Intelligence 41 (2013) 546–552

Contents lists available at SciVerse ScienceDirect

Intelligence

Intelligence and religiosity: Within families and over time

Yoav Ganzach [a,*], Chemi Gotlibovski [b]

[a] Tel Aviv University, Israel
[b] Academic College Tel-Aviv Yafo, Israel

ARTICLE INFO

Article history:
Received 3 March 2013
Received in revised form 9 June 2013
Accepted 1 July 2013
Available online xxxx

Keywords:
Intelligence
Education
Religion
Religiosity
Age effects

ABSTRACT

We study the effect of intelligence (General Mental Ability) on religiosity using research designs that allow for stronger causal inferences compared to previous research in this area. First, we examine how between-siblings differences in intelligence are related to differences in their religiosity. Second, we examine how intelligence is related to changes in religiosity over time. The results of both designs suggest that intelligence has a strong negative effect on religiosity. In addition, our results also suggest that intelligence interacts with age in determining religiosity: the more intelligent the person, the stronger the negative effect of age on religiosity.

1. Introduction

The age-old question whether it is rational to believe in God recently received a renewed attention following the publication of Richard Dawkins' book "The God delusion" (2006, see also Pirsing, 1991, for another influential book). Following this renewed philosophical interest, there was also a renewed interest in the empirical question of whether there is a causal link between intelligence and religiosity and whether intelligence has a negative effect on religiosity. In the current paper we study this link using research designs that allow for stronger causal inferences compared to designs used in previous research in this area.

Studies that provide empirical support for a negative relationship between intelligence (i.e., General Mental Ability or g) and religiosity begun to appear as early as 1928 (Howells, 1928; Sinclair, 1928), and continued to appear since. In reviewing the relevant research, Bell (2002) states that of 43 studies that report correlations between intelligence and religiosity, all but four found a negative correlation. (Bell, 2002, see also, Beckwith, 1986 for similar results). Following the publication of Dawkins' (2006) book, there was a resurgence in studies that relied on more refined methodologies than earlier studies, either by using large representative samples and better controls (Ganzach, Ellis, & Gotlibovski, 2013; Kanazawa, 2010) or a larger number of measurements of intelligence (Bertsch & Pesta, 2009). These studies too found a negative relationship between intelligence and religiosity. In addition, two recent studies also found a negative relationship between intelligence and religiosity on the aggregate level, either by correlating average national intelligence with average national religiosity (Lynn, Harvey, & Nyborg, 2009), or by relating average denominations' intelligence to the strength of their religious beliefs (Nyborg, 2009).

However, the correlational designs of all these previous studies do not allow strong causal inferences about the relationship between intelligence and religiosity, as they did not rule out alternative non-causal explanations. In particular, the correlations reported in these studies do not rule out the possibility that background characteristics affect both the level of intelligence and the degree of religiosity. For example, it is possible that a poor early home environment is associated both with low intelligence and with high religiosity, or that religious parents have both a positive influence on their children's

* Corresponding author at: Faculty of Management, Tel Aviv University, Tel Aviv, Israel.
E-mail address: yoavgn@post.tau.ac.il (Y. Ganzach).

0160-2896/$ – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.intell.2013.07.003

religiosity and a negative influence on their intelligence (see Blau, 1981).[1]

Thus, one purpose of the current paper is to examine whether the observed correlation between intelligence and religiosity can be explained by background variables associated both with intelligence and with religiosity, rather than by a causal link between the two. To do that, we analyze the effect of intelligence on religiosity *within families* by comparing siblings' religiosity as a function of their intelligence. Such an analysis provides a strong control for background characteristics. Under such a control, an observed relationship between intelligence and religiosity is not likely to be due to a third background variable. In essence, in this design siblings are used as their own controls. For example, a significant effect of intelligence – which is essentially a significant relationship between siblings' differences in intelligence and their differences in religiosity – cannot be attributed to home environment, because this environment is similar for both siblings.

Another approach that allows for strong causal inferences regarding the effect of intelligence on religiosity is to examine *changes* in religiosity within individuals over time as a function of their intelligence. A number of studies documented a negative correlation between age and religiosity during childhood and young adulthood (Argyle, 1958; Francis, 1989; Kuhlen & Arnold, 1944; Turner, 1980). These findings were interpreted as an indication for a causal link between *intellectual ability* and religiosity (Lynn et al., 2009), since when growing up people become more intellectually capable. However, it is still an open question what is the effect of *intelligence* – which is essentially intellectual ability standardized by age – on *changes* in religiosity. One possible hypothesis is that changes in religiosity are a function of intelligence, such that the decline in religiosity of the more intelligent is greater than the decline of the less intelligent. The reason for this hypothesis is that under the assumption that religiosity is not rational (e.g., Dawkins, 2006), the brighter individuals will make a 'better' use of their accumulated experiences, and reject religiosity, in the same way they make better use of academic training in achieving academic success (Binet, 1905; Deary, Strand, Smith, & Fernandes, 2007; Zenderland, 1998).

