Coping During COVID-19: Uncovering the Relationship between Executive Control, Amygdala Reactivity and Coping in Psychiatric Patients

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Abstract:

The ability to successfully cope with stressful experiences is an important predictor of resilience and mental health outcomes. Therefore, when confronted with stressors such as the COVID-19 pandemic, coping represents an essential skill for individuals with psychiatric disorders. Psychiatric patients commonly demonstrate deficits in executive control (EC) and increased reactivity of the amygdala to emotional information, which might separately or jointly compromise their coping abilities. However, particularly in light of psychiatric comorbidity, the relationship between EC, amygdala reactivity, and coping in psychiatric patients remains unclear. Therefore, in a naturalistic cohort of psychiatric patients ($N = 88$) and a healthy control group ($N = 49$), we examined the association between EC and coping in daily life and in response to the COVID-19 pandemic. Additionally, we explored whether this relation was mediated by amygdala reactivity to emotional information on a neural level. Using a self-report measure of EC and a spatial working memory (SWM) task, we found that only subjective EC was associated with a higher positive appraisal style and positive reappraisal of the COVID-19 pandemic across patients and controls. Moreover, while discovering as association between SWM performance and right amygdala reactivity, the relation between EC and coping was not mediated by amygdala reactivity. Therefore, further research exploring how EC and amygdala reactivity tie into coping is required. These findings underscore the relevance of subjective EC deficits as a transdiagnostic predictor of coping and reappraisal skills. Targeting EC deficits and reappraisal skills could represent promising pathways to increasing resilience across psychiatric disorders in the future.

Keywords: coping, resilience, executive control, amygdala reactivity, psychiatry, COVID-19

1. Introduction

The outbreak of the COVID-19 pandemic in 2020 marked the beginning of a stressful time for people around the world. In the face of adversity, the ability to successfully cope with the accompanying challenges of the pandemic is an essential skill contributing to and maintaining well-being both in the healthy population and in vulnerable groups. Therefore, a better understanding of the cognitive and neural mechanisms underlying coping will allow for a better preparation and guidance of both vulnerable and non-vulnerable groups alike during stressful situations.

Coping describes a variety of cognitive and behavioral strategies that are employed to deal with stressful situations (American Psychological Association, n.d.). While there are numerous approaches to categorizing coping strategies, some of the most commonly referred to coping styles include problem- and emotion-focused coping, approach and avoidance/disengagement coping, and primary and secondary control coping (see e.g. in Morris et al., 2015; Nieto et al., 2020; O'Rourke et al., 2020). Several studies have established a link between the use of these different coping styles and mental health outcomes, particularly in relation to stress-related disorders which encompass mood and anxiety disorders. Whereas the use of disengagement/avoidance coping has been shown to predict an increase in depressive symptoms and anxiety, greater use of approach coping and secondary control coping has been linked to a decrease in depressive symptomatology in individuals without a current psychiatric diagnosis (Morris et al., 2015; Nieto et al., 2020; O'Rourke, 2020; Radin et al., 2021). In line with that, previous findings have demonstrated that the tendency to use different coping styles is further associated with variance in resilience. Resilience itself is defined as "the process and outcome of successfully adapting to difficult or challenging life experiences" (American Psychological Association, n.d.). and has, accordingly, been associated with decreased psychiatric symptomatology as well as improved mental well-being (Gloria & Steinhardt, 2016; Leipold & Greve, 2009; Min et al., 2013). The employment of adaptive coping styles, such as task-oriented coping, have been linked to increased resilience, while less sustainable coping styles, such as emotion-focused coping, may impair resilience (Campell-Sills et al., 2006; Gloria & Steinhardt, 2016).

The concept of resilience has received further attention in light of the COVID-19 pandemic. In a recent study, resilience was shown to partially mediate the relation between pandemic-related stress and depression- and anxiety-related psychopathology, confirming that it acts as a buffer against mental health problems (Kumar et al., 2022). Higher resilience during the COVID-19 pandemic has further been associated with the extent to which individuals typically exhibit a positive appraisal style of adverse events and the pandemic (Veer et al., 2021). By using reappraisal as a coping mechanism, an individual actively reframes the meaning of a negative situation in order to adjust their emotional response to it (Gross, 1998; Nowlan et al., 2015). Consistent with the findings by Veer and colleagues, reappraisal interventions have been shown to reduce negative and to increase positive emotionality (Nowlan et al., 2015; Troy et al., 2010). Altogether, these findings indicate that adaptive coping strategies are fundamental to resilience and thereby mental well-being. To that end, it is essential to identify the factors that affect coping across the psychopathological continuum.

