The association between the propensity to experience meaningful coincidence and brain anatomy in healthy females: The moderating role of coping skills

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ARTICLE INFO

Keywords:
Meaningful coincidence perception
Personality
Voxel-based morphometry
Fronto-parietal brain regions
Coping

ABSTRACT

When two events co-occur within a specific time interval, some people experience ‘meaningful coincidence’. This may be a consequence of the mind searching for causal structure in reality. In cases of negative events, it may be a coping strategy for managing stress. The present voxel-based morphometry (VBM) study investigated neural correlates of the propensity to experience meaningful coincidence (PEMC). VBM data from 115 females (mean age: 26 years) were correlated with self-reported PEMC and the use of certain coping strategies (e.g. seeking support, positive focusing). PEMC was negatively correlated with grey matter volume (GMV) in the medial prefrontal cortex, the inferior frontal gyrus, and the superior/inferior parietal cortex. Moderation analyses indicated that the negative association between GMV in the mentioned brain regions and PEMC was only present in participants with average or below-average coping skills. The identified fronto-parietal regions are part of an integrated neural network implicated in the detection of causality and cognitive control.

1. Introduction

You are called by a friend you were just thinking about, or a dream you had comes true. Are these coincidences pure chance, or do they have a special meaning? Random events often seem arbitrary and interfere with our need for logic and meaning. The resulting feelings of uncertainty and loss of control trigger us to find explanations for coincidence aside from randomness (Landsman & van Wolde, 2016). A series of experiments conducted by Whitson and Galinsky (2008) demonstrated that perceived loss of control is associated with illusory pattern perception, which is defined as identifying coherent and meaningful interrelationships among a set of random or unrelated stimuli. The authors used multiple methods to reduce personal control, which led the participants to perceive meaningful coincidence, such as seeing images in noise and illusory correlations in stock market information. The use of a coping strategy (self-affirmation) reduced the distressing experience of lacking control and the degree of illusory pattern perception.

Meaningful coincidence perception is not only influenced by situational factors (e.g., stress) but also has trait-like characteristics. People show marked and temporally stable individual differences concerning the frequency of meaningful coincidence perception in everyday life (Beitman, 2009; Bressan, 2002). Therefore, the propensity to experience meaningful coincidence (PEMC) can be considered a personality trait (Bressan, 2002). This trait is associated with other characteristics of a person. For example, in a study by Coleman, Beitman, and Celebi (2009), the frequency of meaningful coincidence perception was positively correlated with self-reports...
of spirituality and religious/spiritual coping (e.g., believing that God causes and speaks to us through meaningful coincidences). Russo-Netzer and Icekson (2020) also suggested that the detection of meaningful coincidence has a psychological coping function. According to the authors, meaning detecting in coincidence helps to experience coherence, purpose, and control in life. Similarly, Hladkyj (2001) has argued that the experience of meaningful coincidence arises from a desire for control and intolerance of ambiguity. Thus, there seems to be a close connection between PEMC and emotional coping, which can be functional (e.g., stress reduction) or dysfunctional (e.g., paranoid thinking, conspiracy theories; see Beitman, 2009).

In contrast to the research on psychological processes underlying PEMC, neural correlates of PEMC have not been analyzed. According to Johansen and Osman (2015) coincidences can be conceptualized in terms of being a psychological experience that is an inevitable consequence of the mind searching for causal structure in reality. In line with this concept, several neuroimaging studies have investigated how the brain tries to detect causal (meaningful) relationships between events (e.g., Fonlupt, 2003; Fugelsang, Roser, Corballis, Gazzaniga, & Dunbar, 2005; Han, Mao, Qin, Friederici, & Jianqua, 2011; Woods et al., 2014). One of the first neuroimaging studies on this topic focused on neural systems supporting the evaluation of mechanical causation (Fonlupt, 2003). The experimental task consisted of viewing two balls that moved across the computer screen with or without a collision of the balls. The participants had to judge the presence or absence of causation. They were asked: 'Did one ball cause the other ball to move? (causation judgment) or ‘In which direction did the ball move?’ (motion judgment; non-causal). Judgments of causality elicited increased activation in the medial prefrontal cortex (right and left superior frontal gyrus) compared to judgments of motion direction. The increase occurred in both the causal and non-causal conditions (collision vs. no collision), suggesting that the activation change was associated with the process of making a causal judgment. Fugelsang et al. (2005) used a similar experimental paradigm. They demonstrated that perceived causal violations (the ball did not collide with the other ball although this was expected) were associated with activation in the prefrontal cortex (i.e. right middle frontal gyrus) and in the parietal cortex (i.e. right inferior parietal cortex). A more recent investigation by Woods et al. (2014) also used the ‘two-ball-paradigm’ to identify specific patterns of activation correlated with spatial, temporal, and decision-making components of perception. The investigation consisted of two experiments with the same ‘two-ball-paradigm’, once with functional magnetic resonance imaging (fMRI) and once with transcranial direct-current brain stimulation (tDCS). The fMRI paradigm was used to identify brain areas (e.g., right inferior/superior parietal cortex, middle frontal gyrus) which then served as target regions for the tDCS approach. In the tDCS experiment, the parietal stimulation (right superior, posterior parietal cortex) decreased participants’ perception of causality based on spatial violations, while the frontal stimulation (bilateral inferior, middle, superior frontal gyri) made participants less likely to perceive causality based on violations of space and time. The authors concluded that the parietal areas contributed to the causal perception of spatial relations, while the selected frontal regions contributed to decision-making.