Finally, although educational attainment is endogenous to intelligence with regard to religiosity, the well documented strong positive effect of intelligence on education (e.g., Neisser et al., 1996a) should be taken into account in examining the effect of intelligence on religiosity. In particular, the effect of intelligence on religiosity may be mediated and/or moderated by educational attainment. First, since the more intelligent are better able to profit from their education (Binet, 1905; Deary et al., 2007), they may become less religious because they are more influenced by their education in developing a rational, non-religious, view of the world (Dawkins, 2006), i.e., a *moderation* effect. Second, since education may lead to decrease in religiosity by providing people with the opportunity to seek rational alternatives to religious dogma (e.g., Durkheim &, 1915, 1915, 1964; Lenski, 1963), the more intelligent may become less religious because they obtain more education, i.e., a *mediation* effect of education (see for example Argyle & Beit-Hallahmi, 1975; Achenbach & Edelbrock, 1987). The results regarding this mediation effect are, however, conflicting. Whereas in studying the relationship between intelligence education religiosity and health on the aggregate (state) level, Reeve & Basalik (2011) did suggest that education mediates the effect of intelligence on religiosity, Ganzach et al. (2013) suggested that, by large, there is no such a mediation, and Kanazawa (2010) suggested that, if anything, education *reduces* the negative net effect of intelligence on religiosity. However, all these results were obtained in a cross-sectional design. A more sensitive longitudinal design such as the one we use in the current paper may reveal a different picture.[2]

2. Method

We use data in which individual and background characteristics were measured when participants were 15 years old on average (with a 13–17 age range), and religiosity and educational attainment were measured at three time points, when participants were, on average, 20, 23 and 26. Thus the age of the participants through the three focal survey years ranged from 18 to 28. In the longitudinal analysis we use all three measurements of religiosity and education, and in the cross-sectional analysis we use only their measurements at the last time point.

2.1. Participants and procedure

The data were taken from an ongoing longitudinal study, the 1997 cohort of the National Longitudinal Survey of Youth (NLSY97). The NLSY97 is a probability sample of 8984 Americans (with over sampling of Afro-Americans, Hispanics and economically disadvantaged whites) born between 1980 and 1984. About 35% were Catholic, 26% Baptists, 29% other Protestants, and the rest from small denominations and religions. The participants came from 6819 households, 1862 of them included more than one participant. As a result 3192 of the participants came from households that included two participants and 835 came from households that included 3 or more participants (as 96% of the same household participants were siblings, we use below the term "siblings" rather than the "same household members"). The participants were interviewed annually starting in 1997. Our analyses draw on the interview that was conducted in 1997 in which intelligence was measured and on the 3 interviews conducted in 2002, 2005 and 2008 in which religiosity (and education) was measured. Thus intelligence and other individual and background characteristics were measured when participants were 15 years old on average (with a 13–17 age range), and religiosity and educational attainment were measured when participants were, on average, 19, 22 and 25, respectively. The retention rate in 2008 was 83.7%.

[1] Similarly, the aggregate level results of Lynn et al. (2009) and Nyborg (2009) are also susceptible to alternative explanations, about a third variable underlying both intelligence and religiosity.

[2] We acknowledge the possibility of alternative explanations for the relationship between education and religiosity. First, a reverse causation explanation by which religiosity affects education (e.g., Darnell & Sherkat., 1997); and second, the existence of other mediators that are related to education and may affect religiosity (e.g., Iannaccone, 1998). However, these alternative explanations do not constitute a threat to the internal validity of the effect of *intelligence* on religiosity.

Table 1
Descriptive statistics and inter-correlations of study variables.

	Mean	SD	1	2	3	4	5	6
1. Intelligence	45.3	29.2	–					
2. Religiosity 02	54.8	30.5	−0.23	–				
3. Religiosity 05	53.9	32.6	−0.28	0.67	–			
4. Religiosity 08	53.1	33.2	−0.30	0.63	0.72	–		
5. Education 02	12.0	1.8	0.49	−0.04	−0.07	−0.10	–	
6. Education 05	12.9	2.4	0.57	−0.05	−0.10	−0.13	0.88	–
7. Education 08	13.3	2.7	0.58	−0.06	−0.11	−0.14	0.80	0.95

Note: n varies between 5642 and 7853, depending on missing values. All correlations are significant on the .0001 level except of the correlation between education 02 and religiosity 02 which is significant on the .001 level.

