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VOXEL-BASED MORPHOMETRY OF OPTIMISTIC AND PESSIMISTIC BRAINS: A DETAILED STUDY FOCUSING ON AGE RANGE AND GENDER

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Abstract: The aim of the present study was to investigate brain volumes in pessimist and optimist participants. Therefore, in the present voxel-based morphometry research, it is investigated whether optimism has a corresponding counterpart in the structure of the brain. Thirty-two participants were screened via a publicly available dataset to test for this. The participants are divided into two groups: low optimists and high optimists, each with sixteen people. In comparison, a significant difference (P<0.05) was not found between the groups we created as a result of statistical calculations; however, statistically significant results (P<0.001) were obtained via a detailed VBM analysis in many brain regions, especially the thalamus, amygdala, left insula, superior frontal gyrus, and right cerebellum regions. These differences were identified and reported.

Keywords: Voxel based morphometry, Magnetic resonance imaging, Optimistic, Pessimistic

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1. Introduction

Interpretations of events, whether pessimistic or optimistic, influence emotional reactions and cognitive processing. Optimism leads to positive outcomes and positive psychological adjustments, while pessimism leads to persistent anticipations and poorer outcomes (Levens and Gotlib, 2012).

Optimistic bias, prevalent across genders, ages, and countries, can lead to increased risk-taking and decreased preventative measures, while also calming the mind and alleviating stress, requiring education and awareness. Therefore, society must study and educate on how false optimism can damage our daily lives and self-esteem.

Brain morphometry refers to the scientific procedure of quantifying the dimensions, typically in terms of volume, of different structures within the brain. The assessment of macroscopic gray matter (GM) asymmetries with a high level of regional specificity is a crucial aspect in brain imaging methodologies, and Voxel Based Morphometry (VBM) stands out as one of the most significant approaches. VBM enables the differentiation of local GM concentration levels at the voxel level, facilitating comparisons between distinct groups or the right and left cerebral hemispheres. The VBM methodology encompasses the process of spatially normalizing structural magnetic resonance imaging (sMRI) scans obtained from all individuals to a standardized stereotactic space. Subsequently, the process of segmentation is executed to partition the image into distinct regions representing GM and white matter (WM). The GM sections are then subjected to a smoothing operation in order to enhance the overall visual quality. Following the application of a smoothing technique to the GM images, voxelwise statistical tests are conducted in order to establish comparisons between the groups or between the right and left hemispheres (Whitwell, 2009; Ocklenburg and Güntürkün, 2018).

Neuroimaging technologies like functional magnetic resonance imaging (fMRI), MRI, and event-related potential (ERP) (Alessandri and De Pascalis, 2017) are being used to study optimism and pessimism. VBM and MRI are used to explore resting-state functional connectivity (RS-FC), often using a region of interest seed approach (Ran et al., 2017). Other resting-state metrics include fractional amplitude of low-frequency fluctuations (f-ALFF) and regional homogeneity (RegHom) (Jiang and Zuo, 2016), which measure brain connections and abnormally localized functioning (Egorova et al., 2017).

Studies show that optimism is correlated with GM in the orbitofrontal cortex (OFC), bilateral putamen, and thalamus, while the rostral anterior cingulate cortex (rACC) and the inferior frontal gyrus (IFG) are critical for self-referential processing and information suppression (Aberg, 2021). Ran et al. (2017) found that dispositional optimism is significantly linked to the strength of the RS-FC between the ventromedial prefrontal cortex (vmPFC) and the middle temporal gyrus (mTG), and negatively associated with the RS-FC between the vmPFC and IFG. Yang et al. (2013) found that optimism is linked to increased gray matter volume (GMV) in the pulvinar/thalamus region, extending to the posterior part of the parahippocampal gyrus, suggesting that individuals with higher optimism may be more adept at emotion regulation. Dolcos et al. (2016) found a significant correlation between increased GMV in the left lateral OFC and optimism in healthy adults, highlighting the link between personality and brain characteristics. Lai et al. (2020) study found that increased bilateral putamen regional GM density significantly correlates with higher levels of optimism. Sharot et al. (2007) investigated that optimism is linked to increased activation in the amygdala and rACC, brain regions responsible for emotional salience, and that rACC activity is associated with trait optimism. Wang et al. (2018) utilized the f-ALFF technique to analyze optimism processes, revealing a correlation between optimism and spontaneous OFC activity and a relationship between the left supplementary motor cortex.

Lai et al. (2020) discovered a relation between increased optimism and higher GM density in the bilateral putamen, an area related to motivation processing. Carver et al. (2010)'s assertion suggests that motivation is strongly related to optimism, with bilateral putamen being responsible for optimistic individuals' motivation. Greater regional GM density correlates with higher optimism degrees.

Additionally, optimism was reported to be associated with higher GMV in the left lateral OFC (Dolcos et al., 2016), reduced f-ALFF in the right OFC, and connectivity seen between supplementary motor cortex and OFC (Wang et al., 2018). Research suggests that the OFC may protect healthy individuals from anxiety symptoms, with increased spontaneous activity linked to elevated anxiety levels in both patients and healthy individuals with anxiety disorders (Qiu et al., 2015).

The rACC's role in self-referential processing contributes to optimistic bias, as individuals rationalize favorable events based on positive self-imagination, which is linked to increased vmPFC activity, as suggested by (Sharot et al., 2007; Blair et al., 2013). Blair et al. (2013; 2017) discovered greater activation in the posterior cingulate cortex and vmPFC, essential for evaluating stimulus subjective value, but did not find a correlation with optimistic bias. They argued that biased subjective value within these regions contributes to optimism, but not to be optimistic bias generation.

Blair et al. (2013) found that participants were optimistic about both good and bad future events, overestimating milestones and underestimating heart attacks. Positive situations increased activity in the posterior cingulate cortex, vmPFC, and rACC, while negative situations decreased activity in the dorsomedial prefrontal cortex (dmPFC) and left insula activity.

Sharot et al. (2011) study used fMRI data to analyze participants' likelihood of encountering 80 unfavorable scenarios. They found that 79% of participants modified their estimation when faced with a decreased likelihood of negative events. Activity in the left IFG, right cerebellum, and bilateral medial prefrontal cortex/superior frontal gyrus increased. When their initial likelihood estimates exceeded reality, activity within the proper IFG decreased.

The study by Sharot (2007) found a significant link between bilateral amygdala activity and rACC activity during positive future scenarios, while negative situations weaken this connection. A rise in rACC and amygdala activation is associated with optimism. Research has shown that negative self-information is not a necessary component of optimism bias, and participants' initial estimations may be updated when faced with actual probability (Sharot et al., 2007; Sharot, 2011; Ran et al., 2017). The IFG found that higher optimism scores lead to poorer outcomes when negative occurrences are greater than initial assessments. This indicates that the right IFG is crucial for rejecting unfavorable information and maintaining beliefs affecting well-being.

