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RESEARCH ARTICLE

Handedness and religiosity, a two-nation study: Evidence that hemispheric functioning may influence religious beliefs

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Abstract

Prior research has reported that so-called consistent-handers are more religious than non-consistent-handers. This study analyzed data bearing on this possibility using large samples of college students from two different countries: Malaysia and the United States. When samples from both countries were separated by sex, no significant support for this prior research was found. However, when we analyzed our data with handedness dichotomized between right-handers and non-right-handers, some significant relationships were found. Among females in both countries, left- and mixed-handers expressed lower degrees of certainty about the existence of God and life-after-death. Also, right-handedness and religious service attendance were positively and significantly associated among Malaysian males. Among US males, however, belief in God was actually significantly stronger among right-handers than among left- and mixed-handers. Assuming that right handedness is a rough proxy for left hemispheric dominance, our findings provide some support for the hypothesis that right hemispheric dominance is associated with orthodox religiosity at least among females.

Keywords: Handedness, Religiosity, hemispheric

INTRODUCTION

Nations vary a great deal in the degree to which their citizens are right-handed. While some of this variation is no doubt due to the use of different handedness measures, research has yet to find any country in which most of its citizens are not right-handed. Typically, the proportion of right-handers are well over 75%, with most percentages being in the 85-90% range (Cavanagh, Berbesque, Wood, & Marlowe, 2016; Mutha, Haaland, & Sainburg, 2013). Even studies of pre-industrial societies have concluded that the majority of people are right-handed, with percentages ranging between 99% among the Jimi in Papua New Guinea to 87% among the Yanomamo in Venezuela (Faurie & Raymond, 2005, p. 27).

When it comes to religiosity, prevalence rates are much more varied than is the case for handedness. As a generalization, the lowest rates are usually found in East Asia, while the highest rates are concentrated in Africa and the Middle East (Zimmer, Jagger et al. 2016, p. 374; Sharma & Ang 2019, p. 3).

Theorizing. The purpose of the present study was to identify possible associations between handedness and religiosity. We undertook this inquiry in light of a genuine desire to better understand why some people are much more religious than others. For reasons explained below, we are lead to suspect (a) that handedness provides a rough indicator of hemispheric functioning, and (b) that hemispheric functioning may in turn affect the likelihood of people becoming religious.

Religiosity does not appear to simply be the result of "how people are raised". Instead, genetic factors appear to be involved. Evidence in this regard has come from studies indicating that identical twins are more likely to share similar religious beliefs than do fraternal twins (Friesen & Ksiazkiewicz 2015; Vance, Maes & Kendler, 2010). This is true even among twins reared apart (Waller, Kojetin, Bouchard, Lykken, & Tellegen, 1990).

Evidence also suggests that genetic factors affect handedness. Both twin and adoption studies have indicated that roughly a third of the variation in handedness is genetic in origin (Medlanda, Duffy, Wright, Geffenc, Hayd, Levye, & Boomsmaf, 2009; Paracchini, 2021; Sha, Pepe, Schijven, Carrión-Castillo, Roe et al., 2021).

While the specific genes affecting both handedness and religiosity have yet to be identified, it is possible that they may overlap to some extent. In this regard, the genes that

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influence handedness appear to operate at least in part by altering how the two hemispheres of the brain contribute to higher thought (Mancini & Mirabella, 2021). Along these lines, most people, especially if they are right-handed, think and reason primarily with the left hemisphere. It so happens that this left hemisphere is where most linguistic skills reside for about 95% of humans (Kim, Ashe, Georgopoulos, Merkle, Ellermann, Menon, Ogawa, & Ugurbil, 1993).

Left-handers and those who are ambidextrous are also highly prone to be left hemispheric when engaged in linguistic thought. However, they have been shown to exhibit at least slightly greater tendencies than right handers to shuttle between both the left and the right hemispheres when carrying out higher thought (Wiberg, Ng, Omran, Alfaro-Almagro, McCarthy et al. 2019). Unlike the left hemisphere, which mainly controls linguistic reasoning, the right hemisphere tends to think analytically, often using mathematical and spatial reasoning concepts (Hawes & Ansari, 2020; Heilman, Nadeau, & Beversdorf, 2003).

Keeping the above associations in mind, now consider how people usually acquire religious beliefs: Research has indicated that inter-generational transmission of religious beliefs relies heavily on repetitious linguistic learning (Whitehouse, 2002). And, once religious doctrines are learned, those exposed are encouraged to repeat them often and discouraged from questioning them. It is also noteworthy that many religious explanations for events and experiences are magical/miraculous in nature, often defying analytical reasoning and un-tethered to verifiable empirical evidence (Gervais & Norenzayan 2012).

When all of the above arguments are combined, they lead one to predict that left- and mixed-handers should be more analytical than right-handers. Consequently, they should be more inclined to question religious teachings than are right-handers. In other words, assuming the same degree of repetitive exposure to religious teachings, non-right-handers should have more doubts about religious doctrines than is the case for right-handers.

