that religious cooperation extends to direct alloparental childcare among extended kin networks and unrelated co-religionists. In other words, religious cooperation generally, and religious alloparenting specifically, are expected to contribute to the maintenance of larger families among the religious.

Childcare provisioning by non-parents poses greater risks to children than direct parental care where evolved attachment mechanisms motivate high levels of investment (Daly & Wilson, 1980; Hrdy, 2005). Parents, therefore, are expected to be reluctant to trust conspecifics, especially non-kin, with their offspring. Religious ecologies, however, promote generalized trust among community members, with ritual behavior, in particular, fostering a sense of trustworthiness among co-religionists (e.g., Anderson, Mellor, & Milyo, 2010; Johansson-Stenman, Mahmud, & Martinsson, 2009; McCullough, Swartwout, Shaver, Carter, & Sosis, 2016; Tan and Vogel, 2008). High levels of trust between co-religionists, in other words, may facilitate greater levels of alloparenting in religious communities, particularly in the secularized environments associated with modernization (Hall et al., 2015; Sosis, 2005).

Previous findings offer preliminary support for the religious alloparenting hypothesis. First, frequent attenders at religious services have larger social networks, and receive more social support, than infrequent or non-attenders (Bradley, 1995; Ellison & George, 1994). Second, parents have been shown to receive more social support from co-religionists than non-parents (Chatters, Taylor, Lincoln, & Schroepfer, 2002). Third, prayer frequency and church attendance predict more offspring among religious women and men; moreover, between-sex

Table 1
Interval/ordinal variables used in analyses.

	Sample (n = 15,822)				At risk for alloparenting (n = 9320)			
Variable	Mean	SD	Range	Missing	Mean	SD	Range	Missing
Religious identification	1.92	2.67	0–7	758	1.83	2.62	0–7	686
Ritual frequency	0.84	2.84	0–60	674	0.80	2.82	0–60	639
Age	49.34	14.04	18–95	9	51.67	16.07	18–95	7
Education	5.05	2.85	0–10	1114	4.88	2.87	1–10	661
Children at home	0.81	1.11	0–13	1267	N/A	N/A	N/A	N/A
Childcare hours	14.96	32.57	0–168.00	546	2.90	10.90	0–168.00	403
Offspring number	1.87	1.52	0–21	259	1.49	1.56	0–21	259
Political orientation	3.57	1.13	1–7	1251	3.56	1.33	1–7	986
Socioeconomic deprivation	4.73	2.76	1–10	589	4.87	2.76	1–10	622

differences imply breeding pairs may use religious activities as cooperation signals (Bulbulia, Shaver, Greaves, Sosis, & Sibley, 2015). Fourth, people are more willing to leave their children with an anonymous stranger when that individual is depicted as pious (Purzycki & Arakchaa, 2013; Sosis, 2005). Fifth, many religious congregations encourage members to be good parents and sanction those who do not fulfill parental obligations (Bartkowski, 2001; Bartkowski et al., 2008; Wilcox, 2004). Presently it is unknown, however, whether members of religious communities engage in greater alloparental support than individuals who are demographically similar but who are not members of religious groups.

1.3. The New Zealand socio-religious context

Testing the religious alloparenting hypothesis requires comparing individuals who are similar with respect to demographic factors known to affect fertility (e.g., education) but who differ in their religious affiliation and extent of religiosity. New Zealand offers an ideal setting for testing the religious alloparenting hypothesis because its population is roughly half-religious and half secular, and it is home to the New Zealand Attitudes and Values Study (NZAVS), a nationally representative study that includes fine-grained demographic resolution and measures of religiosity and childcare.

In 2013, the most recent national census for which data have been released, New Zealand had a population of 4,242,048, with 668,724 (16%) people reporting Maori, or indigenous, ancestry (Statistics New Zealand, 2013). The overwhelming majority of the population are of European ancestry, known as Pakeha in Te Reo (the Maori language), but there are also substantial Asian (11.8%) and Pacific Islander (7.4%) populations, respectively the 2nd and 3rd largest minority groups after Maori. New Zealand society has become increasingly secular over the past 50 years, with a decline of religious affiliation at a rate of about 0.90% per year since 1966 (Hoverd, Bulbulia, Partow, & Sibley, 2015). As of 2013, close to half of the population (1,635,345/41%) reported that they had no religion. Of those who did report a religious affiliation, the overwhelming majority were Christian (1,858,977) and Hindus (89,319) were the largest minority religious group.

Here, we systematically test the religious alloparenting hypothesis using data from a large national sample in New Zealand. To assess fertility, we compare offspring counts among secular and religious individuals, adjusting for socio-environmental variation known to affect fertility rates such as resource abundance and extrinsic threats to mortality (Charlesworth, 1994; Roff, 1992). Finally, we compare rates of alloparenting among secular and religious people who do not have young children of their own, again adjusting for environmental variation.

