

# Frontal Asymmetry in Pilgrims

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**Abstract:** Individuals with religious or spiritual problems experience depressive and anxiety symptoms, together with changes in cognitive style and coping. These problems are associated with altered frontal asymmetry (left greater than right) during the processing of religious stimuli. The present study aimed to investigate the effect of pilgrimage on frontal asymmetry. The participants were 50 individuals experiencing religious or spiritual problems according to DSM-5 criteria. Some 25 of them participated in a two-week religious pilgrimage, and 25 matched volunteers went on non-religious holidays. We recorded resting-state EEG at baseline and after a religious phase (reading a sacred text and listening to music) (NEUVO-CURRY 8X-system, 256-channel). The frontal asymmetry index was calculated for 1 min epochs by subtracting the left electrode sites' logarithmically transformed alpha frequency from homologous right leads (F4-F3, F8-F7). Anxiety, depressive symptoms, and rumination were assessed using self-report scales. Psychological and EEG assessments were performed before and after the pilgrimage or holiday. The results revealed that individuals experienced less anxiety, depression, and rumination following the pilgrimage. There was a significant reduction in frontal asymmetry during the processing of religious stimuli in pilgrims. We found no similar changes in volunteers who went on a non-religious holiday. These results indicate that frontal asymmetry and negative emotionality are ameliorated during a pilgrimage in individuals with religious or spiritual problems.

**Keywords:** frontal asymmetry; EEG; stress; religion and spirituality



**Citation:** Kéri, Szabolcs. 2023. Frontal Asymmetry in Pilgrims. *Religions* 14: 1072. <https://doi.org/10.3390/rel14081072>

Academic Editor: Mary Rute Gomes Esperandio

Received: 8 July 2023  
Revised: 12 August 2023  
Accepted: 15 August 2023  
Published: 21 August 2023



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## 1. Introduction

Recent decades have witnessed a radical shift in the clinical understanding of religious and spiritual experiences. Since the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV, 1994), the Religious or Spiritual Problem (RSP) concept constitutes a separate phenomenon in a section focusing on issues related to psychosocial, personal, and environmental circumstances (Lukoff 1998; Prusak 2016). Although RSP is not a mental disorder, it is often the focus of clinical attention. Individuals with RSP often experience marked anxiety and depressive symptoms related to doubts in faith, strains associated with conversion to a new faith, or questioning spirituality outside organized religious institutions (American Psychiatric Association 2013). Religion and spirituality are two related but distinct concepts that pertain to matters of belief, faith, and personal connection to the divine and transcendent. Religion is based on an organized belief system, rituals, authoritative sacred texts, dogma, doctrine, and group identity. In contrast, spirituality refers to a personal connection with the divine, the universe, or a higher power, which is dominated by inner experiences. It is less institutionalized and open to syncretism (Oman 2013).

Recently, we investigated physiological stress responses in RSP during social-evaluative stress (public speaking) and in a religious context (during Bible reading and listening to sacred music) (Kéri 2023). We found elevated stress responses only in the religious context in RSP, as indicated by increased heart rates, saliva cortisol levels, and relatively higher left than right frontal activity. Frontal asymmetry is especially intriguing, indicating a cognitive style associated with RSP. Marked left frontal brain activity following a stressful

situation may indicate an overload of cognitive coping mechanisms (Davidson 2004) linked to endocrine stress responses (increased cortisol secretion) (Düsing et al. 2016). Enhanced left relative to right frontal activity is an electrophysiological marker of goal-oriented coping strategies, uncertainty in decision-making, repetitive and perseverative thoughts, and rumination on resolving a stressful situation effortfully (Düsing et al. 2016; Roth and Cohen 1986; Haehl et al. 2021).

There are several possible solutions to RSP. Many people embark on a pilgrimage to process their thoughts about a crisis, get out of their daily routine, and find peer support. We investigated how frontal asymmetry changes during the pilgrimage relative to non-religious holidays, together with depressive and anxiety symptoms. We hypothesize that left relative to right frontal activity decreases after the pilgrimage, with reduced anxiety and depressive symptoms. We also hypothesized that reduced left vs. right frontal asymmetry is related explicitly to rumination.