Evidence. Specific evidence bearing on the above theorizing is slim. Only two prior studies were located that seemed to have bearing on the possibility that handedness and religiosity might be related. In one of these studies, Niebauer, Christman, Reid, and Garvey (2004) compared consistent and non-consistent handers regarding a belief in the literal truth of the Bible. Bases on a sample of 153 U.S. university students, it reported that individuals who are strongly right-handed or strongly left-handed were more likely to profess beliefs in the Bible's literal truth than were individuals who were doubtful in this regard.

In the second study, Chen (2018) investigated how handedness consistency was related to (a) belief in God and (b) overall confidence in their religious beliefs. This study, also conducted in the U.S., was based on an internet sample of 743 participants. It found that both of these religiosity measures were positively associated with consistent handedness when compared these individuals were mixed-handers (i.e., those who were ambidextrous). Of course, in both studies, the vast majority of consistent handers would have been right-handers.

Current Study. The present study was undertaken to test the hypothesis that right handers will be more religious than left- or mixed-handers. In conducting this study, we recognized that religiosity comes in many forms that vary considerably from culture-to-culture. For these reasons, we assessed 7 different aspects of religiosity based on sizable samples from two distinct countries, i.e., Malaysia and the United States. Also, in designing our study, sex differences in both handedness and religiosity were recognized. Specifically, most studies have found higher proportions of males being non-right handedness than females (review: Ellis, Palmer, Hopcroft, & Hoskin, 2024a, pp. 71-76). Regarding religiosity, nearly all research throughout the world has indicated that females are more religious than males (review: Ellis et al., 2024a, pp. 717-728). Given these two sex differences, we decided to conduct our analyses separately for males and females.

MATERIALS AND METHODS

Two large samples were obtained for this study. One sample consisted of 2,059 undergraduates at the University of Malaya (in Kuala Lumpur, Malaysia), while the other involved 2,511 predominantly undergraduates attending the following eight United States universities: Boise State University in Idaho (145 respondents), California State University at Fullerton (251 respondents), Evangel University in Missouri (264 students), Minot State University in North Dakota (173 respondents), Pennsylvania State University (110 respondents), the University of Missouri (258 respondents), the University of Texas in the Permian Basin (1,048 respondents), and the University of Texas in San Antonio (261 respondents).

Most of the research participants were enrolled in various social science classes and participated voluntarily with assurance of anonymity. The key eligibility requirement was that they were all at least 18 years of age. Approximately 300 of the 1,048 UTPB sample were recruited by students attending UTPB for classroom extra credit. Some of these recruited participants were not college students themselves, but all were at least 18 years old.

The questionnaire was developed and refined in English by researchers at the University of Malaya in Kuala Lumpur, Malaysia. All of the U.S. participants completed the English version of the questionnaire. For the Malaysian sample, however, the questionnaire was translated into Bahasa Malaysia, Malaysia's official language. To ensure that the Malaysian translation was equivalent to the English version, the Malaysian questionnaire was back-translated into English until all discrepancies were eliminated. Both questionnaires were four pages in length and covered a wide variety of topics, only a few of which are part of the present study. Completed questionnaires were entered into SPSS data files (available for secondary analysis upon request).

Demographics of the Two Countries Sampled

Table 1 shows the means and proportional distributions of key demographic variables for respondents in both countries. Because our sample predominantly consisted of college students, no claim can be made regarding the representativeness of either sample. The table reveals that the proportional representation decidedly favored females for both countries. A major reason for this is that more females are currently attending college in both Malaysia and the United States (DiPrete & Buchmann, 2006; Dorius & Firebaugh, 2010).

Regarding social status, Table 1 shows that there were substantial differences between the Malaysian parents and the U.S. parents, with the latter averaging roughly two years more of education. To obtain information regarding income variations, each respondent was asked to estimate his or her family's income using a scale from 1 (extremely low) to 10

(extremely high). According to Table 1, the average for the U.S. students was 6.04, compared to 4.77 for the Malaysian students. Thus, in terms of both years of education and family income, the U.S. students had substantially higher social status background than did the Malaysian students.

As one would expect, there are tremendous ethnic differences in the two countries sampled. In this regard, Table 1 shows that not a single respondent in the Malaysian sample identified themselves as white, black, or Hispanic. By way of contrast, 94.1% of the U.S. respondents classified themselves within one of these three racial/ethnic categories.

Table 1.
The demographics of the two samples and the means and proportional distributions for the independent and dependent variables.