The present voxel-based morphometry (VBM) study used a correlational approach that focused on PEMC. Based on previous fMRI research on causality/relationship perception (Fonlupt, 2003; Fugelsang et al., 2005; Han et al., 2011; Woods et al., 2014), it was hypothesized that PEMC would be associated with grey matter volume in fronto-parietal brain areas (e.g., medial prefrontal cortex, parietal cortex). Because of the association between meaningful coincidence perception and religious/spiritual coping (Beitman, 2009), we assessed this type of coping and further coping strategies (e.g., acceptance, positive focusing) to correlate the use of these strategies with PEMC. Furthermore, we computed exploratory moderation analyses to quantify the effect of specific coping strategies (e.g., acceptance, positive focusing) on the association of PEMC and GMV in fronto-parietal brain areas. We investigated a female sample to reduce sex-related variance concerning brain morphology and coping styles.

2. Methods and materials

2.1. Participants

A total of 115 females (mean age = 26.3 years, SD = 9.7) participated in the present MRI study. They had been recruited through postings at the University and by directly approaching them at the campus (personal invitation). The majority of participants graduated from high-school (68%) and university (27%), the remaining participants were white-collar workers (5%; managerial or administrative work performed in an office).

Exclusion criteria were reported diagnoses of mental disorders, and neurological disorders because of the association with altered brain volume. MRI incompatible conditions (e.g., pregnancy, metal implants) also led to exclusion from the study. We decided to study an exclusively female sample to reduce sex-related variance concerning brain morphology, and coping styles. Several brain areas appear to be sexually differentiated (e.g. Liu, Seidlitz, Blumenthal, Clasen, & Raznahan, 2020), and males and females prefer different coping strategies. For example, females use emotional coping and social support seeking more often than males (Melendez, Mayordo-Rodríguez, Sancho, & Tomás, 2012).

After a full explanation of the testing procedure, all participants provided written informed consent. The study was conducted following the declaration of Helsinki and had been approved by the ethics committee of the university. Participants did not receive financial compensation for participation.

2.2. Materials

The participants completed the following questionnaires:
(a) The Coincidence Questionnaire (CQ; Bressan, 2002) measures how often individuals experience meaningful coincidence in their daily lives (e.g., ‘Thinking of someone and running unexpectedly into that person soon afterward’; ‘Having a dream that comes true’). The scale consists of 8 items (with a Cronbach’s alpha of 0.77 in the present sample). Response categories are 1 (never), 2 (once or twice), 3 (a few times), 4 (several times), and 5 (very often). A sum score (total CQ score) is computed with possible values ranging between 8 and 40. High values indicate a high propensity to experience meaningful coincidence (PEMC).

The second part of the questionnaire lists seven possible explanations for coincidences: 1) pure chance (e.g., ‘pure luck’), 2) destiny, 3) intervention of God, 4) intuition (e.g. ‘inner sensing’), 5) extra-sensory perception, 6) a physical concept not yet discovered, 7) all-connectedness in the universe. This part of the CQ uses a dichotomous answer format. Respondents indicate whether they believe that coincidences occur for the reasons listed (1 = yes; 0 = no). We computed the percentage of yes-answers for each item across the total sample.

The CQ has been validated with neuroscientific methods (Rominger et al., 2019).