## 2. Methods

### 2.1. Participants and General Procedure

The study included 50 individuals with RSP from Hungarian religious communities (34 Roman Catholic, 16 Protestant) who defined themselves as highly religious believers according to the survey of the Hungarian Central Statistical Office (Budapest, Hungary). First, volunteers received structured interviews and rating scales, and then participated in EEG measurements in a neutral/everyday and religious context. The procedure was performed two times: before and after a given two weeks, during which 25 individuals (21 Roman Catholic, 4 Protestant) participated in a religious pilgrimage (Máriaradna pilgrimage, and Mátraverebély szentkút Franciscan friary, Christian pilgrimage routes in Hungary and Romania, in the Transylvania area) and 25 participants (22 Roman Catholic, 3 Protestant) went on a non-religious holiday (hiking and sightseeing in Hungarian and Romanian destinations). The participants aimed to reduce stress and strain in their lives during the pilgrimage or holiday. The two groups did not differ in confounding factors affecting stress responses, including smoking, alcohol intake, exercising before participation, hours of sleep the previous night, being postmenopausal, acute or chronic illness, hormonal contraception, and distance walked during the pilgrimage and holiday (Narvaez Linares et al. 2020; Schnell et al. 2020) (Table 1).

**Table 1.** Demographic characteristics and rating scales.

	Pilgrims (n = 25)		Non-Religious Holiday (n = 25)	
Age (years)	31.5 (10.6)		33.2 (11.9)	
Education (years)	12.4 (3.8)		12.8 (4.3)	
Sex (male/female)	15/10		13/12	
AU I-E-intrinsic religiosity	4.1 (2.9)		4.7 (3.1)	
AU I-Es-extrinsic religiosity	4.2 (3.7)		4.0 (3.6)	
Distance walked (km/day)	6.2 (3.9)		6.8 (5.1)	
Before and after the pilgrimage/holiday	Before	After	Before	After
BDI-II	12.1 (7.0)	6.2 (3.8) *	14.1 (7.5)	15.0 (8.2)
BAI	10.4 (7.2)	3.5 (3.0) *	11.9 (6.7)	10.0 (6.6)
RSS-10	24.9 (8.0)	19.9 (7.0) *	27.4 (6.9)	27.3 (7.4)

Data are mean (standard deviation) except for sex distribution. AU I-E, Age Universal I-E scale-12; BDI-II, Beck Depression Inventory-II; BAI, Beck Anxiety Inventory; RSS-10, Ruminative Response Scale-10; \* Significantly lower values in the pilgrim group relative to the non-religious holiday group ( $ps < 0.01$ ).

The study was conducted in accordance with the Declaration of Helsinki and approved by the United Ethical Review Committee for Research in Psychology (EPKEB, 2016/032) at the Budapest University of Technology and Economics and the National Medical Research Council (ETT-TUKEB 18814, Budapest, Hungary).

## 2.2. Interviews and Questionnaires

We applied the clinical interview from the DSM-5 (Diagnosis and Statistical Manual of Mental Disorders–5) (First et al. 2016). All participants meet the DSM-5 definition of “Problems related to other psychosocial, personal, and environmental circumstances” (Religious or Spiritual Problem, code: V62.89) (American Psychiatric Association 2013). We used the Beck Depression Inventory-II (BDI-II) and the Beck Anxiety Inventory (BAI) (Perczel-Forintos et al. 2018) to characterize negative emotional responses associated with RSP. Rumination (brooding and reflection) was assessed with the Hungarian version of the 10-item Ruminative Response Scale (Lei et al. 2017). We assessed intrinsic and extrinsic religiosity with the Age Universal I-E scale-12 (Kézdy et al. 2018; Maltby 1999) (Table 1).