Demographic Traits	Malaysian Sample (Numbers & %, or Means & SDs)	U.S. Sample (Numbers & %, Or Means & SDs)	Total Sample (Numbers & %, or Means & SDs)
Gender			
Males	652 (31.7%)	1,027 (40.9%)	1,679 (36.7%)
Females	1,406 (68.3%)	1,484 (59.1%)	2,890 (63.3%)
TOTAL	2,058	2,511	4,569
Age			
Mean (& SD)	20.87 (2.36)	23.96 (9.27)	22.57 (7.22)
Range	18-42	17-81	17-81
TOTAL	2,058	2,511	4,569
Social Status Background (Mean & SD)			
Mother's years of education	10.04 (3.87)	12.57 (4.44)	11.47 (4.38)
Father's years of education	10.78 (3.95)	12.62 (4.81)	11.80 (4.54)
Estimated family income (scale range: 1-10)	4.77 (1.50)	6.04 (2.39)	5.47 (2.14)
Ethnicity			
White/European Ancestry	0	1,394 (55.5%)	1,394 (30.5%)
Black/African Ancestry	0	173 (6.9%)	173 (3.8%)
Hispanic/Latin/Native American	0	745 (29.7%)	745 (16.3%)
Native Malays/Bumiputera/Indonesian	1,474 (71.6%)	5 (0.2%)	1,479 (32.4%)
East Asian (Chinese, "Asian" in US)	477 (23.2%)	66 (2.6%)	543 (11.9%)
Other Asian (primarily Indian)	85 (4.1%)	51 (2.0%)	136 (3.0%)
Other (Mixed, Arabic, Euro-Asian)	3 (0.1%)	67 (2.7%)	70 (1.5%)
No response	19 (0.9%)	4 (0.4 %)	29 (0.6%)
TOTAL	2,058	2,511	4,569
Handedness			
Left almost always	108 (5.2%)	181 (7.2%)	289 (6.3%)
Left most of the time	82 (4%)	231 (9.2%)	313 (6.9%)
Either hand almost equally	65 (3.2%)	43 (1.7%)	108 (2.4%)
Right most of the time	883 (42.9%)	411 (16.4%)	1,294 (28.3%)
Right almost always	887 (43.1%)	1,605 (63.9%)	2,492 (54.5%)
No response	33 (1.6%)	40 (1.6%)	73 (1.6%)
TOTAL	2,058	2,511	4,569
Religious Groupings			
Buddhism	375 (18.2%)	12 (0.5%)	387 (8.5%)
Catholic	0*	666 (26.5%)	666 (14.6%)
Christian (except Catholic in the U.S.)	131 (6.4%)	1,315 (52.4%)	1,446 (31.6%)
Hinduism	71 (3.4%)	5 (0.2%)	76 (1.7%)
Jewish	0	16 (0.6%)	16 (0.4%)
Muslim	1,434 (69.7%)	35 (1.4%)	1,469 (32.2%)
None/Atheist/Agnostics, etc.	15 (0.7%)	367 (14.6%)	382 (8.4%)
Other	0	10 (0.4%)	10 (0.2%)
No response	32 (1.6%)	85 (3.4%)	117 (2.6%)
TOTAL	2,058	2,511	4,569
Mean Religiosity Measures (& SD)			
Belief in god (supreme-being)	8.71 (2.26)	8.12 (3.11)	8.39 (2.77)
Belief in immortality (life after death)	7.77 (3.20)	6.99 (3.53)	7.33 (3.41)
Importance of religion to your daily life	7.70 (2.39)	5.75 (3.40)	6.63 (3.14)
Religious fundamentalism	8.11 (2.30)	5.13 (3.47)	6.49 (3.34)
Obey the teachings of a specific religion	7.54 (2.33)	5.06 (3.50)	6.19 (3.27)
Active in religious observances	7.22 (2.42)	4.89 (3.47)	5.94 (3.26)
Religious strictness of parents	8.16 (1.96)	5.11 (2.90)	6.48 (2.94)
TOTAL	2,058	2,511	4,569
Parental Fertility			
Mean	5.08 (2.87)	3.20 (1.70)	4.05 (2.49)
Range	1-16	1-13.5	1-16
No or Unintelligible Response	8	45	53
TOTAL	2058	2,511	4,569

* In the Malaysian questionnaire, most respondents who were Christian did not identify themselves more specifically. Therefore, no distinction was made between Catholics and other Christians in coding the Malaysian data.

The Independent and Dependent Variables

Handedness. To measure handedness, research participants were asked to report which hand they "use when writing, drawing, brushing teeth, and the like". Their response options were as follows: *left hand almost always*, *left most of the time*, *either hand almost equally*, *right most of the time*, and *right hand almost always*.

To measure consistent handers, we combined those answering *left hand almost always* with those answering *right hand almost always*. The remaining three intermediate handedness categories were combined to constitute our measure of inconsistent handers.

We also conducted an additional handedness measure. This one had to do with comparing right- versus non-right-handedness. In this case, those answering *right most of the time* and *right hand almost always* were combined to constitute right-handedness. To assess non-*right handedness*, we combined all three of the remaining categorical responses (i.e., *left hand almost always*, *left most of the time*, *either hand almost equally*).