2. Materials and methods

2.1. Participants

Initiated in 2009, The New Zealand Attitudes and Values Study (NZAVS) is an annual, longitudinal national probability sample of registered New Zealand voters. We analyzed data from the 2014 wave (N = 15,822), the most recent year of the NZAVS to ask participants the number of children they have living in their home. We modeled offspring counts on the full data set. Our measure of childcare (see below) does not allow us to determine whose children people are looking after. Therefore, in order to model alloparenting from the complete sample, we removed all participants who have children who are under 18 years of age, as well as all participants who have children living in their homes. People often live with and care for children not their own, but such individuals range dramatically, for example from grandparents to step-parents. Step-parents technically engage in alloparenting, but such investments undergo fundamentally different selection pressures (Daly & Wilson, 1985). We therefore opted to remove all people from the sample who have children living with them. This resulted in a sample of 9320 participants at risk for alloparenting, and a cleaner, if more restricted, measure of alloparenting, since many alloparents (such as grandparents, aunts, or uncles living with their young kin) were likely removed by these selection criteria, and many of these individuals engage in substantial alloparenting (e.g., in three generation households). These exclusion criteria also provide a more conservative test since most religious alloparenting is likely reciprocally based on young mothers exchanging alloparenting favors (see Discussion). See Tables 1 and 2 for a summary of each sample.

2.2. Indicators used in analyses

2.2.1. Offspring number

Participants were asked how many children they had given birth to or fathered or adopted (full sample: M = 1.87, SD = 1.52; at risk for alloparenting: M = 1.49, SD = 1.56). The offspring number question on the NZAVS does not distinguish between births and adoptions;

Table 2
Dichotomous variables used in analyses.

Variable	Sample (n = 15,822)	Missing	At risk for alloparenting (n = 9320)	Missing
Male	5800 (37.7%)	20	3531 (38.0%)	17
Employed	12,039 (78.4%)	188	6667 (72.9%)	177
Partner	11,346 (74.7%)	640	5809 (66.7%)	616
Urban dwelling	10,455 (76.0%)	209	6043 (65.9%)	152

however, relative to other Western societies, adoption is rare in New Zealand. From 2007 to 2016, for example, there were an average of 61,383.60 births per year (Statistics New Zealand), while from 2007 to 2016 there were an average of 191 adoptions (0.003% of the number of births) per year for the whole of New Zealand (New Zealand Ministry of Justice, n.d.). In western societies, most adoptions that do occur are kin adoptions (Lancaster & Kaplan, 2000).

2.2.2. Religious identification

To assess religious identification, participants were asked: "Do you identify with a religion and/or spiritual group?" (yes or no). For those who identified with a religion, participants rated on a scale from 1 to 7 "how important is your religion to how you see yourself?" Individuals who did not belong to a religion were coded as a 0 (full sample: $n = 9117$; at risk for alloparenting: $n = 5314$) on this scale (sample: $M = 1.92$; $SD = 2.67$; at risk for alloparenting: $M = 1.57$, $SD = 2.62$).

2.2.3. Ritual frequency

Ritual frequency was assessed by asking participants how many times they attended a house of worship in the past month (full sample: $M = 0.84$, $SD = 2.84$, at risk for alloparenting $M = 0.80$, $SD = 2.83$). Religious identification and ritual frequency were independent measures.

2.2.4. Alloparenting

Alloparental investment was assessed by asking participants how many hours in the past week they spent looking after children (full sample: $M = 14.96$, $SD = 32.57$; at risk for alloparenting $M = 2.90$, $SD = 10.90$).

2.2.5. Age

The mean age of the full sample was 49.34 ($SD = 14.04$), while the mean age for those at risk for alloparenting was 51.67 ($SD = 16.07$).

2.2.6. Children at home

The full sample had a mean of 0.81 children living at home ($SD = 1.11$).

2.2.7. Education

Education was coded as either no qualification "0," Level 1 Certificate "1," Level 2 Certificate "2," Level 3 Certificate "3," Level 4 Certificate "4," Level 5 Diploma/Certificate "5," Level 6 Graduate Certificate/Diploma "6," Bachelor's Degree/Level 7 Diploma/Certificate "7," Postgraduate Diploma/Certificate "8," Master's Degree "9," or Doctorate Degree "10." The full sample had a mean education of 5.05 ($SD = 2.85$), participants coded as at risk for alloparenting had a mean education of 4.88 ($SD = 2.87$).

2.2.8. Employed

12,039 (78.4%) of the full sample participants were employed, while 6667 (72.9%) of those at risk for alloparenting were employed.