Overly optimistic individuals are more probably to disregard negative aspects of themselves. In their study, Kuzmanovic et al.'s study (Kuzmanovic et al., 2016) found that the ventral striatum partially omits negative information, contributing to individuals' optimism bias, as it's a part of the brain's reward system, causing individuals to disregard negative information. Ran et al.'s findings may imply that the mTG and inferior IFG, which are connected with emotion processing and regulation, are also involved in dispositional optimism (Ran et al., 2017).

Due to its interconnections to other limbic structures, the thalamus has formerly been connected with emotional processing (Bush et al., 2000; Davidson et al., 2000). Optimists are more likely to utilize reappraisal as an emotion-regulation approach and express more positive moods than pessimists (Yang et al., 2013). Reappraising experiences helps alleviate unpleasant emotions, as controlling emotions is crucial for maintaining a positive outlook, as evidenced by increased GMV in the thalamus in extremely o-individuals.

Is it able to conduct a methodical, objective, and scientific study of optimism and pessimism? Undoubtedly, although optimism and pessimism are applied uniquely and differentially in each individual's life and despite the subject's breadth, optimism research is quantitative in nature. Therefore, the possibility of qualitative differences in the brain volumes of optimistic and pessimistic people comes to mind. In addition, considering the gender difference, age distribution, and parameters such as the right and left lobes of the brain, it is a matter of curiosity whether these parameter differences have any effect on people's perspectives on life. Therefore, the aim of this study was to evaluate whether there was any difference by dividing people into two groups, optimistic and pessimistic, and then dividing these groups into subgroups, such as male/female, age range, and right and left lobes of the brain. The outline of the study is designed as follows. First, the methods used in the study and the content of the dataset will be summarized in Section 2. Subsequently, the results are presented in Section 3. In Section 4, the results will be discussed, and in the fifth section, the current result and future works will be evaluated.

2. Materials and Methods

2.1. Dataset

The dataset known as the "Leipzig Study for Mind-Body-Emotion Interactions" (Lemon) consists of data from 227 individuals who were deemed healthy. These participants were divided into two groups: a youthful group consisting of 153 individuals with an average age of 25.1 years (ranging from 20 to 35 years), with 45 of them being female; and an elderly group consisting of 74 individuals with an average age of 67.6 years (ranging from 59 to 77 years), with 37 of them being female. The participants were recruited in a cross-sectional manner to investigate mind-body-emotion interactions in Leipzig, Germany, during the period from 2013 to 2015. All participants were subjected to testing at the "University Clinic Leipzig's Day Clinic for Cognitive Neurology" and the "Max Planck Institute for Human and Cognitive and Brain Sciences" (MPI CBS) located in Leipzig, Germany. The research adhered to the guidelines set forth in the Declaration of Helsinki, and its methodology was granted approval by the ethics committee of the medical faculty at the University of Leipzig (reference number 154/13-ff). The recruitment and exclusion criteria have been outlined in previous studies (Oligschläger et al., 2016; Mendes et al., 2017; Golchert et al., 2017a; Golchert et al., 2017b; Babayan et al., 2019). All of the data used in this study can be found on this website: http://fcon_1000.projects.nitrc.org/indi/retro/MPI_LEMON.html.

2.2. Participants

Since our focus in our study was to understand whether there is a difference between highly optimistic and less optimistic brain structures, we grouped our participants according to psychological assessment. Accordingly, the Optimism Pessimism Questionnaire-Revised (LOT-R) test results given under the Psychological Assessment title of (Babayan et al., 2019) were suitable for our purpose. We conducted our study by choosing a narrower focus among all these broad parameters and participants and selected 32 individuals from the Lemon data set, equally distributed in the highly optimistic (H-optimistic) and low optimistic (L-optimistic) (pessimistic) groups.

Each group we formed thus consisted of 16 people. In each group, the number of men and women and the age distribution were equal. Namely, eight women (4 younger - 4 older) and eight men (4 young - 4 older) were selected. Therefore, comparisons were made according to subgroups as well as L-optimistic and H-optimistic groups. Figure 1 presents Group division representation. Subjects were nonsmoker and right-handed dominant, and their education level was generally Gymnasium, and as another lower percentage, Realschule. Furthermore, there was a participant whose education was Hauptschule. The age range had a different range for each group and is presented in Table 1. The participants were matched in psychopathology severity (e.g. HDRS). And the subjects have no SCID-diagnoses.

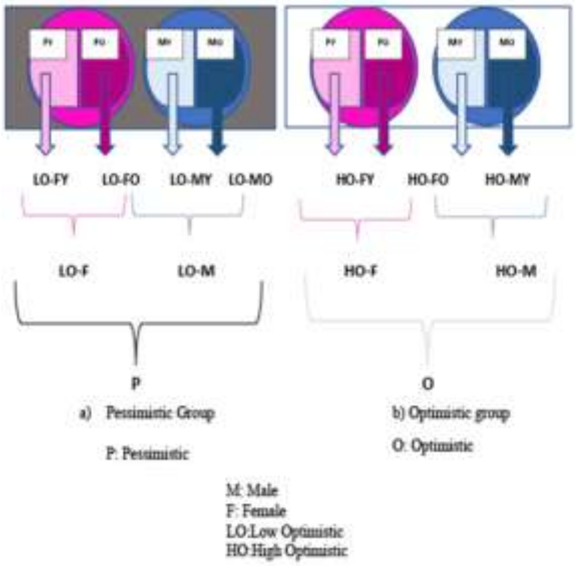

Figure 1. Group division representation.

Table 1. The demographic details of the participants

Participants	High Optimistic Group Female-Old Male-Old	High Optimistic Group Female-Young Male-Young	Low Optimistic Group Female-Old Male-Old	Low Optimistic Group Female-Young Male-Young
Number	4	4	4	4
	4	4	4	4
Age Range	65-75	20-30	60-70	20-30
	60-75	20-30	60-75	30-30
Total Number (32)	8	8	8	8

2.3. Image Acquisition

The neuroimaging procedure was conducted using the 3 Tesla SIEMENS MAGNETOM Verio, manufactured by Siemens in Germany. The acquisition of T1-weighted 3D magnetization data was performed. The anatomical images in the sagittal plane were acquired using the Prepared Rapid Gradient Echo (MPPRAGE) sequence, with specific parameter settings. The sagittal acquisition orientation was used to obtain a 3D volume consisting of 176 slices. The repetition time (TR) was set to 5000 ms, while the echo time (TE) was 2.92 ms. Two inversion times (TI1 = 700 ms, TI2 = 2500 ms) and two flip angles (FA1 = 40°, FA2 = 50°) were employed. Prior to scanning, pre-scan normalization was performed. The echo spacing was set to 6.9 ms, with a bandwidth of 240 Hz/pixel. The field of view (FOV) was 256 mm, and the voxel size was 1 mm isotropic. A GRAPPA acceleration factor of 3 was applied, and the slice order was interleaved. The total duration of the scan was 8 minutes and 22 seconds.