Religiosity. Because of the wide range of religions to which research participants in our two-country sample were affiliated, particularly in Malaysia (see Table 1), we limited our religiosity measures to ones that would apply to virtually all religions. Respondents were given an 11-point scale, ranging from 0, meaning "not at all", to 10, meaning "the most extreme degree possible" for all seven religiosity items. These items were as follows:

Belief in God (supreme-being)
Belief in immortality (life after death)
Importance of religion to your daily life
Religious fundamentalism
Obey the teachings of a specific religion
Active in religious observances
Religious strictness of parents while growing up

Data Analysis

Data were analyzed by dichotomizing the handedness variable, first, in terms of consistency and, second, in terms of right vs. non-right, as will be described in the results section. Preliminary analysis revealed that the religiosity measures were normally distributed, so the appropriate significance test is a t-test of mean differences (Heeren & D'Agostino, 1987). Consequently, t-tests were applied to the two handedness variables for each of the seven religiosity variables separately for the following four groups: Malaysian males and US males and Malaysian females and US females. With the exception of gender, a review of the literature does not suggest any variables that might create a spurious correlation between handedness and religiosity, so it was decided that multivariate analysis was not warranted but that bivariate analyses would be conducted separately for each sex-country combination.

RESULTS

Two sets of findings will be presented. The first set bears on the research findings reported by Niebauer et al. (2004) and Chen (2018) regarding *handedness consistency* and religiosity. In the second set of analyses, we examined the relationship between handedness and religiosity using a slightly different handedness indicator, i.e., one that dichotomizes handedness in terms of *right vs. non-right*.

Handedness Consistency and Religiosity. Specifically, Tables 2 and 3 pertain to the hypothesis that *consistent handers* are more religious than *inconsistent handers*. To test this hypothesis, we combined the two most extreme handedness measures (*left almost always* and *right almost always*, as shown in Table 1) into one category and combined the three intermediate handedness measures into a second category for comparison.

The findings for males are presented in Table 2. One can see that neither for the Malaysian nor or for the US males were significant differences found between handedness and any of the seven religiosity measures used in our study. Nevertheless, it is worth mentioning that one religiosity measure for the US sample did come close to statistical significance ($p = .056$). This particular finding indicated that consistent handers were more likely to believe in life after death than were non-consistent handers.

Regarding females, Table 3 provides findings based on the same t-test procedures as just reported for males in Table 2. Once again, no significant differences were found between consistent handers and non-consistent handers regarding any of the seven religiosity measures. The closest any of the differences came to being statistically significant was the tendency for non-consistent handers to be more likely to believe in God than were the consistent handers ($p = .08$). Had this finding been statistically significant, it would have been directly contrary to findings reported by Chan (2018) based on his US sample.

Right-Handers vs. Left- or Mixed-Handers and Religiosity. Given our failure to find statistically significant support for the hypothesis that consistent handers are more religious than non-consistent handers, we decided to explore the possibility that there might be differences between right-handers and non-right-handers. This distinction was chosen because it is a much more commonly-made handedness dichotomy than the consistency/non-consistency distinction. Also, the right-handedness vs. non-right-handedness distinction is more in line with the theoretical argument made in the introduction about the right hemisphere being associated with more analytical and less exclusively language-based reasoning being likely to affect religiosity than is the case for handedness consistency.

In other words, research has shown that right-handers tend to be more exclusively left hemispheric dominant than non-right-handers, at least regarding linguistic reasoning. One study supporting this conclusion found that the incidence of right-hemispheric language dominance was linearly related to handedness, ranging from just 4% for strong right-handers all the way to 27% for strong left-handers (Knecht, Dräger, Deppe, Bobe, Lohmann, Flöel, et al. 2000).

The findings for males in the two countries sampled appear in Table 4. To facilitate interpretation, the statistically significant differences are bolded. One can see that handedness differences in religiosity were generally not found for males in either country. The two exceptions were (a) in Malaysia, right-handers reported being significantly more active in religious observances than were the non-right-handers, and (b) in the US, non-right-handers professed having *stronger* beliefs in God than did the right-handers. The first of these two findings can be considered supportive of our right-handedness/religiosity hypothesis. However, the second finding is clearly contrary to it.

Turning to our female samples, findings for both countries are presented in Table 5. One can see that, as with males, most of the findings were not statistically significant. The four exceptions are as follows: In both Malaysia and the US, belief in God were stronger for right handers than for non-right-handed.

Another significant handedness difference for women involved belief in immortality. In the US, but not in Malaysia, right-handed females expressed significantly greater confidence in the existence of life after death than did non-right-handers. Finally, Table 5 shows that right-handed females in Malaysia, but not in the US, reported that their parents had been significantly stricter in their religious training than was the case for non-right-handers.

Table 2.
Differences in mean religiosity between extreme right- and extremely left-handers relative to non-extreme handers for males in Malaysia and in the United States.