2.2.9. Ethnicity

All participants in the sample are coded according to ethnicity. In the models reported below, we include a covariate of ethnicity with four categories representing the four largest ethnic groups in New Zealand: European, Maori, Pacific Islander, and Asian. The ethnic composition of the full sample is as follows: 12,586 European, 1977 Maori, 434 Pacific Islander, and 634 Asian. The sample at risk for alloparenting included 7610 Europeans, 1027 Maori, 195 Pacific Islanders, and 357 Asians.

2.2.10. Male

Gender was coded as 0 for females and 1 for males to aid in interpretation of the coefficients in our models. There were 5800 males (37.7%) in the full sample and 3531 (38%) in the sample at risk for alloparenting.

2.2.11. Socioeconomic deprivation

We used the socio-economic status of participants' immediate neighborhood using the 2013 New Zealand Deprivation Index (Atkinson, Salmond, & Crampton, 2014) as a measure of an individual's socio-economic status. New Zealand is unique in having rich census information about each area unit/neighborhood of the country that is made available for research purposes. The smallest of these area units are called meshblocks. The NZAVS includes the meshblock code for each participant.

The geographic size of these meshblock units differs depending on population density. Each unit covers a region containing a median of roughly 81 residents ($M = 95.95$, $SD = 73.49$, range = 0–1899). In 2013 there were a total of 44,211 meshblocks for which data were available. The New Zealand Deprivation Index uses aggregate census information about the residents of each meshblock to assign a decile-rank index from 1 (most affluent) to 10 (most impoverished) to each meshblock unit. Because it is a decile-ranked index, the 10% of meshblocks that are most affluent are given a score of 1, the next 10% a score of 2, and so on. The index is based on a principal components analysis of the following nine variables (in weighted order): proportion of adults who received a means-tested benefit, household income, proportion not owning own home, proportion single-parent families, proportion unemployed, proportion lacking qualifications, proportion household crowding, proportion no telephone access, and proportion no car access.

The New Zealand Deprivation Index thus reflects the average level of deprivation for small neighborhood-type units (or small community areas of about 80–90 people each) across the entire country. The full sample had a mean deprivation index of 4.73 ($SD = 2.76$), and the mean for those at risk for alloparenting was 4.87 ($SD = 2.76$).

2.2.12. Partner

Participants were asked if they currently have a partner. The full sample included 11,346 (74.7%) participants with a partner, while the alloparenting sample included 5809 (66.7%) participants with a partner.

2.2.13. Political orientation

Participants were asked to list their political orientation on a scale from liberal (1) to conservative (7) (full sample: $M = 3.57$, $SD = 1.13$, at risk for alloparenting $M = 3.56$, $SD = 1.33$).

2.2.14. Urban

Based on GPS coordinates, all participants were coded as either living in a rural (0) (5158/24%) or urban (1) (10,455/76%) area.

2.3. Missing data

We modeled associations with multiply imputed datasets generated by the Amelia package (Honaker, King, & Blackwell, 2011). Multiple imputation of missing responses preserves information and provides a method for dealing with response biases where missingness can be predicted from observed variables. Following Amelia package recommendations, ethnicity was treated as a nominal response and religious identification was imputed using the log function. To improve the accuracy of imputations, we included 19 variables that assessed how people spend their time (e.g., using the Internet, watching TV) and how often they interact with the members of different ethnic groups (e.g., Maori, Pacific Islanders). For the expected children count model, we imputed twenty datasets for the whole sample. For the alloparenting model, we imputed twenty datasets for those at risk of alloparenting.

2.4. Analyses

Statistical analyses were performed in R version 3.5.1. Bayesian multivariate, multilevel models were built using the brms package

(Bürkner, 2017) for offspring number and the MCMCglmm package (Hadfield, 2010) for alloparenting. We used MCMCglmm 2.18 to model expected hours of alloparenting because it estimates missing zeros during MCMC estimation and is therefore more reliable when data are heavily zero inflated.

For both the offspring count and the alloparenting models, we employed hurdle models and fit binomial distributions on the binary outcome of childlessness and engaging in any alloparenting respectively, and fit a negative binomial distribution to the positive (non-zero) portion of the offspring count model and a Poisson distribution with an additive dispersion parameter for the alloparenting model (Martin et al., 2005; Mullahy, 1986). A comparison of Deviance Information Criteria (DIC) indicated that these distributions yielded the best fitting models. Hurdle models provide estimates for both the amount of zero de/inflation (see below) as well as estimates for the positive portion of the data. Below we report both sets of estimates separately.

To adjust for multi-level dependencies we modeled denominations as random-effects in both models. Following Statistics New Zealand census protocols, secular individuals were aggregated together into a secular category. Participants were classified using the 2013 New Zealand census categories, which contained 93 categories (Shaver, Troughton, Sibley, & Bulbulia, 2016).