2.4. Voxel Based Morphometry (VBM)

The estimation of the cerebrospinal fluid (CSF), WM, GM and total intracranial volume (TIV), was conducted using the VBM approach. The VBM technique is widely recognized for its efficacy in assessing the voxel-level differences between multiple groups by utilizing sMRI data (Ashburner, 2000). The VBM8-toolbox developed by (http://dbm.neuro.uni-jena.de/vbm8/) (the University of Jena) was employed in this study. The toolbox utilized in this study is derived from the SPM program, which can be accessed at the following URL: http://www.fil.ion.ucl.ac.uk/spm/. The SPM program itself is implemented in MATLAB. The utilization of a 3D T1-weighted sMRI image as input in the VBM8 toolbox allows for the consistent implementation of denoising, normalization, segmentation, and computation of CSF, WM, GM volumes by SPM. After performing segmentation, the normalized WM and GM images were used for VBM analysis. The estimation of TIV was performed by aggregating the volumes of CSF, WM, GM. The volumes of these were subjected to Gaussian smoothing using a kernel size of [18.6 18.2 18.3 mm mm mm; 12.4 12.1. 12.2{voxels}], [1.5 1.5. 15. mm mm mm; 1.0 1.0 1.0{voxels}], [15.5 14.4 14.7 mm mm mm;10.3 9.6 9.8{voxels}] full width at half maximum (FWHM).

2.5. Statistical Approach

The smoothed and normalized adjusted nonlinear, white matter and gray images and cerebrospinal fluid images were employed for between-group comparisons. Absolute threshold masks of 0.05 were operated on the GM, WM, and CSF images. The statistical parametric maps were subjected to two thresholds: an uncorrected voxel-size threshold of P<0.001 and an expected voxel per cluster threshold (>50) for the purpose of eliminating counterfeit small clusters. The Mann-Whitney U test was calculated to compare the estimations of volumes between the H-optimistic and L-optimistic groups in MATLAB.

3. Results

No statistically significant differences were found in the volumes of TIV, WM, GM, and CSF between the groups categorized as H-optimistic and L-optimistic (P<0.05) (Figure 2 and Figure 3 and Table 9).

Furthermore, there were no significant differences observed in TIV, WM, GM, and CSF volumes within the brain for female and male participants, young and old participants, young female and male participants, or old female and male participants (P<0.05) (Tables 2-7). However, in the detailed analysis, many brain regions showed differences between groups when the low optimistic group was set as the default setting of <high optimistic on a scale of P<0.001 (Figure 4). Table 8 presents the regions of significantly different GM and WM and CSF volumes from the whole brain VBM analysis.

Table 2. Volume estimation (mean and standard deviation (SD)) of cerebrospinal fluid (CSF), white matter (WM), gray matter (GM), total intracranial volume (TIV), WM/TIV, and GM/TIV results for female participants

Brain Volumes	High Optimistic Group Mean ± SD	Low Optimistic Group Mean ± SD	P-value
(Absolute Volumes)			
CSF	255±64.38	274.25±76.69	0.46
WM	470.87±33.08	475.37±39.42	0.74
GM	470.75±54.26	635.5±66.6	0.10
TIV	1397.62±87.37	1387.75±67.96	0.84
(Relative Volumes)			
WM/TIV	33.68±0.86	34.22±1.7	0.57
GM/TIV	48.07±3.8	45.85±4.8	0.19
CSF/TIV	18.18±4.2	19.73±5.2	0.31

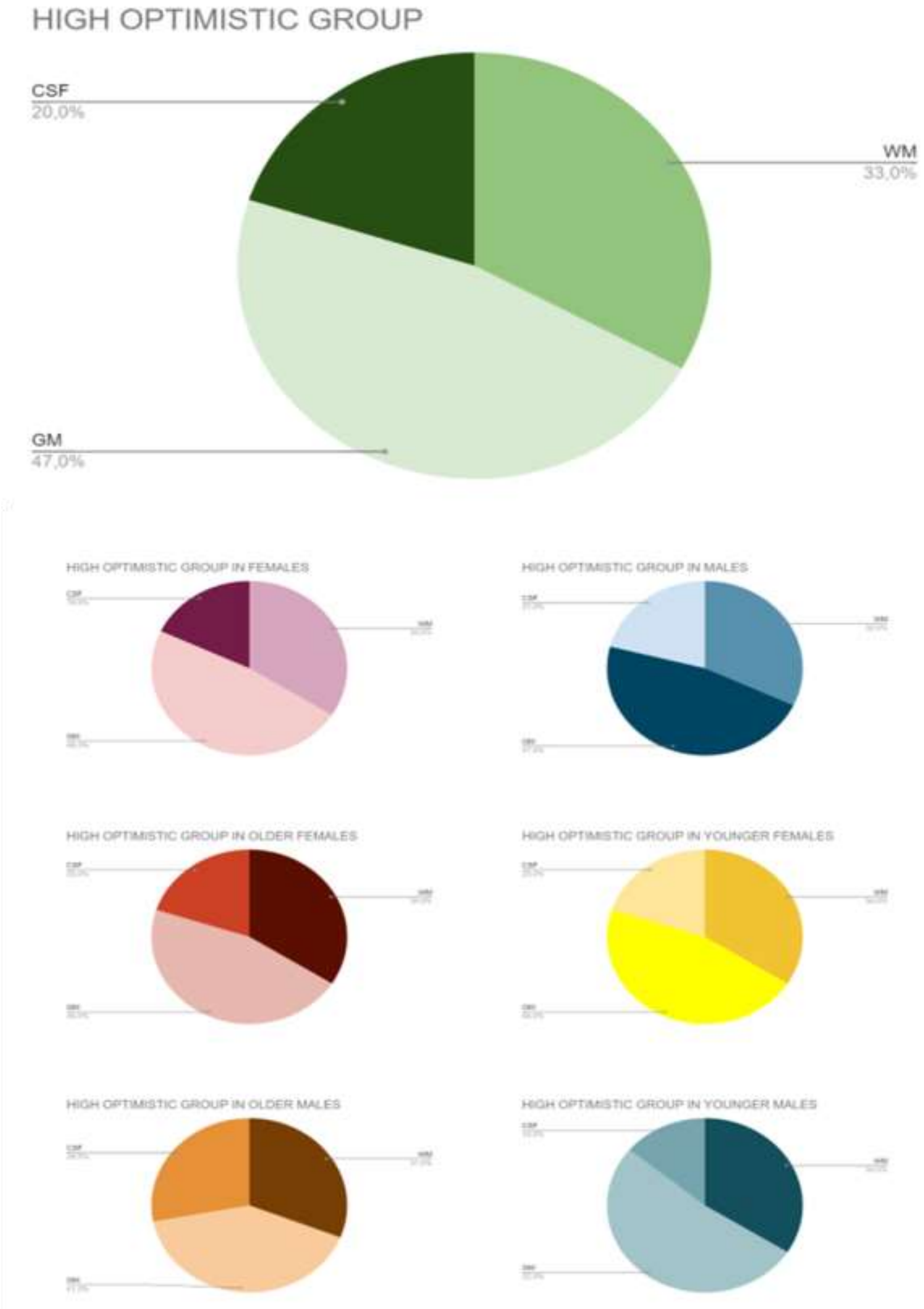

Figure 2. Percentage representation comparisons of highly optimistic groups for GM, WM, and CSF images.