	Malaysia Male Sample				United States Male Sample			
	Handedness		t-test	p-value	Handedness		t-test	p-value
	Consistent	Non-Consistent			Consistent	Non-Consistent		
Belief in God (supreme-being)	8.77	8.62	0.887	.503	8.42	8.12	1.580	.519
Belief in immortality (life after death)	8.58	8.48	0.510	.482	7.85	7.37	2.341	.059
Importance of religion to daily life	7.70	7.63	0.435	.106	6.17	6.09	0.493	.564
Religious fundamentalism	8.15	7.98	0.935	.485	6.09	5.73	1.653	.826
Obey teachings of a specific religion	7.57	7.58	-0.078	.207	5.89	5.70	0.826	.806
Active in religious observances	7.17	7.26	-0.474	.356	5.52	5.55	-.148	.974
Religious strictness of parents	8.28	8.03	1.515	.141	4.76	5.18	-2.120	.879

Table 3. Differences in mean religiosity between consistent handers and non-consistent handers for females in Malaysia and in the United States.

	Malaysia Female Sample				United States Female Sample			
	Handedness		t-test	p-value	Handedness		t-test	p-value
	Consistent	Non-Consistent			Consistent	Non-Consistent		
Belief in God (supreme-being)	8.76	8.87	-0.971	.081	8.84	8.87	0.858	.199
Belief in immortality (life after death)	8.35	8.51	-1.241	.385	7.92	7.50	2.387	.095
Importance of religion to daily life	7.72	7.95	-1.925	.095	6.71	6.71	0.949	.719
Religious fundamentalism	8.12	8.35	-1.976	.287	6.33	6.28	0.287	434
Obey teachings of a specific religion	7.53	7.76	-1.901	.985	6.22	6.26	-0.198	.405
Active in religious observances	7.26	7.51	-2.096	.886	7.09	6.13	-0.164	.585
Religious strictness of parents	8.06	8.26	-1.931	.224	5.28	5.21	0.416	.964

Table 4. Differences in religiosity between right-handers and non-right-handers for males in Malaysia and the United States.

	Malaysia Male Sample				United States Male Sample			
	Handedness		t-test	p-value	Handedness		t-test	p-value
	Right	Non-Right			Right	Non-Right		
Belief in God (supreme-being)	8.72	8.51	0.877	.133	**8.29**	**8.55**	**-1.149**	**.036**
Belief in immortality (life after death)	8.58	8.24	1.418	.314	7.78	7.40	1.515	.220
Importance of religion to daily life	7.70	7.44	1.047	.223	6.15	6.04	0.393	.540
Religious fundamentalism	8.09	7.87	0.917	.292	5.96	6.11	-0.556	.350
Obey teachings of a specific religion	7.59	7.50	0.348	.397	5.84	5.81	0.097	.747
Active in religious observances	**7.28**	**6.88**	**1.610**	**.038**	5.55	5.45	0.360	.948
Religious strictness of parents	8.11	8.31	-.896	.545	4.90	4.80	0.419	.313

Table 5. Differences in religiosity between right-handers and non-right-handers for females in Malaysia and the United States.

	Malaysia Female Sample				United States Female Sample			
	Handedness		t-test	p-value	Handedness		t-test	p-value
	Right	Non-Right			Right	Non-Right		
Belief in God (supreme-being)	**8.86**	**8.41**	**2.513**	**.008**	**8.87**	**8.58**	**1.839**	**.007**
Belief in immortality (life after death)	8.44	8.32	0.549	.543	**7.92**	**7.32**	**3.124**	**.022**
Importance of religion to daily life	7.86	7.55	1.577	.259	6.73	6.41	1.580	.615
Religious fundamentalism	8.25	8.11	.772	4.34	6.34	6.23	0.528	.098
Obey teachings of a specific religion	7.67	7.44	1.177	.497	6.28	6.00	1.301	.241
Active in religious observances	7.41	7.21	1.035	.583	6.12	6.04	0.380	.078
Religious strictness of parents	**8.18**	**7.98**	**1.173**	**.017**	5.32	5.01	1.619	.692

DISCUSSION

Various prior studies have indicated that the left hemisphere (which tends to control the right side of the body along with being dominant for human language) is less analytical than the right hemisphere. Given that religiosity is predominantly acquired through repetitious linguistic experiences, and relatively little analytic reasoning, we reasoned that handedness and religiosity should be related. Specifically, we hypothesized that right-handers would be more religious (especially in terms of beliefs) than left- or mixed-handers.

The only prior studies we located that had some bearing on our hypothesis were those reported by Niebauer et al. (2004) and Chen (2018), although both of them focused on *handedness consistency* as their independent variable rather than *right-handedness versus non-right handedness*. Both of these studies found that consistent handers – the vast majority of whom would have been right handers, of course – seemed to be more religious than non-consistent handers.

In the present study, handedness and seven different measures of religiosity were self-reported by our research participants. We performed two separate analyses, one having to do with handedness consistency and the other involving right versus non-right handedness. Even though our sample sizes were large and drawn from two countries, Tables 2 and 3 show that we were unable to confirm the findings reported by Niebauer et al. (2004) and Chen (2018).