2.2. Variables and measurement

2.2.1. Religiosity

Religiosity was measured using five dichotomous items (see Moore et al., 1999 for scale development). The items included questions in areas such as religious values or attitudes towards religious writings and prayers (see Appendix A for the full instrument). The items were summed and multiplied by 100 to create a religiosity scale ranging from 0 (low religiosity) to 100 (high religiosity). Religiosity was measured only three times, at 2002, 2005 and 2008. The Cronbach's alpha of these measurements was .66, .70 and .71, respectively.

2.2.2. Intelligence

The measurement of intelligence is derived from participants' test scores in the Armed Forces Qualifying Test, a heavily g-loaded intelligence test (Larson, Merritt, & Williams, 1988; Larson & Saccuzzo, 1989). The AFQT is a weighted sum of standardized scores within (three months) age groups of four subtests of the Armed Services Vocational Aptitude Battery (arithmetic reasoning, paragraph comprehension, word knowledge and mathematics knowledge), and is expressed as a percentile score on the basis of the US army scoring scheme aimed at achieving nationally representative standard scores. The test was administered in small groups to the NLSY participants in 1997, five years before the first religiosity measurement was taken.

2.2.3. Age

Age was calculated for each participant at each time point based on year and month of birth.

2.2.4. Sex and ethnicity

Males were coded as 0, and females as 1. Non-blacks were coded as 0, and blacks as 1.

2.2.5. Education

Education was measured by the number of years of education completed at each survey year. Given participants' age range in the data, educational attainment reflects primarily attainment of higher education.

3. Results and discussion

3.1. Preliminary analyses

Table 1 presents the descriptive statistics and zero-order correlations of the study variables. Consistent with previous research, the cross-sectional correlations between intelligence and religiosity were negative for each of the three years in which religiosity was measured (−0.23, −0.28 and −0.30, for 2002, 2005 and 2008, respectively). Note also that these correlations become more negative with time. This pattern is further explored in the longitudinal multi-variate analysis of the last sub-section.

3.2. Cross-sectional within families analysis

In this subsection we examine how between-siblings differences in intelligence (and education) are related to differences in their religiosity. Our analysis relies on the family structure of the data – the fact that many of the participants are siblings – to control for all background variables shared by siblings, even unmeasured background variables.

We begin by presenting the results of a simplified analysis that demonstrates the main thrust of our cross sectional results. It included the 1027 families that had at least two siblings that were interviewed in 2008. In the analysis, the difference in 2008 religiosity between two siblings was regressed on differences in sex, intelligence and educational attainment at this year. Sex was the only control in the regression since, out of a number of possible individual characteristics that could be used as controls and were available in the NLSY97, it was the only individual characteristic's difference that had a significant effect[3] (note that differences in background characteristics are not examined since within families they are equal to zero).

The results of this regression are given by (numbers in parentheses are standard errors; numbers in italics are standardized coefficients; bold-faced numbers indicate significant coefficients):

$$\begin{array}{lllll} \Delta REL = 0.81 - \mathbf{0.15} * \Delta IQ - 0.32 * \Delta EDU + \mathbf{9.1} * \Delta SEX & & & & \\ \quad (1.07) \quad (0.04) \quad (0.45) \quad (1.6) & & & & (1) \\ \quad \textit{0.00} \quad \textit{−}\mathbf{\textit{0.12}} \quad \textit{0.03} \quad \mathbf{\textit{0.18}} & & & & \end{array}$$

where:

ΔREL between siblings difference in religiosity in 2008 (i.e. $REL_1 - REL_2$)

ΔEDU between siblings difference in education in 2008 (i.e., $EDU_1 - EDU_2$)

[3] The individual characteristics that were examined and were not significant were cross sectional age (their age in 2008), a measurement of the behavioral/emotional problems of the child, and a short measurement of the big five personality dimensions based on Gosling, Rentfrow, and Swann (2003).

ΔIQ between siblings difference in intelligence (i.e., $IQ_1 - IQ_2$)

ΔSEX between siblings' difference in sex (i.e., $SEX_1 - SEX_2$), which implies that a positive (negative) relationship between ΔSEX and ΔREL is associated with sisters being more (less) religious than their brothers.