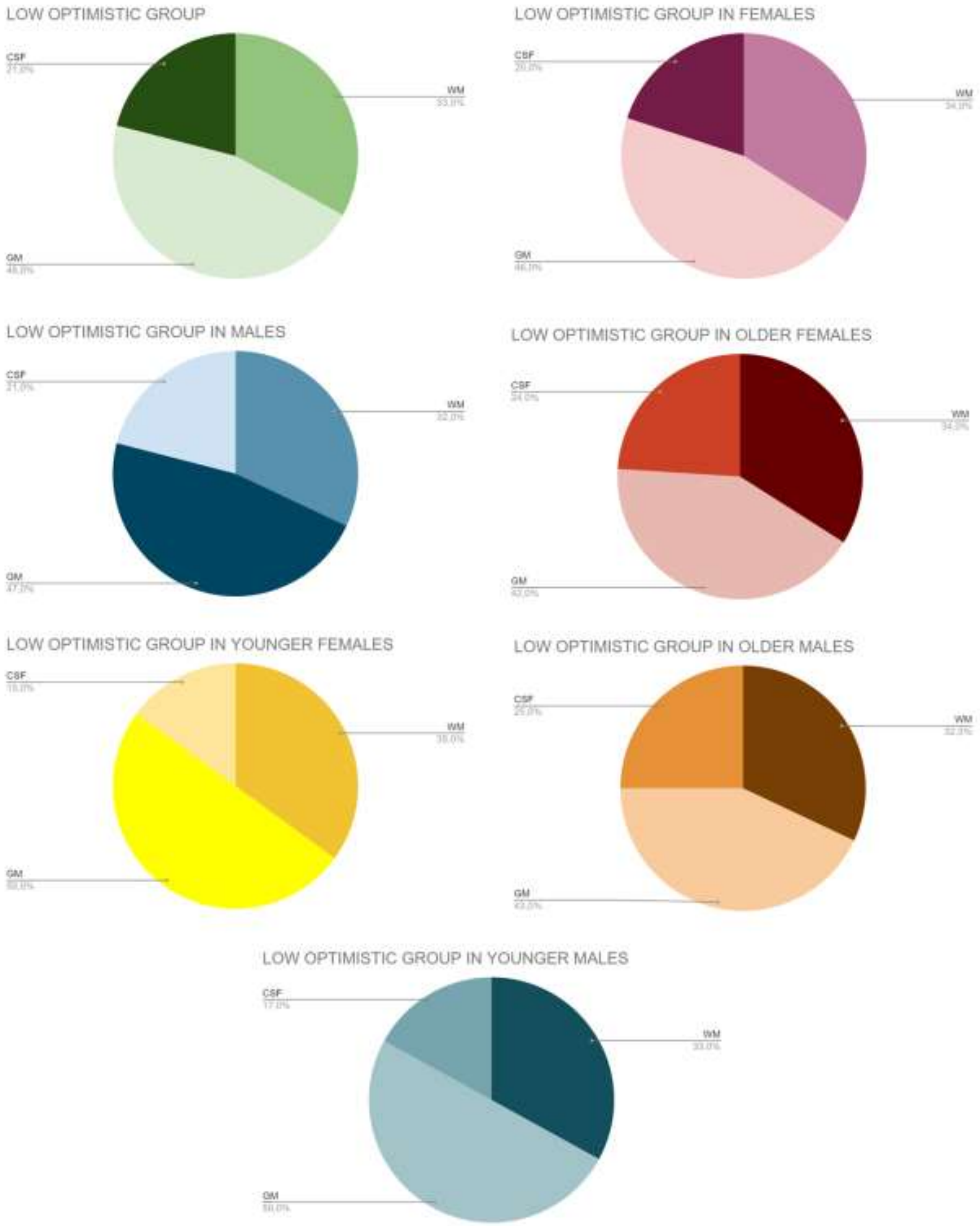

Figure 3. Percentage representation comparisons of low optimistic groups for GM, WM, and CSF images.

Table 3. Volume estimation (mean and standard deviation (SD)) of cerebrospinal fluid (CSF), white matter (WM), gray matter (GM), total intracranial volume (TIV), WM/TIV, and GM/TIV results for male participants

Brain Volumes	High Optimistic Group Mean ± SD	Low Optimistic Group Mean ± SD	P-value
(Absolute Volumes)			
CSF	315.12±114.60	329.87± 80.95	0.44
WM	489.75± 56.35	508.75±42.09	0.84
GM	706.625±131.24	728±80.82	0.46
TIV	1513.12±145.34	1568.12±86.89	0.38
(Relative Volumes)			
WM/TIV	32.37±1.8	34.42±1.7	0.94
GM/TIV	46.61±6.4	46.46±4.7	0.81
CSF/TIV	20.93±7.7	21.02±4.8	0.84

Table 4. Volume estimation (mean and standard deviation (SD)) of cerebrospinal fluid (CSF), white matter (WM), gray matter (GM), total intracranial volume (TIV), WM/TIV, and GM/TIV results for young female participants

Brain Volumes	High Optimistic Group Mean ± SD	Low Optimistic Group Mean ± SD	P-value
(Absolute Volumes)			
CSF	224.75±74.66	215.25±42.35	0.87
WM	469.25±49.58	480±4	0.62
GM	697.25±60.63	687±48.51	0.62
TIV	1392±132.48	1382.75±24.47	0.87
(Relative Volumes)			
WM/TIV	33.7±1.19	34.7±0.66	0.50
GM/TIV	50.22±3.65	49.67±3.22	1.00
CSF/TIV	16.05±4.66	15.57±3.05	0.87

Table 5. Volume estimation (mean and standard deviation (SD)) of cerebrospinal fluid (CSF), white matter (WM), gray matter (GM), total intracranial volume (TIV), WM/TIV, and GM/TIV results for young male participants

Brain Volumes	High Optimistic Group Mean ± SD	Low Optimistic Group Mean ± SD	P-value
(Absolute Volumes)			
CSF	241±37.7	269.75±39.39	0.12
WM	520.5±55.24	513.5±47.25	0.62
GM	811.25±97.03	795.75±52.77	0.87
TIV	1546.5±183.67	1579.75±102.44	0.87
(Relative Volumes)			
WM/TIV	33.72±0.51	32.5±1.82	0.37
GM/TIV	52.47±1.21	50.4±1.81	0.25
CSF/TIV	13.77±1.24	17.7±2.28	0.12