## 2.3. EEG Measurements

The experiment was conducted between 11 h and 17 h. In the neutral phase (30-min), the participants relaxed in a quiet room, reading newspapers and listening to non-religious music. At the end of this phase, we conducted the EEG measurements. Immediately after the neutral phase, the volunteers participated in the religious phase (30-min): they read verses from the Bible and listened to sacred piano music (Kéri 2023). Following the religious phase, the EEG measurements were repeated.

We recorded resting-state EEG at baseline and after the religious phase, as described previously (Kéri 2023). “EEG was recorded and processed with a NEUVO–CURRY 8X-system with a 256-channel Quik-Cap Neo Net (high-density EEG cap, Ag/AgCl electrodes, four bipolar leads for vertical and horizontal electrooculogram, extended international 10–20 system) (Compumedics, NeuroScan). The electrode impedances were checked ( $<5\text{ k}\Omega$ , homologous bilateral leads:  $<1\text{ k}\Omega$ ). The sampling rate was 500 Hz. For data processing, we used the EEGLAB interactive MATLAB toolbox (Schwartz Center for Computational Neuroscience, University of California). Each measurement included eight 1 min resting periods (four occasions with eyes open and four with eyes closed, counterbalanced across subjects). Following built-in automatic and manual artifact reduction, the 1 min epochs were segmented in 2-s periods with 75% overlap between epochs (epoch amplitudes  $< \pm 75\text{ }\mu\text{V}$ ) and were low-pass filtered at 30 Hz (Düsing et al. 2016). We used Fourier transformation to generate the spectral power ( $\mu\text{V}^2$ ) (resolution of 0.488 Hz) in the alpha band (8–13 Hz). Every 1 min EEG registration included at least 20 2-s epochs, and power density was averaged using all epochs. We used logarithmic transformation ( $\ln$ ) for averaged power density values. We calculated the frontal asymmetry index for the 1 min epochs by subtracting the logarithmically transformed alpha frequency of left electrode sites from homologous right leads (e.g., F4-F3, F8-F7). Higher alpha-asymmetry scores indicate relatively more robust left-sided frontal activation (Düsing et al. 2016; Duan et al. 2019)”.

## 2.4. Data Analysis

We used STATISTICA 13.5 (Tibco) for data analysis. The data were checked for normal distribution (Kolmogorov–Smirnov test) and homogeneity of variance (Levene’s test). Data were entered into repeated measures analyses of variance (ANOVAs). Tukey’s HSD (honestly significant differences) tests were applied for post hoc analysis. The demographic and rating scale scores were analyzed with two-tailed *t*-tests and chi-square tests (sex distribution). The level of statistical significance was set at  $\alpha < 0.05$ . Effect sizes ( $\eta^2$ ) were also calculated for ANOVA main effects and interactions, and 95% confidence intervals were reported.