The results of this regression suggest that differences in religiosity between siblings are negatively related to differences in their intelligence (i.e., the negative sign of the coefficient of IQ implies that the more positive the IQ difference between the siblings, the more negative the difference between their religiosity), but are not related to differences in their education (the coefficient of ΔEDU was not significantly different from zero). The results also indicate that – consistent with previous reports (e.g., Argyle, 1958) – females were more religious than males.

We turn now to a more rigorous analysis that takes into account all siblings in the family, and examine the within-families relationships between the levels of intelligence education and religiosity rather than the relationships between siblings' differences in these variables. In this analysis we rely on a cross sectional database in which each participant has one observation, and each family has m observations, where m is the number of siblings which were interviewed in 2008. Each observation included the participant's religiosity and education in 2008 and her intelligence as measured in 1997 as well as the individual characteristic controls. To control for the dependence associated with using siblings' data, we used family fixed effects regressions, regressions that include a dummy variable for each family (see note to Table 2 for the exact specification).[4]

Our basic hypothesis that intelligence is related to religiosity is examined in regression 1 of Table 2 in which religiosity in 2008 is regressed on intelligence (centered around its mean), sex (weighted effect coded) and the family dummies. The coefficient of intelligence in this regression is negative ($b = -0.137$, $sderr = 0.036$; i.e., a one percentile increase in intelligence is associated with a decrease of 0.137 units on our religiosity scale), suggesting that when background characteristics are adequately controlled via a within family design, intelligence has a significant effect on religiosity.

[Note that that this regression estimated only the within family effect of intelligence, and therefore underestimated the overall effect of intelligence that includes also the between families effect. Indeed, when the family dummies were omitted from the regression, the coefficient of intelligence was −0.343 (stderr = 0.014), about 3 times as high in absolute value. This higher coefficient captures the effect of background variables correlated with intelligence, or alternatively it captures the indirect effect of shared family intelligence on religiosity through its influence on these background variables].

The results of regression 2 also suggest that the estimated effect of education on religiosity obtained in our within family design is not significantly different from zero. This result is consistent with previous findings regarding the effect of education on religiosity that were obtained in a standard cross-sectional design (Ganzach et al., 2013), but are not consistent with the effect of education on religiosity in our longitudinal analysis below. In addition, the results of regression 3 also suggest that education does not interact with intelligence in determining religiosity.

Table 2
Within families fixed effects regression predicting religiosity (numbers in parentheses are standard errors).

	Regression 1	Regression 2	Regression 3
Sex	8.54***	8.72***	8.66***
	(1.49)	(1.38)	(1.44)
Intelligence	−0.137**	−0.142**	−0.140**
	(0.036)	(0.038)	(0.038)
Education		0.191	0.181
		(0.412)	(0.412)
Education * intelligence			−0.010
			(0.011)

n = 5951.

Note: The models estimated are (for brevity we present only the most comprehensive model): $REL_{hi} = b_1 * SEX_{hi} + b_2 * IQ_{hi} + b_3 * EDU_{hi} + b_4 * IQ_{hi} * ED_{hi} + \Sigma D_h$ where h is an index for the household and i for a sibling within this household and D is n − 1 household dummy variables where n is the number of households.

*** p < .0001.

** p < 0.01.

Finally, we repeated these analyses using religiosity in 2002 and 2005 as dependent variables and education in these years and sex as independent variables. The results for these years were similar to the results reported above, although the coefficients of intelligence became more negative from 2002 to 2005 to 2008 (as also indicated by the temporal pattern in the correlations between intelligence and religiosity in Table 2), a pattern consistent with *changes* in religiosity being a function of intelligence. This phenomenon is directly examined in the next subsection.

3.3. Longitudinal within individuals change analysis

In this subsection we examine how intelligence is related to change in religiosity over time. We use the temporal structure of the data – both religiosity and education were measured three times over 6 years – to control for the main effects of both background characteristics and stable individual characteristics, even unmeasured characteristics.

We begin by presenting the results of a simplified analysis that demonstrate the main thrust of our longitudinal results. In this analysis change in religiosity between 2008 and 2002 was regressed on intelligence, black ethnicity and on change in education (change in age is constant, 6 years for all participants). Ethnicity was added to the regression since, out of a number of possible controls that were available in the NLSY97, it was the only characteristic that had a significant effect.[5]

[4] We did not use random effects models because these models could be biased as a result of the correlation between omitted level-2 variables (i.e., background characteristics) and our level-1 variables (i.e., intelligence) (e.g., Antonakis, Bendahan, Jacquart, & Lalive, 2010). Thus, for example, parental education (a level-2 variable) may be correlated with the average siblings' intelligence resulting in a biased intelligence coefficient. Fixed effects models are not influenced by this bias.