Table 6. Volume estimation (mean and standard deviation (SD)) of cerebrospinal fluid (CSF), white matter (WM), gray matter (GM), and total intracranial volume (TIV), WM/TIV, and GM/TIV results for old female participants

Brain Volumes	High Optimistic Group Mean ± SD	Low Optimistic Group Mean ± SD	P-value
(Absolute Volumes)			
CSF	285.25±40.70	333.25±51.44	0.25
WM	472.5±9.39	470.75±59.60	1.00
GM	644.25±36.36	584±27.54	0.12
TIV	1403.25±13.40	1392.75±100.55	0.87
(Relative Volumes)			
WM/TIV	33.67±0.57	33.72±2.38	0.87
GM/TIV	45.92±2.85	42.02±2.21	0.12
CSF/TIV	20.32±2.74	23.9±2.84	0.25

Table 7. Volume estimation (mean and standard deviation (SD)) of cerebrospinal fluid (CSF), white matter (WM), gray matter (GM), and total intracranial volume (TIV), WM/TIV, and GM/TIV results for old male participants

Brain Volumes	High Optimistic Group Mean ± SD	Low Optimistic Group Mean ± SD	P-value
(Absolute Volumes)			
CSF	416.25±44.19	390±64.04	0.87
WM	459±42.85	504±42.90	0.62
GM	602±39.85	660.25±14.79	0.12
TIV	1479.75±112.17	1556.5±82.24	0.37
(Relative Volumes)			
WM/TIV	31.02±1.56	32.35±1.93	0.62
GM/TIV	40.75±1.71	42.52±2.70	0.87
CSF/TIV	28.1±0.97	24.97±2.87	0.25

Table 8. The regions of significantly different gray and white matter and cerebrospinal fluid volumes from the whole brain VBM analysis (P<0.001 uncorrected)

LOW>HOG	Total Number of Voxels	z	T	MNI coordinate (x y z)
Gray Matter	547254	3.91	3.16	18 -14 60
		3.90	3.16	17 -39 42
		3.81	3.81	14 -39 44
White Matter	390919	4.18	4.92	-5 -81 -8
		3.84	4.41	0 -68 18
		3.27	3.62	11 -62 15
		3.74	4.26	-5 -17 48
		3.58	4.03	-35 29 42
		3.42	3.82	-12 -33 51
		3.27	3.62	-20 -47 60
		3.26	3.60	29 44 21
		3.17	3.49	-44 -21 36
		3.13	3.43	-57 -15 -41
		3.09	3.39	-26 27 36
Cerebrospinal Fluid	631691	4.07	4.75	-39 30 45
		3.67	4.17	47 -2 57
		3.65	4.14	8 8 -21
		3.60	4.07	-56 21 36
		3.55	4.00	-60 -32 32
		3.53	3.97	-9 29 50
		3.49	3.91	50 -44 29
		3.36	3.74	60 -38 42
		3.33	3.69	54 -9 -5
		3.32	3.69	-30 -95 14
		3.26	3.61	68 -39 9
		3.24	3.58	-53 -48 48
		3.22	3.55	54 0 44

3.1. Gray Matter Evaluations in terms of Anatomical Localization

In our study, the reference group is the group obtained by subtracting the low optimistic group from the high optimistic group. We evaluated our results first by grouping the participants into low-optimistic and high-optimistic groups with 16 subjects per group. Accordingly, when the low optimistic group was compared to the high optimistic group (P<0.001), there were significant differences in brain right hemisphere volumes. These regions: Right cerebral white matter, Right OFuG, Right LiG, Right lateral ventricle, Right calcarine calcarine cortex, Right IOG.

When females in the L-optimistic group were compared to females in the H-optimistic group (P<0.001), no significant differences were found.

However, when males in the L-optimistic group were compared to males in the H-optimistic group (P<0.001), significant differences were found. These regions are the right cerebral white matter, right PrG, right SPF, right PCu, right PCgG, right MPrG, and right MPoG.

Table 9. Volume estimation (mean and standard deviation (SD)) of cerebrospinal fluid (CSF), white matter (WM), gray matter (GM), total intracranial volume (TIV), WM/TIV, and GM/TIV results

Brain Volumes	High Optimistic Group Mean ± SD	Low Optimistic Group Mean ± SD	P-value
(Absolute Volumes)			
CSF	285.06 ± 95.01	302.06 ± 81,41	0.2145
WM	480.31 ± 45.69	492.06 ± 42.99	0.5179
GM	688.69 ± 98.77	681.75 ± 85.83	0.6417
TIV	1455.37 ± 130. 30	1477.93 ± 119.81	0.5349
(Relative Volumes)			
WM/TIV	33.03 ± 1.52	33.32 ± 1.90	0.6483
GM/TIV	47.34 ± 5.15	46.15 ± 4.62	0.2443
CSF/TIV	19.56 ± 6.17	20.38 ± 4.91	0.5014