To facilitate interpretation and mixing, education, political orientation, and socioeconomic deprivation were scaled and age was transformed into 10-year intervals and centered. We transformed age into 10 year units, which enables us to interpret effects more easily (i.e., age is a linear transform). The effect of a one unit change in year is small, but summing over a decade we can notice what appear to be generational differences. Although all individuals with children under 18, and those with children living in the home, were removed prior to analyses, many individuals in the remaining sample have adult children. We therefore include child number in the alloparenting model because we assume that people with larger families will be at greater risk for alloparenting.

Bayesian models were run on each of the twenty multiply imputed datasets and the resultant estimates were pooled using Rubin's rules to arrive at a single estimate (Rubin, 2004). For the offspring count model, we ran four chains at 40,000 iterations on each imputed dataset. We used weakly informative priors for all parameters, and $\check{R}$ values (all < 1.01) and effective samples indicated that the offspring count model mixed well.

We ran the alloparenting models for 53,000 cycles with a burnin of 3000 cycles and a thin interval of 10. Evidence from plots of the posterior distributions for all models indicated MCMC chains mixed well and there was no evidence of significant auto-correlation in the chains. Effective samples were all well over 1000. Priors for the fixed components of the model were uninformative; parameter expanded priors were weakly informative with a mean of zero and variance of 108. Following Hadfield (2010), we used parameter expanded priors to adjust for the variance of denominations. Parameter expanded priors were centered at zero, and assumed a variance of 102. Priors on residual variances were centered at zero, and assigned a normal inverse Wishart distribution that was not informative. The size and diversity of our sample warrants the use of uninformative priors.

MCMC calculates a DIC which we used to assess the improvement of the theoretical model over the intercept-only model, including the random denomination-level effects (Hadfield, 2010). The average DIC for the intercept-only model across the twenty imputed datasets was: 19,157.15. The average DIC for the theoretical model across the twenty imputed datasets was 18,740.79. The difference between these two sets of average scores is −416.35. Improvements of > 10 DIC units suggest and improvement of model fit. This difference suggests that theoretical model substantially improves upon the intercept-only model.

Multicollinearity was assessed by building general linear models for both analyses and examining the variance inflation factors (VIFs) for each predictor in the models. All VIFs were < 2.1, indicating that multicollinearity was not a problem (James, Witten, Hastie, & Tibshirani, 2014) for either model. The R code for all analyses can be found on the NZAVS website (https://www.psych.auckland.ac.nz/en/about/our-research/research-groups/new-zealand-attitudes-and-values-study/nzavs-bibliography.html).

In hurdle models, brms estimates each coefficient's contribution to zero *in*flation, while MCMCglmm models each coefficient's contribution to zero *de*flation. In order to remain consistent in reporting, we convert the results of the brms hurdle models to estimates of zero deflation.

Table 3
Estimates of zero deflation in having at least one child (n = 15,822).

	Regression estimate	Lower 95% confidence interval	Upper 95% confidence interval
Intercept	0.55	0.40	0.69
Religious identification	0.03	0.01	0.06
Ritual frequency (log)	0.02	−0.08	0.12
Maori	0.43	0.30	0.57
Pacific	0.25	0.00	0.51
Asian	−0.26	−0.47	−0.05
Age 10 yrs (centered)	0.85	0.81	0.88
Education (scaled)	−0.11	−0.16	−0.06
Employed	−0.09	−0.21	0.02
Male	−0.33	−0.43	−0.24
Partner	1.58	1.48	1.68
Political orientation (scaled)	0.13	0.08	0.18
Socioeconomic deprivation (scaled)	−0.05	−0.09	−0.00
Urban dwelling	−0.34	−0.44	−0.25

3. Results

3.1. Offspring quantity

The results of the multi-level hurdle model predicting whether an individual has children is presented in Table 3 and the results of the multi-level model predicting number of children among people who have at least one child is presented in Table 4.

3.1.1. Religion and offspring number

Religious identification is associated with an increased likelihood of having children (0.03, 95% CI = [0.01, 0.06]), while ritual frequency is not associated with having children (−0.02, 95% CI = [−0.08, 0.12]). Among those individuals who have at least one child, a person's

Table 4
Estimates of number of children among all parents (n = 15,822).

	Regression estimate	Lower 95% confidence interval	Upper 95% confidence interval
Intercept	0.63	0.58	0.68
Religious identification	0.02	0.01	0.03
Ritual frequency (log)	0.07	0.04	0.10
Maori	0.19	0.15	0.23
Pacific	0.21	0.13	0.29
Asian	−0.24	−0.34	−0.15
Age 10 yrs (centered)	0.12	0.11	0.13
Education (scaled)	−0.03	−0.04	−0.01
Employed	−0.02	−0.05	0.01
Male	0.03	0.00	0.06
Partner	0.07	0.04	0.11
Political orientation (scaled)	−0.13	−0.18	−0.08
Socioeconomic deprivation (scaled)	0.04	0.03	0.06
Urban dwelling	−0.06	−0.09	−0.03

religious identification (0.02, 95% CI = [0.01, 0.03]) and ritual frequency (0.07, 95% CI = [0.04, 0.10]) are associated with more children.