[5] The other characteristics that were examined and were not significant included the individual characteristics that were examined in the within-families model (i.e., cross sectional age, a measurement of the behavioral/emotional problems of the child, and a short measurement of the big five) as well as background characteristics: family income, parents' education and parents' religiosity.

The results of this regression with centered intelligence are given by (numbers in parentheses are standard errors; numbers in italics are standardized coefficients; bold-faced numbers indicate significant coefficients):

$$\Delta REL = -1.91 - \mathbf{0.057}*IQ - \mathbf{0.829}*\Delta EDU + \mathbf{2.51}*ETH \quad (2)$$
$$(0.54)\quad (0.014)\quad (0.234)\quad (0.86)$$
$$\boldsymbol{0.00}\quad -\boldsymbol{0.06}\quad -\boldsymbol{0.05}\quad \boldsymbol{0.04}$$

where:

- ΔREL — change in religiosity between 2002 and 2008 (i.e., $EDU_{08} - EDU_{02}$)
- ΔEDU — change in education between 2002 and 2008 (i.e., $REL_{08} - REL_{02}$)
- IQ — intelligence (centered around its mean)
- ETH — a dummy variable having a value of 1 if the participant is black and 0 otherwise (using a weighted effect coding).

The results of this regression (n = 5545) suggest that: (1) holding change in education constant, changes in religiosity were negatively related to intelligence (the negative sign of the coefficient of IQ implies that the higher the IQ the more negative is the change in religiosity); (2) holding intelligence constant, changes in religiosity were negatively related to changes in education (the negative sign of ΔEDU implies that gaining more education is associated with a negative change in religiosity); and (3) by large (i.e., at the mean intelligence level and when no change in education occurs), age had a negative effect on religiosity (the intercept was significantly negative). (The results also indicated that there was less decrease in religiosity over time among black participants).

We turn now to a more rigorous analysis that takes into account all three measurements of education and religiosity, and examine the relationships between the levels of age, education and religiosity rather than the relationship between changes in these variables. In this analysis we use a longitudinal database in which each participant has three observations, one for each of the three survey years. Each observation includes religiosity, education, age and the year at which these variables were measured, as well as intelligence and the control variables as measured in 1997. To control for the dependence associated with the within subject observations we used individuals' fixed effects regressions (see for example, Allison, 2009). In such models a dummy for each subject is entered into the regression prior to the estimation of the effects of the independent variables, or alternatively, subjects' means are subtracted from each of their measurements on the time-varying variables (both dependent and independent variables) resulting in variables being expressed as a deviation from the subject mean value. Such models fully control for individual differences. All stable attributes of the individual, even those that are not measured explicitly, are captured by this approach. In essence, we model changes in religiosity and ignore stable individual differences in religiosity. Note that the models also control for the effect of individual differences in intelligence—therefore the main effect of intelligence cannot be estimated. However, the interactions between intelligence and the time varying variables (age and education) can be estimated. Examining these interactions is the central purpose of these analyses since they represent the effect of intelligence on the way by which age and education affect changes in religiosity.[6, 7]

Table 3
Within individuals longitudinal fixed effects regressions predicting religiosity and education (numbers in parentheses are standard errors).

	Regression 4: religiosity	Regression 5: education
Age	−0.198**	0.233***
	(0.074)	(0.003)
Education	−0.681**	
	(0.214)	
Age * ethnicity	0.424**	0.015*
	(0.136)	(0.006)
Age * intelligence	−0.0072**	0.0044***
	(0.0027)	(0.0001)
Intelligence * education	−0.012*	
	(0.006)	

n = 18,103 person-year observations.
Note: Ethnicity was coded using weighted effect coding with non-blacks as a base group. The model estimated for religiosity and education is, respectively: $REL_{ij} = b_1 * AGE_{ij} + b_2 * ETH_i * AGE_{ij} + b_3 * IQ_i * AGE_{ij} + b_4 * EDU_{ij} + b_5 * IQ_i * ED_{ij} + \Sigma D_i EDU_{ij} = b_1 * AGE_{ij} + b_2 * ETH_i * AGE_{ij} + b_3 * IQ_i * AGE_{ij}$ where i is an index for the individual and j an index for survey year, D is p − 1 individuals' dummy variables where p is the number of individuals.
*** p < .0001.
** p < 0.01.
* p < .1.