(b) The Brief-COPE (‘Coping Orientation to Problems Experienced’; German version by Knoll, Rieckmann, & Schwarzer, 2005) assesses coping strategies with a total of 28 items. The four subscales are: Focus on Positive (acceptance, positive reframing, humor; e.g., ‘I’ve been accepting the reality of the fact that it has happened’, ‘I made jokes about it’; Cronbach’s alpha = 0.78), Support Coping (instrumental support, emotional support, religion; e.g., ‘I prayed or meditated’, ‘I asked other people for help and advice’; \( \alpha = 0.71 \)), Active Coping (active coping and planning; e.g., ‘I tried to come up with a plan for what I can do’; \( \alpha = 0.69 \)), and Evasive Coping (self-blame, denial, venting; e.g., ‘I criticized and blamed myself’; \( \alpha = 0.58 \)). The items are answered with a four-level response format (1 = not at all; 4 = very much). Two COPE items specifically address spiritual/religious coping (‘I’ve been trying to find comfort in my religion or spiritual beliefs; I’ve been praying or meditating’). The subscale Evasive Coping was not included in the analysis because of insufficient reliability.

The German version of the Brief-COPE is based on the COPE Inventory (brief version) created by Carver (1997). The COPE, which has been translated into many languages, is one of the most widely used measures to assess coping strategies.

The conducted sensitivity analysis (G*Power; Faul, Erdfelder, Lang, & Buchner, 2007) indicated that with a sample size of \( n = 110 \) and a power of 80% small effects (>0.26) can be detected.

2.3. Procedure and analyses

2.3.1. MRI recording

The MRI session was conducted with a 3 T scanner (Skyra, Siemens, Erlangen, Germany) with a 32-channel head coil. Structural images were obtained using a T1-weighted MPRAGE sequence (voxel size: 0.9 \( \times \) 0.9 \( \times \) 0.9 mm; 192 transverse slices, FoV = 224 mm, TE = 1.88 ms, TR = 1680 ms, TI = 1000 ms, flip-angle = 8°). The structural scans were analyzed with Matlab (v8.6) and the Computational Anatomy Toolbox (CAT12; v1450; http://www.neuro.uni-jena.de/cat/) implemented in SPM12 (v7487; Wellcome Trust Centre for Neuroimaging; http://www.fil.ion.ucl.ac.uk/spm/software/spm12/) to gain voxel-wise comparisons of grey matter volume (GMV).

Structural data were segmented into grey matter, white matter, and cerebrospinal fluid. Spatial registration of grey matter images was carried out by using the optimized shooting approach (Ashburner & Friston, 2011). To preserve the total amount of grey matter, signal images were modulated. The final resulting voxel size was 1.5 \( \times \) 1.5 \( \times \) 1.5 mm. Segmented grey matter images were smoothed with a Gaussian kernel with a full width at half maximum (FWHM) of 8 mm. Finally, only voxels with a grey matter volume of at least 0.1 were analyzed (absolute threshold).

2.3.2. Voxel-based morphometry analysis

We conducted region of interest (ROI) analyses. Based on previous research on causality/relationship perception (Fonlupt, 2003; Fugelsang et al., 2005; Han et al., 2011; Woods et al., 2014), we selected the following ROIs: a) the medial prefrontal cortex (mPFC: a combination of the paracingulate gyrus, anterior cingulate gyrus, and superior frontal gyrus; see Jahn, Nee, Alexander, & Brown, 2016; L: 10,840 voxels, R: 14,312 voxels), b) the superior/ inferior parietal cortex (SIPC: a combination of the inferior parietal lobe (IPL; anterior/posterior supramarginal and angular gyrus) and superior parietal lobe; L: 10,544 voxels, R: 11,480 voxels), and c) the inferior frontal gyrus (IFG; a combination of the pars opercularis and pars triangularis, L: 3104 voxels, R: 2640 voxels).

We used masks with a 25% threshold derived from the Harvard–Oxford cortical structural atlas center for morphometric analysis, MGH-East, Boston/MA, USA). The masks were resliced to a voxel size of 1.5 \( \times \) 1.5 \( \times \) 1.5 mm with nearest-neighbor interpolation. The initial cluster building threshold was set to 0.001 uncorrected. For all analyses, results were small-volume corrected and considered significant if the peak-level statistic was below \( p < .05 \), corrected for family-wise error (FWE; only the highest peaks are reported). To correct for differences in brain size, the total intracranial volume (TIV) was implemented as a covariate. Age was used as an additional covariate because of the relatively high standard deviation.