3.1.2. Ethnicity and offspring number

Relative to New Zealanders of European descent, Maori are more likely to have a child (0.43, 95% CI = [0.30, 0.57]), and compared to New Zealanders of European descent with at least one child, Maori have more total children (0.019, 95% CI = [0.15, 0.23]). Similarly, Pacific Islanders are more likely to have a child (0.25, 95% CI = [0.00, 0.51]), and relative to parents of European descent, Pacific Islander ethnicity is associated with more total children (0.21, 95% CI = [0.13, 0.29]). Conversely, Asians are less likely to have children, (−0.26, 95% CI = [−0.47, 0.05]), and they have fewer total offspring when compared to European New Zealanders with at least one child (−0.24, 95% CI = [−0.34, −0.15]).

3.1.3. Basic demographics and offspring number

A person's age is associated with an increased likelihood of having at least one child (0.85, 95% CI = [0.81, 0.88]), and among people with at least one child, age is positively associated with having more total children (0.12, 95% CI = [0.11, 0.13]). A person's education is associated with a decrease in having at least one child (−0.11, 95% CI = [−0.16, –0.06]), and with having fewer total children when compared with all other parents (−0.03, 95% CI = [−0.04, −0.01]). A person's employment status trends toward a decreased likelihood of having children (−0.09, 95% CI = [−0.21, −0.02]), but is not associated with total number of children (0.06, 95% CI = [−0.13, 0.25]). Males are more likely to be childless than females (−0.33, [−0.43, −0.24]), but men with at least one child are more likely to have more children than females with at least one child (0.03, 95% CI = [0.00, 0.06]). Having a partner is associated with being a parent, (1.58, 95% CI = [1.48, 1.68]), and, among those who have parented at least one child, with having more children (0.07, 95% CI = [0.04, 0.11]). A person's conservatism is associated with parenting at least one child (0.13, 95% CI = [0.08, 0.18]), but with a reduction in total child number when compared to people with at least one child (−0.13, 95% CI = [−0.18, −0.08]). Socioeconomic deprivation is associated with an increase in childlessness (−0.05, 95% CI = [−0.09, −0.00]), but with an increase in the total number of offspring among all parents (0.04, 95% CI = [0.03, 0.06]). Living in an urban area is associated with a decreased likelihood of having children (−0.34, 95% CI = [−0.44, 0.25]) and having fewer total children, when compared to rural individuals with at least one child (−0.06, 95% CI = [−0.09, −0.03]).

3.2. Alloparental investments

The results of the multi-level hurdle model predicting whether a person engages in any alloparenting is presented in Table 5 and Fig. 1, and the results of a multi-level model predicting total hours of alloparenting among people who engage in some alloparenting is presented in Table 6 and Fig. 2.

3.2.1. Religion and alloparenting

A person's religious identification (0.05, 95% CI = [−0.02, 0.12]) and ritual frequency (0.015, 95% CI = [−0.02, 0.33]) are both associated with engaging in alloparenting. Although these coefficients cross zero, the majority of the probability density for both is positive, indicating with a high level of certainty that both are associated with an increased odds of alloparenting. Among those who engage in some alloparenting, however, a person's religious identification is negatively associated with total hours of alloparenting (−0.04, 95% CI = [−0.09, 0.00]). Among those who engage in some childcare, ritual frequency is unrelated to total hours of alloparenting (0.01, 95% CI = [−0.12, 0.14]).

Table 5
Estimates of zero deflation in alloparenting (n = 9320).

	Regression estimate	Lower 95% confidence interval	Upper 95% confidence interval
Intercept	−4.53	−4.97	−4.11
Religious identification	0.05	−0.02	0.12
Ritual frequency (log)	0.15	−0.02	0.33
Maori	0.25	0.00	0.49
Pacific	0.45	−0.03	0.93
Asian	−0.56	−1.11	−0.01
Age 10 yrs. (centered)	−0.06	−0.13	0.02
Adult offspring number	0.21	0.14	0.27
Education (scaled)	0.01	−0.08	0.09
Employed	0.06	−0.13	0.25
Male	0.04	−0.13	0.22
Partner	0.20	0.01	0.29
Political orientation (scaled)	0.04	−0.05	0.13
Socioeconomic deprivation (scaled)	−0.13	−0.21	−0.04
Urban dwelling	0.26	0.08	0.43