Table 3 presents the results of our longitudinal analysis (see note in Table 3 for the exact specification). In the regressions reported in this table the stable characteristics (intelligence and ethnicity) were centered around the sample means, so the main effects of the time-varying variables represent typical effects, i.e. effects at the mean level of the stable characteristics (note also that in a fixed effects regression the time-varying variables could also be viewed as centered around the unit means). The results of this model are consistent with the results of the change model (Eq. (2)). First, there is a significant main effect of age (b = −0.382, stderr = 0.052) suggesting that – consistent with previous reports based on cross-sectional data (Argyle, 1958; Francis, 1989; Kuhlen & Arnold, 1944; Turner, 1980) – religiosity decreased with age in young-adulthood. Second, there is a significant main effect of education (b = −0.810, stderr = 0.200), suggesting that religiosity decreased with education. Note that these results imply that growing older in one year results in a decrease of about 0.2 points on our religiosity scale, whereas gaining one more year of education implies a decrease of about 0.7 points on this scale.

[6] Our longitudinal fixed effects models represent regressions within individuals. They could be viewed as representing the combined results of within individuals regressions (i.e. regressions that are estimated for *each individual* separately) in which one's religiosity at time t is regressed on the time varying variables (age and education) at time t. The main effects of the time varying variables in these models represent the averages of the coefficients of the individual. Since each individual intelligence is constant, intelligence cannot appear in the individual model, and the main effect of intelligence cannot be estimated. However, the coefficients of the time varying variables may depend on intelligence, and this dependence is represented in the models by the interaction between intelligence and the time varying variables.

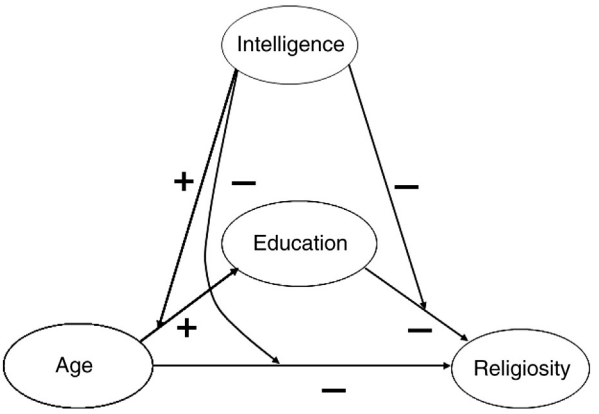
[7] Again, we did not use random effects models here because of the problem of correlation between level-2 error and the mean level-1 variables (see footnote 4).

Particularly interesting is the significant negative interaction between age and intelligence in regression 5 (b = −0.0133, stderr = 0.0020), which examined the relationship between intelligence and changes in religiosity. The results suggest that the higher the intelligence, the more negative was the effect of age on religiosity. Thus, the extent to which one's religiosity declined when growing up was to a large extent influenced by one's intelligence. Finally the results also suggest that there was less decrease in religiosity with age among blacks than among non-blacks.

Fig. 1 summarizes the results of our longitudinal change model of the effect of age, education and intelligence on religiosity (included in this figure are the results of an additional regression, regression 5 in Table 3, predicting education, which indicates a highly significant main effect of age on education, b = 0.233, stderr = 0.003, simply suggests that with age young adults obtained more education, and the highly significant interaction between age and intelligence, b = 0.0044, stderr = 0.0001, suggesting that the more intelligent obtained more education than the less intelligent). This model suggests that age had a negative direct effect on religiosity, as well as a negative indirect effect, mediated by education. It also suggests that intelligence moderated the direct effect of age, and to some extent also the effect of education, on religiosity. Finally, the change in the main effect of age between regressions 2 and 3 indicates that, by large, education mediated the effect of age on religiosity (Z = 3.2, $p < 0.001$ in the Sobel test).

4. Discussion

The current results provide strong empirical evidence for a causal link between intelligence and religiosity. The cross-sectional analysis suggests that intelligence influenced cross-sectional differences in religiosity, and that this effect cannot be explained by background correlates of intelligence. The longitudinal analysis, which focused on changes on religiosity (and therefore did not examine the effect of intelligence on levels of religiosity) suggests that intelligence drove changes in religiosity in that the more intelligent were primarily those that became less religious.



Note: A plus sign for a moderation indicates that the higher the intelligence the more positive the main effect. A negative sing indicates that the higher the intelligence the more negative is the main effect. Since the model is a change model, it does not include a direct negative effect of intelligence on the level of religiosity.

Fig. 1. A longitudinal within individuals change model for the mediation effect of education and moderation effect of intelligence.