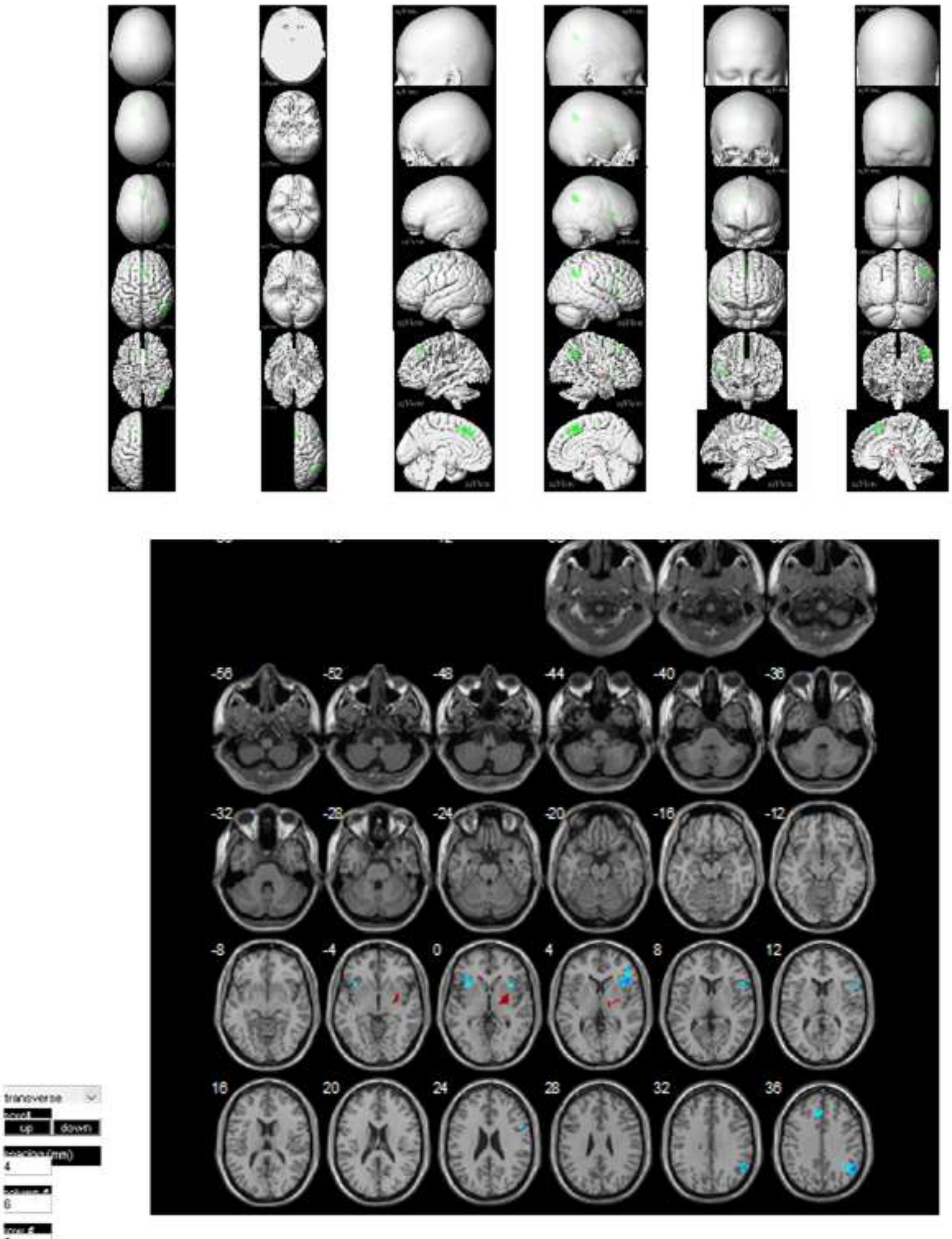

Figure 4. Render and Slice View of the GM images.

- When older females in the L-optimistic group were compared to older females in the H-optimistic group (P<0.001), no significant differences were found.
- When younger females in the L-optimistic group are compared to younger females in the H-optimistic group (P<0.001), significant differences are found, The regions under consideration include the Right SFG, Right MSFG, Right Cerebral White Matter, Right OFuG, Right LiG, Right Exterior of the Cerebellum, Right IOG, Right Palladium, Right Thalamus Proper, Right Amygdala, Left TrIFG, Left MFG, Left Cerebral White Matter, Left Ventral DC, Left Thalamus Proper, Brain Stem, 3rd Ventricle, CSF, Right Ventral DC, and 4th Ventricle.
- When older males in the L-optimistic group were compared to older males in the H-optimistic group (P<0.001), significant differences were found. The aforementioned regions include the Left MOG, Left SOG, Left Cerebral White Matter, Left Occipital Pole, Left Cuneus. The regions of interest identified in our study include also the Left Ventral DC, Left Thalamus Proper, Left Pallidum, Right Thalamus Proper, Right Ventral DC, Left PCu, and Right PCu. The left PCgG, left MPoG, right PCgG, left MPrG, left MCgG, and right MCgG were observed. The MPrG, was also the focus of discussion. The regions of interest in this study include also the right cerebral white matter, left MTG, left ITG, left IOG, right PrG, right MPrG, right SFG, right SMC, left SOG, left MOG, left Calc, left Cun, left lateral ventricle, left cerebellum exterior, left OFuG, right MTG, right STG, right PCu, right SPL, left PCu, right TMP, right ITG, right FuG, right PHG, brain stem, right cerebellum exterior, right OFuG, right LiG, right IOG, and the fourth ventricle.
- When younger males in the L-optimistic group were compared to younger males in the H-optimistic group (P<0.001), significant differences were found. The aforementioned regions encompass the Left Ventral DC, Left Thalamus Proper, Left Cerebral White Matter, and 3rd Ventricle. The left pallidum, right thalamus proper, right ventral DC, right FuG, right ITG, right cerebral white matter, right MPrG, and right PCgG, the right medial segment of the postcentral gyrus and the right precuneus in the posterior cingulate cortex, the right PrG, left MPrG, right MCgG, right PoG, and right MPrG were observed. The left OpIFG, left FO, and left TrIFG were examined in this study. The regions of interest in this study include also the right cerebral white matter, the right OFuG, and the right LiG. The regions of interest identified in the study include also the right lateral ventricle, the left IOG, left OFuG, left SPL, left AnG, right SOG, right MOG, right OCP, left FuG, left ITG, left PHG, right Cun, left cerebellum exterior, right IOG, right OFuG, right Calc, left Cun, left LiG, left MFG, left Calc, and left OCP.

3.2. White Matter Evaluations in terms of Anatomical Localization

Similarly, we evaluated our outcomes first by grouping the participants into low optimistic and high-optimistic groups with 16 subjects per group. Accordingly, when the pessimistic group was compared to the optimistic group (P<0.001), there were significant differences in brain right and left hemisphere volumes. These regions are Left LiG Lingual gyrus, Left Cerebral White Matter, Left Calc calcarine cortex, Left Cerebellum Exterior, Cerebellar Vermal Lobules VI-VII, Left PCu, Left Cun cuneus, Right Cun cuneus, Right PCu, Right CALC, Right Cerebral White Matter, Right LiG, Left MCgG, Left SMC, Left MPrG, Right MCgG, Right MPrG, Right SMC, Left MFG, Left PCgG, Left MPoG, Left PrG, Left Pogyrus, Left MFG, Left PCgG, Right MFG, Left SFG, Left MPoG, Left MFG.

When females in the L-optimistic group were compared to females in the high optimistic group (P<0.001), significant differences were found. The regions of interest in this study include the Left MPoG, Left PrG, Left Cerebral White Matter, Left SMG, Right Cerebral White Matter, Right Lateral Ventricle, Left Lateral Ventricle, Right Caudate, Right Accumbens Area, and Right SCA subcallosal area, 3rd Ventricle, Left Caudate, Right Ventral DC, Left SCA, and Right Thalamus Proper. The regions of interest in the brain include also the left accumbens area, right basal forebrain, right pallidum, left ventral DC, left PT, left STG, left CO, left PO, left PoG, left SMG, left TTG, left MTG, and left PO accumbens area. Additionally, the left PoG, left SMG, and left TTG was also of interest.