However, we did find some evidence supporting our hypothesis that right-handers would be more religious than non-right-handedness. Specifically, in females, handedness and belief in God were related. In both the Malaysian and the US samples, right-handed females expressed stronger confidence in the existence of God than did non-right-handed females. Also, in the US sample, females with strong beliefs in life-after-death were more likely to be right-handed than females who were non-right-handed. This evidence clearly supports the theorizing presented in the introduction.

When it came to males, however, we obtained one finding that was contrary to our hypothesis. Among the U.S. sample of males, non-right-handers were significantly *more* likely to express a belief in God than were right-handers.

Despite our failure to identify any significant relationships between *handedness consistency* and religiosity, we are still inclined to agree with Niebauer et al. (2004) and Chen (2018) that brain hemispheric factors could be helpful in understanding human variations in religiosity. To elaborate on this line of reasoning, it seems certain that religious beliefs are fundamentally derived from linguistic communication. Most people are exposed to religiously-oriented communication linked to a particular religion. Despite this exposure, some people appear to be less inclined to believe some of what they are taught than is the case of others. Following Niebauer et al. (2004) and Chan (2018), we propose that the relative dominance of the two hemispheres could be responsible for some of the differences in people's inclinations to believe certain religious teachings. Our views along these lines can be summarized in terms of the following six forms of evidence:

First, studies have shown that, while the two hemispheres nearly always interact, they have been shown to reason differently. As a rule, the left hemisphere is more oriented toward linear linguistic reasoning, while the right hemisphere, tends to be more analytic, holistic, and creative in how it reasons (Kinsbourne, 1982; Shamay-Tsoory, Adler, Aharon-Peretz, Perry, & Mayseless, 2011). In this regard, whether the right hemisphere is relying on language or some other method of thought, such as visuospatial reasoning, it is less inclined to follow simple linguistic arguments it has been trained to believe and repeat (Chen, Beaty, Cui, Sun, He, & Zhuang, 2019).

Second, to the extent that the right hemisphere is contributing to how an individual reasons, one would expect him/her to consider possibilities beyond what he/she has been taught to believe. This means that, to the degree that the left hemisphere is solely responsible for how an individual thinks (with little or no input from the right hemisphere), one tends to think in a very *logically rigid* manner. In religious terms, logical rigidity is what may be referred to as *faith*, and individuals with strong faith are unlikely to conceive of supernatural entities and events in any way except as they were taught to believe.

Third, handedness is associated with the two hemispheres in terms of *hemispheric dominance*. Basically, right-handers have greater left hemispheric dominance, whereas non-right-handers have less hemispheric dominance and occasionally actually have a right dominant hemisphere (Bradshaw & Nettleton, 1981; Coulson & Lovett 2004; Powell, Kemp, & García-Finaña, 2012). If so, non-right-handers are more likely to think by using both brain hemispheres, rather than relying primarily on the left hemisphere. One result may be somewhat greater logical rigidity among right-handers than among non-right-handers.

Fourth, experiments with left temporal lobectomy patients with intact right hemispheres have been found these patients to be more inclined to switch beliefs than left temporal lobectomy patients (Rausch, 1977). This suggests that the right hemisphere retains beliefs, while the left hemisphere is more inclined to update views. Christman et al. (2008) found that mixed-handed subjects were more likely to adjust their beliefs when presented with information inconsistent with what they originally believed, while right-handers tended to resist making any adjustments to their beliefs.

Fifth, as noted in the introduction, there are sex differences regarding both handedness and hemispheric dominance. Generally, while the differences are fairly subtle, males have greater tendencies to be non-right-handed than females (review: Ellis et al., 2014a, pp. 71). Males also appear to rely less than females do on their left hemisphere when performing language tasks (review: Ellis et al., 2014b, pp. 466). These handedness and hemispheric differences may be due to sex differences in how the brain is configuration. For example, males appear to separate the functioning of their two hemispheres more, depending on the particular task they are pursuing, while females exhibit greater left hemispheric dominance, regardless of task being addressed (meta-analysis: Sommer, Aleman, Bouma, & Kahn, 2004).

Sixth, numerous studies have shown that females are usually more religious than males, especially regarding beliefs (reviews: Miller & Stark, 2002; Ellis et al., 2024a, p. 717). We hypothesize that this sex difference could be at least partially due to females being more left hemisphere dominant than males. Specifically, most religious ideas seem to emanate primarily from repetitive language-based learning. If so, one would expect to find that belief in God would be stronger for right-handed females than for non-right-handed females (Table 4).

Of course, the above line of reasoning does not explain why non-right-handed males in our U.S. sample were more confident about the existence of God than were right-handed males (Table 5). Given that the two hemispheres appear to function interactively in males more than in females (Clements, Rimrodt, Abel, Blankner, Mostofsky, &

Pekar, 2006), our theoretical arguments clearly fails to account for this finding. More research is needed.

STRENGTHS AND LIMITATIONS

The main strengths of this study have to do with its large sample sizes and cultural diversity. Also, the fact that seven different indicators of religiosity were assessed, rather than just one or two, made it possible to explore how a wide range of religiosity measures might correlate with handedness.