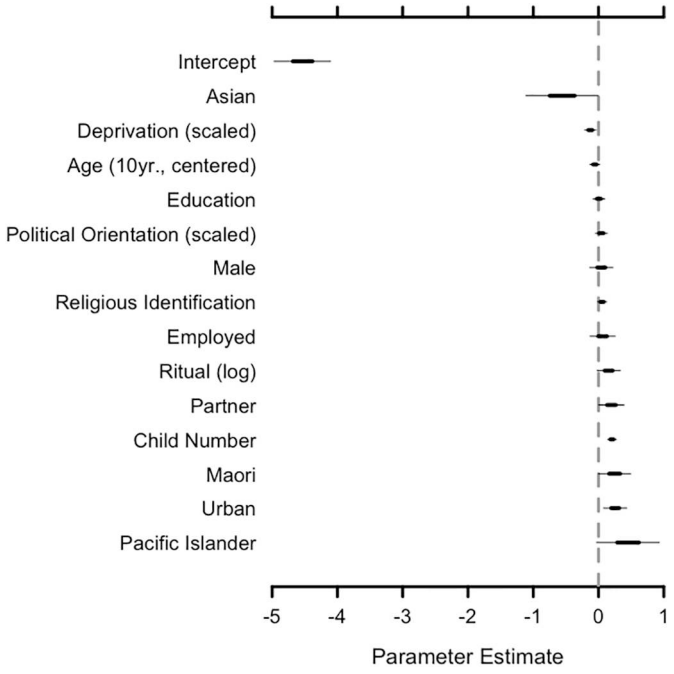

Fig. 1. Estimates of zero deflation in alloparenting.
A plot of the posterior means and 95% posterior density intervals for all coefficients in the hurdle model.

3.2.2. Ethnicity and alloparenting

Relative to New Zealanders of European descent, Maori are more likely to engage in some alloparenting (0.25, 95% CI = [0.00, 0.49]), and among those who engage in alloparenting, Maori participants spend more time alloparenting (0.20 95% CI = [0.03, 0.37]). Similarly, Pacific Islanders are more likely to look after someone else's children (0.45, 95% CI = [−0.03, −0.93]), and among people who do some alloparenting, Pacific Islanders are more likely to engage in a greater number of hours of childcare (0.35 95% CI = [0.03, 0.68]). People of Asian descent are less likely to engage in any alloparenting (−0.56, 95% CI = [−1.11, −0.01]), but there is no association between Asian identification and total hours of alloparenting among all parents (0.00, 95% CI = [−0.41, 0.41]). In general, populations with higher fertility (Maori and Pacific Islanders) engage in more alloparenting, and those populations with lower fertility (Asians) engage in less alloparenting. On the national scale, in other words, fertility levels and alloparenting

Table 6
Estimates of hours of care among alloparents (n = 9320).

	Regression estimate	Lower 95% confidence interval	Upper 95% confidence interval
Intercept	1.93	1.62	2.23
Religious identification	−0.04	−0.09	0.00
Ritual frequency (log)	0.01	−0.12	0.14
Maori	0.20	0.03	0.37
Pacific	0.35	0.03	0.68
Asian	0.00	−0.41	0.41
Age 10 yrs (centered)	−0.06	−0.12	−0.00
Adult offspring number	0.12	0.07	0.17
Education (scaled)	0.01	−0.05	0.08
Employed	−0.07	−0.21	0.06
Male	−0.55	−0.68	−0.42
Partner	0.09	−0.05	0.24
Political orientation (scaled)	0.03	−0.03	0.10
Socioeconomic deprivation (scaled)	0.01	−0.51	0.08
Urban dwelling	−0.40	−0.17	0.09

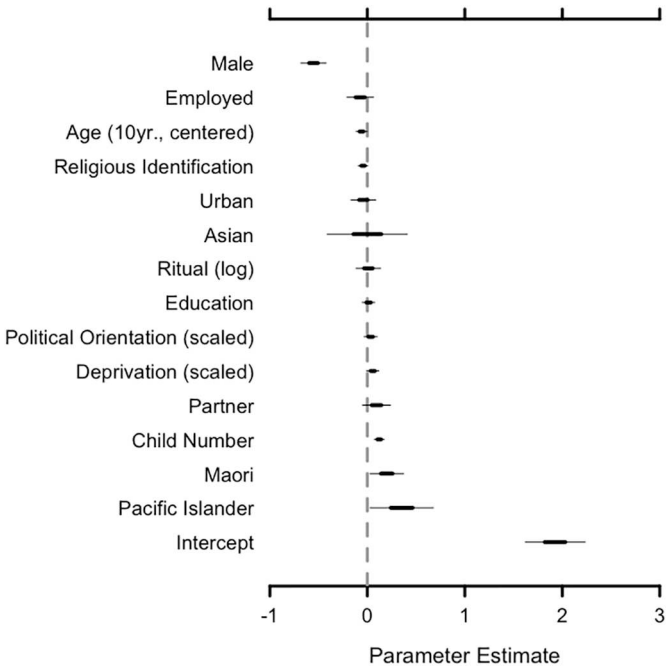

Fig. 2. Estimates of hours of care among alloparents.
A plot of the posterior means and 95% posterior density intervals for all coefficients in the zero-altered Poisson model.

levels trend in the same direction.