Moreover, when males in the L-optimistic group were compared to males in the H-optimistic group (P<0.001), significant differences were found. The aforementioned regions encompass the Left Cerebral White Matter, Left SMC, and the Left MPrG. The left middle cingulate gyrus, right medial segment of the precentral gyrus, right middle cingulate gyrus, and right supplementary motor cortex were observed. The region of interest was also the calcaneus CALC. The right cuneus, right precuneus, and left precuneus were observed. The right LiG was also a region of interest in the brain. The left lingual gyrus, left cuneus, and left calcarine cortex were observed. The right cerebral white matter and right lateral ventricle were the anatomical structures under consideration. The SMC was observed as a region of the brain that plays a role in motor control. The central operculum located in the left cerebral hemisphere was examined. The left temporal pole of the middle temporal gyrus, the left OpIG, the left FO, the left STG, the left PrG, the left Alns, the left Cun, and the left OCP was seen. The regions of interest in this study include the right MFG, right SFG, left LiG, right LiG, left cerebellum exterior, right PrG, and right MFG. The right cuneus, right SPL, left SMG, left PoG, left PO, left SPL, left PoG, left PCu, and left MPoGwere identified. In addition,

- When older females in the L-optimistic group were compared to older females in the H-optimistic group

(P<0.001), significant differences were found. The aforementioned regions include the Right Cerebral White Matter, Right Posterior Insula of the Planum Polare, Right ALNS, and Right PP. The right putamen, right vessel, right hippocampus, right inferior lateral ventricle, right putamen, and right amygdala were observed. The entorhinal area, also known as the Ent entorhinal area, was identified as a region of the brain. The left superior parietal lobule and left precuneus of the posterior cingulate cortex were examined. The white matter in the left cerebral hemisphere was seen. The following brain regions were identified: the SOG, the CUN, the ALNS, the FO, the OpIFG, the OpIFG, CO, and the ITG. The left FuG, the left cerebellum exterior, right MFG, right SFG, right ITG, and right FuG were the specific brain regions under consideration. The following brain regions were identified in the left hemisphere: the left putamen, left posterior insula of the parietal lobe, left anterior insula, left pallidum, left vessel, left hippocampus, left planum polare of the parietal lobe, left inferior lateral ventricle, left superior occipital gyrus, left angular gyrus ,left amygdala, left fusiform gyrus, left lateral ventricle, left entorhinal area, left basal forebrain, left vessel, and left planum polare of the parietal lobe. In the right hemisphere, the identified regions were the right lateral ventricle, right caudate, right thalamus proper, right lateral ventricle, left middle occipital gyrus, right precentral gyrus, and right postcentral gyrus.

- When younger females in the L-optimistic group were compared to females in the younger H-optimistic group (P<0.001), significant differences were found. These regions are Left Cerebral White Matter, Right Cerebral White Matter, Left MFG, Right SFG, Left CUN, Right CUN, Left CALC, Left STG, Left PT, Left MTG, Left TTG, Left MCgG, Right MCgG ,Left SMC, Left AnG, Left MOG, Right FuG, Right ITG, Right Cerebellum Exterior, Right PHG, Right MSFG, Left MSFG, Left OFuG, Left CALC, Left IOG, Left OCP, Left LiG, Right Plns, Right PP, Right ALNS, Right TTG, Right CO, Right STG, Left STG, Left PT, Left PO, Left CO, Left PoG, Left SMG, Left SFG, Left MFG, Left PrG, Left ACgG, Left Hippocampus, Left Amygdala, Left Pallidum, Left Ventral DC, Left Putamen, Left Inf Lat Vent, Left Ent entorhinal area, Left vessel, Right ACgG, Right LiG, Left LiG, Right CALC, Left CALC, Right CUN, Left CUN.
- When older males in the L-optimistic group were compared to older males in the H-optimistic group (P<0.001), significant differences were found. These regions are Left Cerebral White Matter, Right Cerebral White Matter, Right PCu, Left PCu, Left MPrG Left PCgG, Left MPoG, Left MCgG, Left STG, Left MTG, Left PT planum temporale, Left TTG, Right MTG, Right SFG, Left CO, Left PP, Left OpIFG, Left FO frontal operculum, Left TMP, Left PrG, Left ALNS, Right PCgG, Right TMP, Left IOG, Left MOG, Left SMC, Left MPrG, Right MCgG, Right SMC, Right MPrG, Left MTG, Left ITG, Left IOG, Right SPL, Right MSFG, Right ACgG, Left CALC, Left OpIFG, Left PrG Precentral gyrus, Right MPrG, Right MCgG, Right SMC, Left MPrG, Left SMC, Left MCgG, Right PCgG, Right TMP, Right ENT, Right ITG, Right FuG.
- When younger males in the L-optimistic group were compared to younger males in the H-optimistic group (P<0.001), significant differences were found. These regions are Right Cun cuneus, Left Cun cuneus, Left Cerebral White Matter, Right Cerebral White Matter, Right Calc calcarine cortex, Left Calc calcarine cortex, Right PCu, Left PCu, Right LiG, Left LiG, Right FuG, Right ITG, Right ENT, Right PHG, Right TMP, Right Hippocampus, Right Amygdala, Right Inf Lat Vent, Cerebellar Vermal Lobules VI-VII, Cerebellar Vermal Lobules VIII-X, Left Cerebellum Exterior, Right Cerebellum Exterior, Left MFG, Left PrG, Right GRe, Left GRe, Right MOrG, Right MFC, Left MFC, Right POrG, Right LOrG, Right AOrG, Right PrG, Right MFG, Left SMG, Left PoG, Left parietal operculum, Left SMC, Left MPrG, Left MCgG, Right MPrG, Right SMC, Right MCgG, Left OCP, Right CO, Right TTG, Right PP, Right Plns posterior insula, Right Alns anterior insula, Right PT.

3.3. Cerebrospinal Fluid Evaluations in terms of Anatomical Localization

Furthermore, we evaluated our outcomes by grouping the participants into low optimistic and high optimistic groups, with 16 subjects per group with cerebrospinal fluid. Accordingly, when the pessimistic group was compared to the optimistic group (P<0.001), there were significant differences in brain right and left hemisphere volumes. These regions are the left MFG, right PrG precentral gyrus, left SMG, left cerebral white matter, right SMG, right cerebral white matter, left MOG, right STG, left SMG, right PrG, and right PoG.

By extension, when females in the L-optimistic group were compared to females in the H-optimistic group (P<0.001), significant differences were found. These regions are the Left FuG fusiform gyrus, Left Cerebral White Matter, Right Cerebral White Matter, Left SOG, Left PoG postcentral gyrus, Left SMG, and Right GRe.

Moreover, when males in the L-optimistic group were compared to males in the H-optimistic group (P<0.001), significant differences were found. These regions are the left cerebral white matter, right cerebral white matter, right MFG, right PrG, brain stem, right FuG, left MFG, left SPL, and left AnG. Additionally;

- When older females in the L-optimistic group were compared to older females in theH- optimistic group (P<0.001), significant differences were found. These regions were the left cerebral white matter, right cerebral white matter, right PrG, left ITG, left GRE gyrus rectus, left SPL, right AOrG , left PrG, right PCu, right ventral DC, and left MOG.
- When younger females in the L-optimistic group were compared to females in the younger H-

optimistic group (P<0.001), significant differences were found. These regions were the left cerebral white matter, right cerebral white matter, right PT, left SMC, left LiG, left SMC, left SPL.