Regarding the study's limitations, there are at least five that are worth noting. First, our measurement of handedness was confined to responses to a single 5-point scale. Obviously, more elaborate scales are available and would be recommended for future studies.

Second, the participants in our study were obtained using convenience sampling, making generalizing difficult. In particular, because nearly all participants were young adult college students, samples were younger and more middle/upper-class than were the populations as a whole in either country.

Third, the fairly low reliability of self-report data are well-known (Paulhus & Vazire, 2007, pp. 228-230). Research participants sometimes answer questionnaires carelessly or provide what they regard as socially desirable answers rather than ones that are completely accurate.

Fourth, our study would have been strengthened had we measured brain hemispheric functioning directly rather than simply assuming that handedness provides a rough proxy for such functioning.

Lastly, the only variable that was controlled in the present study was sex. Obviously, many other traits could be contributing to the relationship between handedness and religiosity. Researchers who conduct future studies in this emerging field of religiosity might want to control for some additional variables.

CONCLUSIONS

Our study provides evidence that a handedness indicator of left hemisphere dominance is more conducive to strong religious beliefs than is more mixed or right hemisphere dominance. This pattern was most strongly supported among females regarding beliefs in God and immortality. However, our findings that the strength of one's belief God among males was significant and in the opposite direction did not support this conclusion. More research into how handedness and hemispheric dominance may be associated with religiosity is needed. Findings could lead to a better understanding of how religious beliefs are affected by neurological functioning.

DECLARATIONS

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Conflicts of interest/Competing interests

The authors have no conflict of interest.

Ethics approval

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

Availability of data and material

Data used in the study are available upon request.

Code availability

Data were analyzed with IBM SPSS Statistics 27 software. No code was required.

REFERENCES

Bradshaw, J. L. & Nettleton, N. C. (1981). The nature of hemispheric specialization in man, *Behavioral and Brain Sciences, 4,* 51-91.

Cavanagh, T.; Berbesque, J.C.; Wood, B.; Marlowe, F. (2016). Hadza handedness: Lateralized behaviors in a contemporary hunter–gatherer population. *Evolution and Human Behavior, 37*, 202–209.

Chen, E. Y. (2018). Handedness and religious beliefs: Testing the two possible accounts of authoritarianism and belief updating. *Personality and Individual Differences, 127*,101-106.

Chen, Q., Beaty, R. E., Cui, Z., Sun, J., He, H., Zhuang, K., . . . Qiu, J. (2019). Brain hemispheric involvement in visuospatial and verbal divergent thinking. *Neuroimage, 202*, 116065.

Christman, S. D., Henning, B. R., Geers, A. L., Propper, R. E., & Niebauer, C. L. (2008). Mixed-handed persons are more easily persuaded and are more gullible: Interhemispheric interaction and belief updating. *Laterality*, *13*, 403-426.

Clements, A. M., Rimrodt, S. L., Abel, J. R., Blankner, J. G., Mostofsky, S. H., Pekar, J. J., . . . Cutting, L. E. (2006). Sex differences in cerebral laterality of language and visuospatial processing. *Brain and Language, 98*, 150-158.

Coulson, S., & Lovett, C. (2004). Handedness, hemispheric asymmetries, and joke comprehension. *Cognitive Brain Research, 19*, 275-288.

Davis, J. A. (1985). *The logic of causal order* (No. 55). Sage.

DiPrete, T. A., & Buchmann, C. (2006). Gender-specific trends in the value of education and the emerging gender gap in college completion. *Demography, 43*, 1-24.

Dorius, S. F., & Firebaugh, G. (2010$). Trends in global gender inequality. *Social Forces, 88*, 1941-1968.

Ellis, L., Palmer, C. T., Hopcroft, R. & Hoskin, A. W. (2024a). *Handbook of sex differences, Volume II: Cognitive Variables*. Routledge (Taylor & Francis).

Ellis, L., Palmer, C. T., Hopcroft, R. & Hoskin, A. W. (2024b). *Handbook of sex differences, Volume I: Basic Biology*. Routledge (Taylor & Francis).

Faurie, C., & Raymond, M. (2005). Handedness, homicide and negative frequency-dependent selection. *Proceedings of the Royal Society B, 272*, 25-28.

Friesen, A., & Ksiazkiewicz, A. (2015). Do political attitudes and religiosity share a genetic path? *Political Behavior, 37*, 791-818.

Gervais, W. M., & Norenzayan, A. (2012). Analytic thinking promotes religious disbelief. *Science, 336*(6080), 493-496.

Hawes, Z., & Ansari, D. (2020). What explains the relationship between spatial and mathematical skills? A review of evidence from brain and behavior. *Psychonomic Bulletin & Review, 27*, 465-482.

Heeren, T., & D'Agostino, R. (1987). Robustness of the two independent samples t-test when applied to ordinal scaled data. *Statistics in medicine*, *6*(1), 79-90.