One factor that was found to have a substantial impact on coping is executive control (EC). Several studies have reported an association between the use of different coping styles and the level of functioning in various EC domains. Lower levels of EC, including deficits in inhibition, working memory (WM), planning, and global EC, have been associated with the use of less active and more avoidance/disengagement coping in individuals without a current psychiatric diagnosis (Grech et al., 2017; Nieto et al., 2020; O'Rourke et al., 2020; Rakers et al., 2018). This was the case for both performance-based and self-report measures of EC. WM deficits, next to poorer flexibility and inhibitory control, have further been linked to the use of more emotion-focused coping (O'Rourke et al., 2020). A greater WM capacity, on the contrary, has been associated with the use of secondary control coping, reappraisal ability, and overall increased emotion regulation abilities (Andreotti et al., 2013; Garrison & Schmeichel, 2022; McRae et al., 2012; Schmeichel et al., 2008). Interestingly, Zaehringer and colleagues (2018) reported a negative association between WM, cognitive flexibility and prefrontal cortex (PFC) activity during reappraisal, indicating that individuals with higher levels of EC require less neural resources to downregulate negative emotions. Thus, they demonstrate more efficient emotion regulation not only on a behavioral, but also on a neural level.

Taken together, these findings indicate that the level of EC is related to the use of different coping strategies, where impaired EC is associated with maladaptive coping styles and therefore decreased resilience. This is especially relevant for individuals who suffer from psychiatric problems, as EC deficits are common across psychiatric disorders and oftentimes persist after remission (Rock et al., 2014; Sweeney et al., 2000; Weiland-Fielder et al., 2004). Potentially, prevailing EC deficits might compromise the ability to cope with stressful situations and thereby contribute to the maintenance or deterioration of psychiatric disorders (Nieto et al., 2020).

Beyond that, psychiatric populations might be more vulnerable to the impact of acute stressful situations as a consequence of altered stress reactivity. One global indicator for this is the level of amygdala reactivity, which signifies sensitivity of the amygdala in response to emotional information. Alterations in amygdala reactivity are strongly linked to psychiatric symptomatology and are commonly observed in a wide range of psychiatric disorders, including mood, anxiety, and neurodevelopmental disorders (Brotman et al., 2010; Fitzgerald et al., 2017; Viering et al., 2021). Increased and sustained reactivity of the amygdala, in particular, is robustly linked to depression and anxiety. Accordingly, it is considered a risk factor for psychological problems (Hyde et al., 2011; Mandell et al., 2014; Siegle et al., 2007).

Based on its critical involvement in emotional processing and regulation of the stress response (Phelps & LeDoux, 2005; Roozendaal et al., 2009), it seems likely that the amygdala is further implicated in modifying coping responses in stressful situations. However, evidence for the impact of amygdala reactivity on coping is still sparse. Thus far, a study by Drabant and colleagues (2009) reported a relation between greater reappraisal use in everyday life and decreased amygdala reactivity while processing negative social stimuli (Drabant et al., 2009). Additionally, a recent meta-analysis described significant deactivation of certain amygdala clusters while engaged in cognitive reappraisal, which suggests that successful reappraisal relies on downregulation of the amygdala (de Voogd & Hermans, 2022).

Notably, the authors reported a similar deactivation of amygdala clusters during a WM task that partly overlap with the clusters found to be downregulated during reappraisal (de Voogd & Hermans, 2022). Lending further support to the presence of a link between the amygdala and WM, higher WM performance has been associated with lower task-related amygdala activation (West et al., 2021). Moreover, patients with lesions in the basolateral amygdala have been shown to demonstrate higher WM performance than healthy controls (Morgan et al., 2012). Collectively, these findings indicate that successful WM performance relies on decreased activity of the amygdala.