Our analysis also provided some insight into the process by which intelligence affected changes in religiosity over time. It suggests that when growing up, the more intelligent became less religious because of two, perhaps even three, reasons. First, they obtained more education, which in turn negatively affected their religiosity. Second, controlling for changes in education, they were more influenced by the processes of growing up than the less intelligent. And third, education tended to have a stronger effect on their religiosity than on the religiosity of the less intelligent, although the evidence for this effect is weak.

Whereas the findings regarding the relationship between intelligence and religiosity were clear-cut, the findings regarding the relationship between education and religiosity were less clear. We found that whereas the zero-order correlations between education and religiosity were negative, the partial correlations controlling for intelligence were positive. Furthermore, whereas the cross-sectional analysis suggested that education did not affect religiosity, the longitudinal analysis suggested that it had a negative effect. We put more weight on the latter analysis since it controlled both for the main effects of individual characteristics and for the main effects of background characteristics, whereas the former analysis controlled only for background (family) characteristics.

Two important limitations of the current study have to do with the measurement of the religiosity and the measurement of education. First, religiosity is a highly complex phenomenon. It covers a variety of meanings having both attitudinal behavioral cognitive and affective facets. Although the current study relied on a well-established multiple item measurement of religiosity, this measure had a somewhat fundamentalist flavor. Other, less fundamentalist measures of religiosity (see for example, Voas, 2007 and Krause, 1993 for surveys of instruments in the study of religiosity) could lead to different results, as their relationship with education and intelligence may be somewhat different (and in particular we believe that the less fundamentalist is the measurement of religiosity, the less negative is the relationship between intelligence and religiosity). Second, the measurement of education by number of years of education completed is limited particularly since it does not take into account the quality of education (see Betts, 1995) or the type of education (i.e., religious versus secular oriented education, see Ganzach et al., 2013).

Finally, the current study is consistent with the cumulative evidence about the negative effect of intelligence on religiosity (e.g., Bertsch & Pesta, 2009; Kanazawa, 2010; Lynn et al., 2009; Nyborg, 2009; Reeve, 2009; Reeve & Basalik, 2011), and with the views that intelligence, because of its association with rationalism, skepticism, and feeling of control over nature, leads to secularism (e.g., Frazer, 1922; Inglehart & Welzel, 2005; Kuhlen & Arnold, 1944). The main contribution of the current study is that it examines the relationship between intelligence and religiosity within families and over time. The within families examination, which shows that the more intelligent sibling is less religious, allows for ruling out alternative explanations suggesting that background variables such as SES explain the link between intelligence and religiosity. The longitudinal change analysis, which shows that intelligent

people become less religious over time, sheds some light on the dynamic of changes in religious beliefs. It suggests that intelligence is not only linked to the level of religiosity (as previous cross-sectional analyses as well as the current within families cross-sectional analysis suggest), but it is also linked to changes in religiosity over time. This analysis suggests that consistent with some previous research (Reeve & Baslik, 2011), but in contrast to other research (Ganzach et al., 2013; Kanazawa, 2010) education mediates some, but not all, of the effect of intelligence on religiosity.

Appendix A. Religiosity instrument

I do not need religion to have good values (reverse coded).
Religious teachings are to be obeyed exactly as written.
I pray more than once a day.
I often ask God to help me make decisions.
God has nothing to do with what happens to me personally (reverse coded).