3.2.3. Basic demographics and alloparenting

There is evidence of a trend of younger people engaging in at least some allocare (−0.06, 95% CI = [−0.13, 0.02]), and evidence of a negative association between age and total hours of alloparenting (−0.06, 95% CI = [−0.12, −0.00]). People with more adult children are more likely to engage in alloparenting (0.21, 95% CI = [0.14, 0.27]), and among individuals who look after children, there is a positive association between number of adult children and total hours of childcare (0.12, 95% CI = [0.07, 0.17]). There is no association between a person's education and engaging in alloparenting (0.01, 95% CI = [−0.08, 0.09]), nor total hours of alloparenting (0.01, 95% CI = [−0.05, 0.08]). Similarly, there is no association between employment status and alloparenting (0.06, 95% CI = [−0.13, 0.25]), nor employment and total hours of alloparenting –(0.07, 95% CI = [−0.21, 0.06]). Males are no less likely to engage in alloparenting than females (0.04, 95% CI = [−0.13, 0.22]), however, among those who engage in some childcare, males spend fewer hours alloparenting (−0.55, 95% CI = [−0.68, −0.42]). People with a partner are more likely to engage in some alloparenting (0.20, 95% CI = [0.01, 0.29]), but among those who engage in alloparenting, there is no association between relationship status and total hours of alloparenting (0.09, 95% CI = [−0.05, 0.24]). There is no evident relationship between political conservatism and some alloparenting (0.04, 95% CI = [−0.05, 0.13]) nor hours spent alloparenting (0.03, 95% CI = [−0.03, 0.10]). Socioeconomic deprivation is negatively associated with whether an individual engages in alloparenting (−0.13, 95% CI = [−0.21, −0.04]), but not with total hours alloparenting (0.01, 95% CI = [−0.51, 0.08]). People living in urban areas are more likely to engage in some alloparenting (0.26, 95% CI = [0.08, 0.43]), but there is no effect of urban/rural status and total hours spent in childcare (−0.40, 95% CI = [−0.17, 0.09]).

3.2.4. How much does religion affect the probability of alloparenting?

To interpret the magnitude of these effects we use the model results to estimate the expected amount of alloparenting for different populations in New Zealand. To calculate expected values in MCMCglmm for a zero-altered model on the data scale requires transforming the regression coefficient by the function *-exp(exp(x))*, where *x* are the estimate regression solutions (MCMCglmm estimates solutions). Here we focus on estimated marginal means for different populations in New Zealand.

Among employed, urban people of European descent with a partner, who do not affiliate with a religion or attend church, the expected probability of zero alloparenting is 0.9818. To put this result in perspective, in any given week, out of a 100 unaffiliated people without young children, we would expect 1.82 people to care for children who are not their own.

By contrast, among employed, urban people of European decent with a partner and without young children of their own, but who are fully religiously identified (7) and attend church four times per month, the expected probability of zero alloparenting is 0.9665. Among 100 of these people, we would expect 3.35 people to care for children who are not their own. In other words, there is about twice the frequency of alloparenting among the highly religious and frequently attending group than among the unaffiliated group.

The expected probability of zero alloparenting among secular Maori is 0.9767, and among fully religiously identified and regular church going Maori, the expected probability of zero allopareting is 0.9572. The expected probability of zero alloparenting among Pacific Islanders is even more pronounced - zero alloparenting among secular Pacific Islanders in New Zealand evinces a probability of 0.9709, and among fully religiously identified and regular attending Pacific Islanders, the number drops to 0.9468 or a realization of 5.32 people per 100 potential alloparents.

In general, the prevalence of alloparenting in New Zealand among people without young children is low; however, alloparenting differs among ethnic groups, and, after adjusting for these ethnic group differences, religion is positively associated with an increase in alloparenting.

4. Discussion

This study proposes and tests a core prediction of the religious alloparenting hypothesis (Shaver, 2017). The hypothesis addresses a central paradox in the evolutionary study of culture: across a broad array of biological taxa (Roff, 1992; Stearns, 1992), as well as among modern human populations (Lawson & Mace, 2008, 2009, 2011; Lynch, 2016), high fertility is associated with a decrease in proximate measures of offspring fitness, yet children born to religious parents do not appear to exhibit reductions along these measures (Bartkowski et al., 2008; Ellison & Xu, 2014), despite larger sibling numbers. The religious