2.3.3. Statistical analyses

For the self-report variables (CQ, COPE), Pearson correlations were performed. For the GMV data, multiple regression analyses were computed. First, associations between the CQ and GMV were investigated. The GLM consisted of four regressors (mean, CQ, TIV, age). Second, separate regression analyses were performed to investigate the association between the COPE scales ‘Positive Focusing’,
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Support Coping’, ‘Active Coping’, and GMV. The GLM consisted of four regressors (mean, respective COPE scale, TIV, age). Assumptions for all conducted linear models were met (e.g., normality of residuals, homoscedasticity).

Furthermore, we computed exploratory moderation analyses to quantify the effect of coping strategies on the association of PEMC and GMV in fronto-parietal brain areas. GMV clusters associated with the centered CQ scores (left IFG, left mPFC, left SIPC) were extracted and forwarded for the moderation analyses into the ‘medmod’ package implemented in the free statistical software ‘jamovi’ (version: 1.6.0.0; https://www.jamovi.org/). Results of the moderation analyses were corrected for multiple testing using the Benjamini-Hochberg procedure (Benjamini & Hochberg, 1995).

3. Results

3.1. Self-report data

Descriptive statistics for the questionnaires and correlations are displayed in Table 1. Significant associations were found between the CQ and two subscales of the COPE, ‘Focus on Positive’ and ‘Support Coping’. The COPE items addressing spiritual/religious coping were positively correlated with the CQ (comfort through religion or spiritual beliefs: $r = 0.44$; praying/meditating: $r = 0.43$).

The coincidence of events was attributed to different causes. Of the participants, 77% attributed coincidence with intuition, 58% with destiny, 56% with the all-connectedness in the universe, 49% with pure chance, 29% with extra-sensory perception, 22% with divine intervention, and 14% with a physical concept not yet discovered. The majority of participants attributed the coincidence of events to three different causes ($x_{\text{Mod}} = 3$).

3.2. VBM results

3.2.1. Results of the regression analyses

Results for the regression of CQ on GMV are displayed in Table 2 and Fig. 1. The propensity to experience meaningful coincidence (CQ score) correlated negatively with GMV in the left medial prefrontal cortex (mPFC peak: paracingulate gyrus), the left inferior frontal gyrus (IFG peak: pars opercularis), and the left superior/inferior parietal cortex (SIPC peak: inferior parietal lobe). Non-significant ROI findings are provided in supplementary Table S1.

‘Support Coping’ correlated negatively with grey matter volume in the left IFG (peak: pars triangularis) and the left SIPC (peak: inferior parietal lobe). ‘Focus on Positive’ correlated negatively with left IFG volume (peak: triangularis: see Table 2).

3.2.2. Results of the moderation analyses

The results of the moderation analyses (see Table 3) indicated that the negative associations between GMV in the fronto-parietal ROIs and the CQ were only present in participants with average or below-average coping skills concerning ‘Support Coping’ and ‘Positive focusing’.

4. Discussion

The present VBM study revealed that the propensity to experience meaningful coincidence (PEMC) was negatively correlated with grey matter volume (GMV) in the medial prefrontal cortex (mPFC), the inferior frontal gyrus (IFG), and the superior/inferior parietal cortex (SIPC) in females with average or below-average coping skills.

The mPFC has a wide variety of cognitive and emotional functions, which are based on its reciprocal connections with brain regions that are implicated in memory (hippocampus, dorsolateral prefrontal cortex), affective processing (amygdala), and higher-order sensory functions (e.g., parietal cortex). According to the model by Wood and Grafman (2003), the mPFC holds representations of event sequences that have predictable relationships with sensorimotor processes. The mPFC contains neural representations of goal-oriented sets of events that are structured in sequence and represent thematic knowledge, abstractions, and social-moral concepts. Thus, the mPFC stores task-specific rules and goals. As a consequence, the mPFC is involved in processes related to decision-making and top-down control over behavior and executive functions (e.g., Heekeren, Marrett, & Ungerleider, 2008).

The mPFC peak identified in the present investigation was located in the paracingulate gyrus, the anterior dorsal region of the cingulate cortex. Research that focused on the anterior cingulate cortex (ACC), particularly on the more dorsal portions, identified attentional control, updating of predictive models in changing contexts, and allocation of control based on expected reward as central functions.

| Table 1 | Descriptive statistics (means, standard deviations) and Pearson correlations. |
|---|---|---|---|---|
| | M (SD; range) | r (p) | 1 | 2 | 3 |
| 1. CQ | 21.80 (5.08; 10–34) | | | | |
| 2. COPE_Positive | 2.64 (0.63; 1.17–4) | 0.30 (<0.001) | | | |
| 3. COPE_Support | 2.64 (0.59; 1–4) | 0.48 (<0.001) | 0.27 (0.003) | | |
| 4. COPE_Active | 3.18 (0.52; 2–4) | 0.15 (0.110) | 0.40 (<0.001) | 0.36 (<0.001) | |