References

Achenbach, T., & Edelbrock, C. (1987). *The manual for the youth self-report and profile.* Burlington, VT: University of Vermont.
Allison, P. E. (2009). *Fixed effects regression models.* New York: Sage.
Antonakis, J., Bendahan, S., Jacquart, P., & Lalive, R. (2010). On making causal claims: A review and recommendations. *The Leadership Quarterly*, *21*, 1086–1120.
Argyle, M. (1958). *Religious behaviour.* London: Routledge and Kegan Paul.
Argyle, M., & Beit-Hallahmi, B. (1975). *The social psychology of religion.* London: Routledge and Kegan Paul.
Beckwith (1986). The effect of intelligence on religious faith. *Free inquiry*(1).
Bell, P. (2002). Would you believe it? *Mensa Magazine* (Feb., 12–13).
Bertsch, S., & Pesta, B. J. (2009). The Wonderlic Personnel Test and elementary cognitive tasks as predictors of religious sectarianism, scriptural acceptance and religious questioning. *Intelligence*, *37*, 231–237.
Betts, J. R. (1995). Does school quality matter? Evidence from the National Longitudinal Survey of Youth. *The Review of Economics and Statistics*, 231–250.
Binet, A. (1905). *New methods for the diagnosis of the intellectual level of subnormals. L'Annee Psychologique*, *12*. (pp. 191–244)Vineland, NJ: Publications of the Training School at Vineland, 191–244 (Translated in 1916 by E. S. Kite in The Development of Intelligence in Children.).
Blau, Z. (1981). *Black children/white children: Competence, socialization and social structure.* New York: The Free Press.
Darnell, A., & Sherkat., D. E. (1997). The impact of Protestant fundamentalism on educational attainment. *American Sociological Review*, *62*, 306–315.
Dawkins, R. (2006). *The God delusion.* Boston: Houghton Mifflin.
Deary, I. J., Strand, S., Smith, P., & Fernandes, C. (2007). Intelligence and educational achievement. *Intelligence*, *35*, 13–21.
Durkheim, E. (1915, 1964). *The elementary forms of the religious life, a study in religious sociology*. London: G. Allen & Unwin; New York, Macmillan.
Francis, L. J. (1989). Measuring attitudes towards Christianity during childhood and adolescence. *Personality and Individual Differences*, *10*, 695–698.
Frazer, J. G. (1922). *The golden bough.* London: Macmillan.
Ganzach, Y., Ellis, S., & Gotlibovski, C. (2013). On intelligence education and religious beliefs. *Intelligence*, *41*, 121–128.
Gosling, S. D., Rentfrow, P. J., & Swann, W. B. (2003). A very brief measure of the Big-Five personality domains. *Journal of Research in Personality*, *37*, 504–528.
Howells, T. H. (1928). A comparative study of those who accept as against those who reject religious authority. *University of Iowa Studies of Character*, *2*(3).
Iannaccone, L. R. (1998). Introduction to the economics of religion. *Journal of Economic Literature*, *36*, 1465–1495.
Inglehart, R., & Welzel, C. (2005). *Modernization, cultural change, and democracy: The human development sequence.* Cambridge: Cambridge University Press.
Kanazawa, S. (2010). Why liberals and atheists are more intelligent? *Social Psychology Quarterly*, *73*, 33–57.
Krause, N. (1993). Measuring religiosity in later life. *Research on Aging*, *15*, 170–197.
Kuhlen, R. G., & Arnold, M. (1944). Age differences in religious beliefs and problems during adolescence. *Journal of Genetic Psychology*, *65*, 291–300.
Larson, G. E., Merritt, C. R., & Williams, S. E. (1988). Information processing and intelligence: Some implications of task complexity. *Intelligence*, *12*, 131–147.
Larson, G. E., & Saccuzzo, D. P. (1989). Cognitive correlates of general intelligence: Toward a process theory of g. *Intelligence*, *13*, 5–31.
Lenski, G. E. (1963). *The religious factor.* Garden City, NY: Doubleday.
Lynn, R., Harvey, J., & Nyborg, H. (2009). Average intelligence predicts atheism rates across 137 nations. *Intelligence*, *37*, 11–15.
Moore, et al. (1999). *NLSY codebook supplement, appendix 9: Family process and adolescent outcome measures.* Center for Human Resource Research The Ohio State University (http://www.nber.org/nlsy97/appendix9.pdf).
Neisser, U., Boodoo, G., Bouchard, T. J., Boykin, A. W., Brody, N., Ceci, S. J., et al. (1996). Intelligence: Knowns and unknowns. *The American Psychologist*, *51*, 77–101.
Nyborg, H. (2009). The intelligence–religiosity nexus: A representative study of white adolescent Americans. *Intelligence*, *37*, 81–93.
Pirsing, R. M. (1991). *Lila: An inquiry into morals.* New York: New York: Bantam Books.
Reeve, C. L. (2009). Expanding the g-nexus: Further evidence regarding the relations among national IQ, religiosity and national health outcomes. *Intelligence*, *37*(5), 495–505.
Reeve, C. L., & Basalik, D. (2011). A state level investigation of the associations among intellectual capital, religiosity and reproductive health. *Intelligence*, *39*(1), 64–73.
Sinclair, R. D. (1928). A comparative study of those who report the experience of the divine presence with those who do not. *University of Iowa Studies of Character*, *2*(3).
Turner, E. B. (1980). General cognitive ability and religious attitudes in two school systems. *British Journal of Religious Education*, *2*, 136–141.
Voas, D. (2007). Surveys of behaviour, beliefs and affiliation. In James Beckford, & N. Jay Demerath (Eds.), *Handbook of the sociology of religion* (pp. 128–150) (Thousand Oaks, CA).
Zenderland, L. (1998). *Measuring minds: Henry Herbert Goddard and the origins of American intelligence testing.* Cambridge, UK: Cambridge University Press.