- When older males in the L-optimistic group were compared to older males in the H-optimistic group (P<0.001), significant differences were found. These regions were the left cerebral white matter, right cerebral white matter, right MFG, right PoG, right caudate, left PrG precentral gyrus, right MSFG superior frontal gyrus medial segment, left PCu , left MSFG, left IOG, right TrIFG, left OFuG, and right SMG.
- When younger males in the L-optimistic group were compared to younger males in the H-optimistic group (P<0.001), significant differences were found. These regions were the right cerebral white matter, right OrIFG, right OCP, right STG, and right STG, left AnG, right CO, right AnG, and right SMG.

4. Discussion

Significant differences in all of these regions in our study were found in the following comparisons: In GM evaluations in terms of anatomical locations, when younger females in the L-optimistic group were compared to younger females in the H-optimistic group, significant differences were found in the right and left thalamus proper. Similarly, when older males in the L-optimistic group were compared to older males in the H-optimistic group and younger males in the L- optimistic group were compared to younger males in the H-optimistic group, significant differences were found in these regions. Although we cannot detect an increasing GM according to our results, we can declare that we found a significant result in the statistical comparison between the H- optimistic and L-optimistic groups. In addition to the literature, we can state that we found almost a similar result in gender and age discrimination.

In WM evaluations regarding anatomical locations, when females in the L-optimistic group were compared to females in the H-optimistic group, significant differences were found in the right and left thalamus proper. Additionally, when older females in the L-optimistic group were compared to older females in the H-optimistic group, significant differences were found in these regions. Since there is no WM study on optimism in the literature, we could not make an additional comment on this issue.

When we turn to GM evaluations in terms of anatomical locations, when younger females in the L-optimistic group are compared to younger females in the H-optimistic group, significant differences are found in the right amygdala. Similarly, in terms of anatomical locations, when older females in the L-optimistic group were compared to older females in the H-optimistic group, significant differences were found in the right and left amygdala. This comparison for younger females has only statistical significance in the left amygdala. This comparison for younger males has only statistical significance in the right amygdala.

If we evaluate the results we found for "Insula," we see that we could not find a significant difference in any insula region in GM evaluations. However, when we looked at WM evaluations in terms of anatomical locations and when males in the L-optimistic group were compared to males in the H-optimistic group, statistical significance was found in the left Alns anterior insula. When older females in the L-optimistic group were compared to older females in the H-optimistic group, there was statistical significance in the right PLNS, right ALNS, left PLNS and left ALNS. Similarly, this comparison for older males only showed statistical significance in the left ALNS. Again, there was a significant difference in the right PLNS and right ALNS when comparing younger males.

What remains is to evaluate the SFG and right cerebellum regions, which are our intersection areas with the literature. Considering GM evaluations in terms of anatomical locations, males in the L-optimistic group were compared to males in the H-optimistic group, and significant differences were found in the right SFG. Similar results are valid for younger females as well. There was statistical significance in the right SFG and the right MSFG. This comparison for older males has only statistical significance in the right SFG. When we turn to WM evaluations regarding anatomical locations, there was a statistically significant difference in the right SFG in the H and L-optimistic group comparisons. This region shows a significant difference in males in the H- and L-optimistic groups and older females in the H- and L-optimistic groups. Concerning younger females, there was a statistically significant difference in the right SFG in addition to the left SFG. There was also a statistically significant difference in the right and left MSFG regions in this comparison. There was a statistically significant difference in the right SFG and right MSFG in older males. Furthermore, there was a statistically significant difference in the right cerebellum exterior when comparing younger females and older males in GM evaluations in terms of anatomical locations. Additionally, there was a statistically significant difference in the right cerebellum exterior between younger and older females and younger males in WM evaluations in terms of anatomical locations.

As a result of our detailed study, we can say that we found similar results to the literature. The most striking of these brain regions are the thalamus, amygdala, left insula, superior frontal gyrus, and right cerebellum, as mentioned in the literature. If we summarize what we found in the literature on optimism and our results, the studies in the following paragraphs are outstanding.

5. Conclusion

In summary, the study issue is quite dynamic, and future studies may lead to the establishment of more interconnections that create optimism. Based on the findings described in this study, it is safe to conclude that optimism is not a product of a single brain region. Rather than that, the GM, WM, CSF volumes of specific locations are critical, as is functional connectivity between distinct parts in producing optimism.

Due to the numerous health advantages associated with optimism, this research further establishes the importance of optimism for nonclinical individuals. This research advances our understanding of optimism and the factors that underpin it. It is thus critical for the advancement of treatment and therapy aimed at enhancing individuals' well-being.

The antithesis of an optimistic perspective on life - a pessimistic perspective – is related to a variety of depressed symptoms and negative future expectations. Identifying potential disparities in optimism and determining whether it connects with depressive symptoms in nonclinical persons may aid in the avoidance of health problems such as anxiety and depressive symptoms.

Unfortunately, we could not control whether there was a significant difference regarding age between the H-optimistic group and the L-optimistic group since only the age range of the experiment participants was given in the LEMON dataset. Additionally, the study can be made more reliable by increasing the number of participants.

On the other hand, during our literature review, the results of increased and decreased activity in some brain regions in studies using fMRI provided satisfactory answers. We regret to inform you that we used anatomical MRI for the VBM study. Apart from this, some studies have also found information such as GM volume increase. Because of the VBM, we were only able to detect whether there was a significant difference rather than observing the volume increase or decrease.

In this study, we performed an analysis using only the participants grouped according to the LOT-R test performed before the experiment, but this study can be re-evaluated by considering the optimistic bias and by designing the videos to be watched.

The study's novelty is its detailed VBM analysis of brain structures in relation to optimism and pessimism, specifically focusing on regions such as the thalamus, amygdala, left insula, superior frontal gyrus, and right cerebellum. Detailed VBM analysis identified statistically significant structural brain differences associated with optimism levels across different genders and age ranges, despite the lack of significant differences in initial comparisons between low and high optimists. This aids in comprehending the neurobiological basis of optimism and pessimism.

Author Contributions

The percentage of the author contributions is presented below. The author reviewed and approved the final version of the manuscript.

	P.O.
C	100
D	100
S	100
DCP	100
DAI	100
L	100
W	100
CR	100
SR	100
PM	100
FA	100

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The author declared that there is no conflict of interest.

Ethical Consideration

The research adhered to the guidelines set forth in the Declaration of Helsinki, and its methodology was granted approval by the ethics committee of the medical faculty at the University of Leipzig (reference number 154/13-ff). The recruitment and exclusion criteria have been outlined in previous studies (Oligschläger et al., 2016; Mendes et al., 2017; Golchert et al., 2017a; Golchert et al., 2017b; Babayan et al., 2019).

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