alloparenting hypothesis posits that religious people engage in more alloparenting than secular people, reducing the strength of offspring quantity-quality tradeoffs. The hypothesis predicts that: (1) religious people engage in greater alloparenting than non-religious people, and that (2) greater alloparenting in religious communities buffers children from the effects of high fertility. The first prediction, which we test here, is consistent with increasing evidence, reviewed above, that religious cultures evolved to support, and continue to support, within-group cooperation. It is not possible to test prediction (2) with our current data. Though (2) is plausible, the extent to which religious alloparenting buffers religious children is a matter for future investigations. It is possible that greater cooperation among religious parents (Bartkowski & Ellison, 1995; Ellison & Sherkat, 1993; McKune & Hoffman, 2009; Smith, 2003), higher levels of investment among closely related kin (see Shaver, 2017) and religious fathers (Bartkowski & Xu, 2000; Ellison & Xu, 2014; Wilcox, 2002), health-enhancing norms and habits, and other factors also contribute to buffering children in religious families. Nonetheless, the effect of religiously motivated cooperation on child development remains an important future horizon for evolutionary investigation.

Though the religious alloparenting model does not offer a magic bullet explanation of the high fertility of religious communities, it offers an evolutionary theory of religious group dynamics and parenting, and draws into focus the core biological demands of breeding as among the cooperative problems that religious cultures evolved to solve. Specifically, the model (1) identifies a central paradox in demography: despite global evidence for greater fertility among religious communities in comparison to secular communities, the mechanisms that enable religious people to achieve higher fertility remain unclear; (2) addresses the issue of religious fertility by appealing to widely accepted evidence that religious cultures evolve to enable cooperation; and (3) draws attention to a fundamental evolutionary problem confronting humans, the task of breeding, and considers whether religious cultures offer solutions to this task.

Testing the predictions of the religious alloparenting hypothesis is challenging because it requires comparing alloparenting behavior in a large sample of individuals who are demographically similar but differ in religious affiliation and involvement. The New Zealand Attitudes and Values Study affords such comparisons at a national scale in roughly equivalent numbers of religious and secular parents. Consistent with the religious alloparenting hypothesis, we observe that religious people have more children than non-religious parents, and that religious non-parents are more likely to engage in alloparenting than secular non-parents.

Though religious identification and ritual frequency are associated with an increased probability of alloparenting, we find a negative relationship between religious identification and total hours of alloparenting. Though future investigation is imperative, we suggest several possible interpretations of this finding. First, we suspect that most of the cooperation that affects children likely occurs among parents (e.g., watching one's own children whilst watching someone else's), however, our data are currently unable to address such cases. After cooperation among parents is considered, the demand for additional alloparenting may not be on the scale of multiple hours per week. Since most highly religious people of reproductive age have children, and because more people engage in some alloparenting among religious communities that are highly identified, there may be little need for high levels of investment by all. Conversely, when there are relatively fewer alloparents, such as in those communities characterized by low religious identification, each alloparent might contribute more total hours. Lastly, commitments within religious communities are generally realized not by extended investments but rather by providing reliable investments when needed (Bulbulia, 2004; Irons, 2001; Sosis, 2003). Alloparenting in modern environments is often unplanned and brief, helping parents deal with competing demands (e.g., I have to take Johnny to baseball practice – can you watch Melissa while she is napping?). In other words, we would expect membership in a religious community to put one at greater risk of alloparenting that buffers against contingencies, not necessarily extended bouts of alloparenting. Although we cannot currently address these possibilities, we hope that future research will examine how frequency and levels of alloparenting vary according to religious group and religious intensity.

We find that on the nationwide scale, fertility levels differ between ethnic groups, and levels of alloparenting between these groups trend in the same direction as fertility levels. Specifically, both Maori and Pacific Islanders have higher fertility and greater frequencies of alloparenting than European New Zealanders. Asians, by contrast, have lower fertility and lower frequencies of alloparenting. These findings suggest that fertility levels are adjusted to community-wide levels of alloparental support. Importantly, after adjusting for these ethnic differences in fertility and alloparenting, we find that religion is associated with both family size and cooperative childcare above and beyond these ethnic differences. As our models also adjust for denominational level differences, our findings suggest that religious involvement independently impacts fertility and alloparenting at a nationwide scale.

Our results have general implications for understanding cultural evolutionary dynamics (Rowthorn, 2011; Wilson, Hartberg, MacDonald, Lanman, & Whitehouse, 2016). Cultural groups vary substantially in levels of alloparenting (Kramer, 2010). At an individual level, human reproductive decision-making evolved to be sensitive to alloparental resources (Lawson & Mace, 2011). Religious groups vary tremendously in their fertility levels, and the model supported here suggests that the differential fertility of religious groups may be the result of facultative responses to varying levels of alloparental support among local co-religionists. This model may therefore help to clarify how cultural norms simultaneously drive the fitness of individuals and the growth of cultural groups. These dynamics, in other words, may contribute to an explanation for the continued resilience of religion in the modern world.

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