Heilman, K. M., Nadeau, S. E., & Beversdorf, D. O. (2003). Creative innovation: possible brain mechanisms. *Neurocase, 9*, 369-379.

Kim, S.G.; Ashe, J.; Georgopoulos, A.P.; Merkle, H.; Ellermann, J.M.; Menon, R.S.; Ogawa, S.; Ugurbil, K. (1993). Functional imaging of human motor cortex at high magnetic field. J. Neurophysiology, 69, 297–302.

Kinsbourne, M. (1982). Hemispheric specialization and the growth of human understanding. *American Psychologist, 37*, 411-420.

Knecht, S., Dräger, B., Deppe, M., Bobe, L., Lohmann, H., Flöel, A., . . . Henningsen, H. (2000). Handedness and hemispheric language dominance in healthy humans. *Brain, 123*, 2512-2518.

Kushner, H. I. (2013). Why are there (almost) no left-handers in China? *Endeavour, 37*, 71-81.

Mancini, C., & Mirabella, G. (2021). Handedness does not impact inhibitory control, but movement execution and reactive inhibition are more under a left-hemisphere control. *Symmetry, 13*(9), 1602, 1-20.

Medlanda, S., Duffy, D., Wright, M., Geffenc, G., Hayd, D., Levye, F., Boomsmaf, D. (2009). Genetic influences on handedness: Data from 25,732 Australian and Dutch twin families, Neuropsychologia, 47, 330-337.

Miller, A. S., & Stark, R. (2002). Gender and religiousness: Can socialization explanations be saved? *American Journal of Sociology, 107*, 1399-1423.

Mutha, P.K.; Haaland, K.Y.; Sainburg, R.L. (2013). Rethinking motor lateralization: Specialized but complementary mechanisms for motor control of each arm. PLoS One 2013, 8, e58582.

Niebauer, C. L., Christman, S., Reid, S., & Garvey, K. (2004). Interhemispheric interaction and beliefs on our origin: Degree of handedness predicts beliefs in creationism versus evolution. *Laterality, 9*, 433-447.

Paracchini, S. (2021). Recent advances in handedness genetics. *Symmetry, 13* (1792), 1-11.

Paulhus, D. L., & Vazire, S. (2007). The self-report method. In R.W. Robins et al. (Eds.), *Handbook of research methods in personality psychology (pp.* 224-239). Guilford Press.

Powell, J. L., Kemp, G. J., & García-Finaña, M. (2012). Association between language and spatial laterality and cognitive ability: An fMRI study. *Neuroimage, 59*, 1818-1829.

Rausch, R. (1977). Cognitive strategies in patients with unilateral temporal lobe excisions. *Neuropsychologia*, *15*(3), 385-395.

Sha, Z., Pepe, A., Schijven, D., Carrión-Castillo, A., Roe, J. M., Westerhausen, R., . . . Francks, C. (2021). Handedness and its genetic influences are associated with structural asymmetries of the cerebral cortex in 31,864 individuals. *Proceedings of the National Academy of Sciences, 118*(47), e2113095118.

Shamay-Tsoory, S. G., Adler, N., Aharon-Peretz, J., Perry, D., & Mayseless, N. (2011). The origins of originality: the neural bases of creative thinking and originality. *Neuropsychologia, 49*, 178-185.

Sharma, S., & Ang, J. (2019, August 12-15). More for God-less for climate association of religiosity with stringency of climate change policies. *International Conference on Applied Energy, Vasteras, Sweden*.

Sommer, I. E., Aleman, A., Bouma, A., & Kahn, R. S. (2004). Do women really have more bilateral language representation than men? A meta-analysis of functional imaging studies. *Brain, 127*, 1845-1852.

Vance, T., Maes, H. H., & Kendler, K. S. (2010). Genetic and environmental influences on multiple dimensions of religiosity: A twin study. *Journal of Nervous and Mental Disease, 198*(10), 755-761.

Waller, N. G., Kojetin, B. A., Bouchard Jr, T. J., Lykken, D. T., & Tellegen, A. (1990). Genetic and environmental influences on religious interests, attitudes, and values: A study of twins reared apart and together. *Psychological science, 1*(2), 138-142.

Whitehouse, H. (2002). Modes of religiosity: Towards a cognitive explanation of the sociopolitical dynamics of religion. *Method & Theory in the Study of Religion, 14*, 293-315.

Wiberg, A., Ng, M., Al Omran, Y., Alfaro-Almagro, F., McCarthy, P., Marchini, J., . . . Furniss, D. (2019). Handedness, language areas and neuropsychiatric diseases: insights from brain imaging and genetics. *Brain, 142*, 2938-2947.

Zimmer, Z., Jagger, C., Chiu, C.-T., Ofstedal, M. B., Rojo, F., & Saito, Y. (2016). Spirituality, religiosity, aging and health in global perspective: A review. *SSM-Population Health, 2*, 373-381.