Footnote: CQ: coincidence questionnaire; COPE: Coping Orientation to Problems Experienced.
functions of this region (for a summary see Ebitz & Hayden, 2016). Moreover, self-control and strategic decisions have been associated with the dorsal part of the ACC (Heilbronner & Hayden, 2016). Additionally, the inferior frontal cortex plays an important role in decision-making, category selection, and response modulation (Heekeren et al., 2008; Woods et al., 2014).

The mentioned cognitive processes are mediated by the interaction of prefrontal regions (mPFC/dorsal ACC, IFG) with the parietal cortex. The identified peak in the present investigation was located in the inferior parietal lobule (IPL). Several neuroimaging studies have linked the IPL to causality attribution (e.g., Woods et al., 2014; Han et al., 2011; Blakemore et al., 2001). In each of the mentioned studies, activation of the IPL was detected during causality judgments.

Table 2
Association between the propensity to experience meaningful coincidence, coping strategies, and grey matter volume in regions of interest.

| Region of interest (peak)                  | H  | x   | y   | z   | t    | p(FWE) | CS  |
|-------------------------------------------|----|-----|-----|-----|------|--------|-----|
| Coincidence Questionnaire (CQ)            |    |     |     |     |      |        |     |
| IFG (opercularis)                         | (-)| L   | -50 | 20  | 15   | 3.33   | 0.052| 49  |
| mPFC (paracingulate)                      | (-)| L   | -9  | 54  | 8    | 4.03   | 0.023| 76  |
| SIPC (inferior parietal)                  | (-)| L   | -63 | -35 | -44  | 4.21   | 0.012| 376 |
| COPE Positive Focusing                    |    |     |     |     |      |        |     |
| IFG (triangularis)                        | (-)| L   | -50 | 30  | -8   | 3.49   | 0.034| 26  |
| COPE Support                              |    |     |     |     |      |        |     |
| IFG (triangularis)                        | (-)| L   | -46 | 16  | -2   | 3.61   | 0.025| 29  |
| SIPC (inferior parietal)                  | (-)| L   | -57 | -33 | 38   | 4.05   | 0.019| 495 |

Footnote: COPE: Coping Orientation to Problems Experienced; IFG (inferior frontal gyrus), mPFC (medial prefrontal cortex); SIPC (superior/inferior parietal cortex); H: hemisphere (left/right); MNI coordinates x,y,z; p FWE (p-value corrected for family-wise error); CS: cluster size (number of voxels); labels in parentheses represent voxel-peaks.

Fig. 1. Regression of propensity to experience meaningful coincidence on grey matter volume in the left medial prefrontal cortex (mPFC), left inferior frontal gyrus (IFG) and left superior/inferior parietal cortex (SIPC) Footnote: Results are small volume-corrected; threshold: p = .024.
The fronto-parietal network enables behavior to be guided by internal representations. It is crucial for the learning of causal relations, rules, and thus cognitive control (Ostlund & Balleine, 2005; Wolpert, Goodbody, & Husain, 1998). Moreover, mPFC volume has been linked with emotion regulation skills and stress habituation (Moreno-Lopez, 2020). A large study (Jensen et al., 2015) with 494 participants reported reductions in mPFC volume in stress-resilient adults. In a VBM study by Schienle, Hofler, and Wabnegger (2020), religious coping (the belief that divine interventions can improve one’s wellbeing and can cure disease) correlated negatively with mPFC volume. The mentioned findings indicate an association between the ability to cope with stressful life events and GMV in the mPFC.

In the present investigation, PEMC was correlated with two coping strategies: positive focusing and support coping. High PEMC was associated with seeking help from other people and/or supernatural powers (e.g., God). This finding replicates previous research. Coleman et al. (2009) also observed a positive correlation between religious/spiritual coping and PEMC.