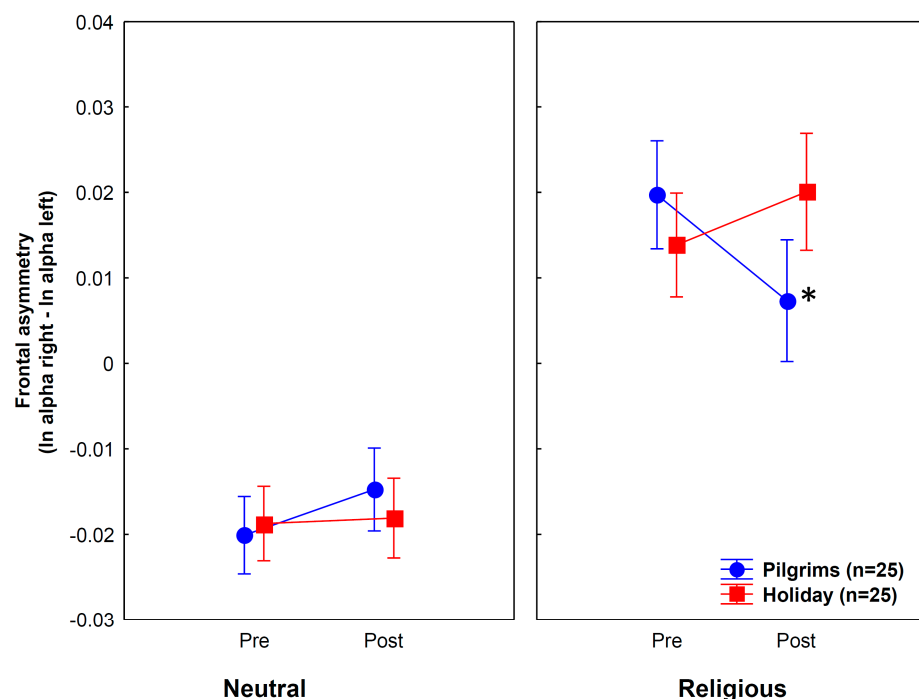
### 3. Results

#### 3.1. Demographics and Rating Scales

Individuals with RSP who participated in a pilgrimage and a non-religious holiday did not differ in age, education, religiosity, and sex distribution ( $ps > 0.5$ ). Before the pilgrimage or holiday, the two groups scored similarly on the BDI-II, BAI, and RSS-10 scales ( $ps > 0.2$ ). However, after the pilgrimage or holiday, we observed significantly lower BDI-II scores ( $t(48) = -4.82, p < 0.001$ ), BAI scores ( $t(48) = -4.44, p < 0.001$ ), and RSS-10 scores ( $t(48) = -3.69, p < 0.005$ ) in the pilgrim group relative to the non-religious holiday group (Table 1).

#### 3.2. Frontal Asymmetry

Regarding left vs. right frontal activity, there were no significant main effects of group (individuals with RSP participating in a pilgrimage or a non-religious holiday) ( $p = 0.82$ ) or testing session (before and after pilgrimage or non-religious holiday) ( $p = 0.98$ ). However, the main effect of session type (neutral and religious) was significant ( $F(1,48) = 304.66, p < 0.001, \eta^2 = 0.86$ ), with significantly higher frontal asymmetry in the religious condition than in the baseline condition ( $p < 0.001$ ) (Figure 1). The two-way interactions between group and testing session ( $p = 0.05$ ), and group and session type ( $p = 0.34$ ) were not significant. Critically, the three-way interaction among the group, testing session, and session type reached the level of significance ( $F(1,48) = 9.94, p < 0.01, \eta^2 = 0.17$ ). Tukey's HSD tests indicated that the frontal asymmetry in the religious condition significantly decreased in pilgrims ( $p < 0.05$ ), but not in those who went on a non-religious holiday ( $p = 0.47$ ). In the neutral phase, we found no significant differences in either condition ( $ps > 0.5$ ) (Figure 1). We found no significant correlations between frontal asymmetry and rating scale scores (BDI-II, BAI, and RRS-10) ( $ps > 0.2$ ).



**Figure 1.** Frontal asymmetry following neutral and religious stimuli before (pre) and after (post) pilgrimage or non-religious holidays. \*  $p < 0.05$ , a significant reduction in pilgrims. Error bars indicate 95% confidence intervals.

### 4. Discussion

We found support for our central hypothesis: individuals with RSP showed reduced left vs. right frontal activation when exposed to sacred text and music following the

pilgrimage. They also experienced less anxiety and fewer depressive symptoms. However, we did not find associations between frontal asymmetry and rumination. Interestingly, individuals with RSP who participated in a non-religious holiday did not exhibit significant changes in frontal asymmetry and negative emotional experiences.