The association between PEMC and brain volume in prefrontal and inferior parietal regions (mPFC, IFG, SIPC) was moderated by the coping strategies ‘positive focusing’ and ‘support seeking’. Only those participants who reported average or below-average coping skills showed a significant negative correlation between PEMC and ROI volume. An fMRI study by Straube and Chatterjee (2010) also revealed individual differences in judging (non/causal) relationships that were associated with distinct neural signatures. Participants differed in their sensitivity to spatial and temporal characteristics of events when perceiving causality. Only those participants who predominantly relied on spatial cues (instead of temporal cues) showed inferior parietal activation during causality perception. In a somewhat similar way, a high vs. low degree of a specific coping skill (e.g. positive focusing) influenced the neural signature of PEMC. Future studies now need to further elucidate these conditional effects, in particular when meaningful coincidence perception helps to deal with stressful life events. Neural correlates, such as the mPFC implicated in stress reactivity and resilience might be a region of special interest within this context (see Moreno-Lopez, 2020; Jensen et al., 2015).

We need to mention the following limitations of the present research. We only studied female participants; therefore, our results cannot be generalized to men. The assessment of meaningful coincidence perception was based on the CQ (Bressan, 2002). Future

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### Table 3

Results of the moderation analyses.

| Conditional Effects of CQ on mPFC volume | Interaction: CQ X Positive Focusing | Z     | β    | p    |
|----------------------------------------|------------------------------------|-------|------|------|
| Moderator: Positive Focusing           |                                    |       |      |      |
| Simple Slope Analysis                  |                                    |       |      |      |
| M – 1SD                                |                                    | 2.15  | 0.004| 0.032*|
| M                                      |                                    | –3.72 | –0.006| <0.001|
| M + 1SD                                |                                    | –3.43 | –0.004| <0.001|
| Moderator: Support Coping              |                                    |       |      |      |
| Interaction: CQ X Support Coping       |                                    | 1.98  | 0.003| 0.048|
| Simple Slope Analysis                  |                                    |       |      |      |
| M – 1SD                                |                                    | –3.56 | –0.005| <0.001|
| M                                      |                                    | –2.98 | –0.003| 0.003|
| M + 1SD                                |                                    | –0.93 | –0.001| 0.352|

### Conditional Effects of CQ on IFG volume

| Moderator: Support Coping              |                                    |       |      |      |
| Interaction: CQ X Support Coping       |                                    | 2.09  | 0.003| 0.036*|
| Simple Slope Analysis                  |                                    |       |      |      |
| M – 1SD                                |                                    | –3.54 | –0.005| <0.001|
| M                                      |                                    | –2.86 | –0.003| 0.004|
| M + 1SD                                |                                    | –0.77 | –0.001| 0.444|

### Conditional Effects of CQ on SIPC volume

| Moderator: Support Coping              |                                    |       |      |      |
| Interaction: CQ X Support Coping       |                                    | 3.15  | 0.0038| 0.002*|
| Simple Slope Analysis                  |                                    |       |      |      |
| M – 1SD                                |                                    | –4.13 | –0.004| <0.001|
| M                                      |                                    | –2.75 | –0.002| 0.006|
| M + 1SD                                |                                    | –0.40 | –0.001| 0.972|

| Moderator: Positive Focusing           |                                    |       |      |      |
| Interaction: CQ X Positive Focusing    |                                    | 2.23  | 0.003| 0.026*|
| Simple Slope Analysis                  |                                    |       |      |      |
| M – 1SD                                |                                    | –4.04 | –0.0050| <0.001|
| M                                      |                                    | –3.83 | –0.0031| <0.001|
| M + 1SD                                |                                    | –1.15 | –0.001| 0.249|

Footnote: M: mean; SD: standard deviation; CQ: Coincidence Questionnaire; mPFC: medial prefrontal cortex; IFG: inferior frontal gyrus; SIPC: superior/inferior parietal cortex; * significant with Benjamini-Hochberg correction (false discovery rate = 5%).
research should also include alternative inventories to capture similar or related phenotypes of PEMC. One of these associated concepts is a ‘sense of coherence’ (Antonovsky, 1987), which involves three main components: comprehensibility (the degree of understanding of internal/external stimuli), manageability (availability of resources to manage the stimuli), and meaningfulness (the extent to which we feel that our lives have some kind of emotional meaning). Finally, even though the present findings provide insight into the neural basis of PEMC, results do not provide causal directions. Therefore, a longitudinal approach is needed.

5. Conclusion

This VBM study demonstrated that the propensity to experience meaningful coincidence is associated with grey matter volume in fronto-parietal brain regions in females. This association was moderated by the use of certain coping strategies (positive focusing and seeking support).

CRediT authorship contribution statement

Isabella Unger: Writing - original draft, Data curation, Formal analysis. Albert Wabnegger: Data analysis, Writing - review & editing. Anne Schienle: Conceptualization, Writing - review & editing.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.concog.2021.103132.

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