Pilgrimage, a journey to a sacred or spiritually significant place, has been associated with several psychological advantages. It is important to note that the psychological benefits can vary based on individual beliefs, motivations, and experiences. While many people report positive outcomes from their pilgrimage journeys, the extent of these advantages may differ from person to person. Pilgrimage provides a sense of purpose and meaning as individuals seek spiritual growth, connection with a higher power, cultural enrichment, and a deeper understanding of themselves. The pilgrimage experience often encourages mindfulness and self-reflection as pilgrims step away from their routine lives to focus on their spiritual journey. This can lead to increased self-awareness and personal insights. It often involves interactions with other pilgrims, fostering a sense of community and shared purpose. This social connection can combat feelings of isolation, loneliness, and depression (Mikaelsson 2012; Schnell and Pali 2013; Hilario and Sy Su 2023; Sørensen and Høgh-Olesen 2023). We confirmed that the act of pilgrimage could lead to reduced stress and anxiety at the subjective and neurobiological levels, with a particular emphasis on renewed faith and belief. As compared to regular holidays, for those with religious beliefs, pilgrimage can strengthen their faith and deepen their sense of spirituality.

The DSM concept of RSP has precedents and parallels in the literature. Extensive research has dealt with the issue of religious and spiritual struggle (Pargament and Exline 2022; Exline and Rose 2005; Exline et al. 2014). Two major components of RSP in the DSM, the “loss or questioning of faith” and “conversion to a new faith,” are similar to divine struggles (anger or disappointment with God) and doubt-related struggles (confusion and doubt about religious/spiritual beliefs and values) (Exline et al. 2014). The “questioning of spiritual values” in the DSM resembles moral struggles (guilt about not living according to the standards of the religion) and struggles of ultimate meaning (concerns related to the deeper value and meaning of life) (Exline et al. 2014). However, a high covariance exists between the separate dimensions of religious and spiritual struggle (divine, demonic, doubt-related, moral, ultimate meaning, and interpersonal), revealing a general RSP factor (Stauner et al. 2016).

Numerous attempts have been made to treat religious or spiritual problems with psychotherapies (Pargament and Exline 2022; Pargament 2007; Richards et al. 2023). The present study has shown that pilgrimage can productively alleviate negative emotions associated with religious and spiritual crises and changes in frontal asymmetry. Following the religious journey, the pilgrims did not report religious or spiritual problems and exhibited markedly reduced anxiety and depressive symptoms. We observed no similar changes in individuals participating in secular traveling and relaxing activities. However, the present study did not fully answer how frontal asymmetry is related to subjective negative experiences. Contrary to our hypothesis, we found no relationship between frontal asymmetry and rumination. Therefore, further studies are warranted to unravel the cognitive correlations between altered frontal asymmetry and the other constituents of the stress response.

At baseline, the pilgrim and the holiday groups did not differ in age, sex, education, anxiety, depression, religiosity, and EEG measures, which supports their comparability. However, individuals participating in a pilgrimage and a non-religious holiday were not randomized, and therefore a hidden group-related bias cannot be excluded. Another limitation is that we could not conclude the effect on different religious denominations because of the small sample size (Roman Catholic vs. Protestants), and we did not assess the durability of the pilgrimage’s effects over time. The final limitation is that we did not use a rating scale for religious and spiritual struggle; only the DSM-5 criteria were applied. It is essential to underline that the pilgrimage phenomenon is not monolithic, as it contains



diverse sociocultural dimensions that can influence the outcome. The present study was conducted in an Eastern-European Christian context, mainly Roman Catholic.

In conclusion, when religious stimuli are processed, religious or spiritual problems are characterized by left vs. right frontal asymmetry. This frontal asymmetry is ameliorated after the pilgrimage. Further studies are needed to elucidate the relationship between frontal asymmetry and religious cognitions and their changes following interventions in psychological and spiritual crises.

**Funding:** This research was funded by the National Research, Development, and Innovation office, NKFIH 142765.

**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki and approved by the United Ethical Review Committee for Research in Psychology (EPKEB, 2016/032) at the Budapest University of Technology and Economics and the National Medical Research Council (ETT-TUKEB 18814, Budapest, Hungary).

**Informed Consent Statement:** Written informed consent has been obtained from the participants.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Acknowledgments:** I thank Ibolya Halász, Katalin Kaza, and Péter Nagy for their assistance.

**Conflicts of Interest:** The author declares no conflict of interest.

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