Further evidence supports the presence of a similar link between EC and amygdala reactivity to emotional information, specifically. Firstly, EC training has been found to alter prefrontal-amygdala connectivity and to reduce amygdala reactivity to aversive information (Cohen et al., 2016). Moreover, it has been shown that WM and amygdala reactivity are both altered in patients with Borderline personality disorder while in a state of dissociation, indicating the presence of shared processes (Krause-Utz et al., 2018). Lastly, it has been demonstrated that event-related amygdala reactivity is predictive of subsequent WM performance, depending on the WM load (Schaefer et al., 2006). These results point towards a potential bidirectional relation between the level of amygdala reactivity and EC performance. Thus, it seems likely that amygdala reactivity and EC are not merely independently related to coping but might also have an interdependent effect.

This notion is in line with a general competition between top-down and bottom-up cognitive control processes, during which prefrontal executive control networks and the amygdala compete for neural resources (Morgan et al., 2012). In the context of psychiatry, EC deficits are commonly linked to alterations in PFC functioning. For instance, the presence of depressive and anxiety-related symptomatology has consistently been associated with hypoactivity and inefficiency of the dorsolateral prefrontal cortex (DLPFC) during cognitive tasks and rest (Fales et al., 2009; Koenigs & Grafman, 2009; Nejati et al., 2021; Pizzagalli & Roberts, 2022). Compromised PFC functioning might not only impair EC performance, but additionally result in the increased allocation of neural resources to the processing of emotional information in the amygdala. Both pathways could individually and jointly impair coping and thereby negatively affect resilience and mental health.

However, to date, the role of amygdala reactivity in the link between EC and coping has not been explored, particularly in the context of psychiatric comorbidity and environmental challenges. The COVID-19 pandemic, in this regard, offers a rare opportunity to assess coping in response to a collectively experienced and naturalistic environmental stressor. Given their potential transdiagnostic relevance, understanding the relation between EC, amygdala reactivity and coping could not only expand our foundational knowledge about the factors predictive of coping, but further have meaningful implications for clinical practice. Therefore, this study firstly aimed to assess whether there is a relation between performance-based and subjective executive control and coping in a naturalistic cohort of psychiatric patients and healthy controls. Establishing a transdiagnostic link between EC and coping could, prospectively, offer the possibility to target individual EC deficits as a strategy to improve coping. We were specifically interested in the use of positive behavioral coping strategies and reappraisal during everyday life and in response to the COVID-19 pandemic. Secondly, we explored whether the relation between executive control and coping is affected by amygdala reactivity on a neural level.

Based on findings demonstrating that higher levels of EC are linked to the use of more active coping strategies, as well as to more efficient emotion regulation and cognitive reappraisal, we predicted a negative association between executive dysfunction and the use of behavioral coping strategies and reappraisal. With regards to our second aim, we hypothesized a mediating effect of amygdala reactivity on the association between EC and coping. Given that EC deficits might be indicative of reduced prefrontal capacity, we expected to observe a positive association between executive dysfunction and amygdala reactivity, showing that individuals with EC impairments display increased amygdala reactivity to emotional information. Since this increased reactivity, in turn, is likely to interfere with coping, we further expected a negative association between amygdala reactivity and positive coping and reappraisal use.

2. Methods

This study uses data from the *Measuring Integrated Novel Dimensions* (MIND-Set) psychiatric cohort study that was initiated by the Department of Psychiatry of the Radboud university medical center (Radboudumc) and the Donders Institute in Nijmegen, the Netherlands (van Eijndhoven et al., 2022). Initial data collection (baseline, T0) started in 2016 as a cross-sectional study and included questionnaires assessing demographics and symptomatology, behavioral tasks, neuropsychological tests, and the collection of biometric material and neuroimaging measures (van Eijndhoven et al., 2022). With the surge of the COVID-19 pandemic in 2020, participants were approached for an online follow-up study which included additional questionnaires tailored to assess effects of and behaviors in response to the pandemic between August 2020 and July 2021. In this study, we focused on data from both T0 and the first out of four follow-up assessments (T1).

2.1 Participants

The participant sample consisted of 88 patients of the psychiatric outpatient clinic of the Radboudumc Nijmegen and 49 healthy matched controls (see Table S1 in supplementary materials). Patients were eligible for inclusion if they were clinically diagnosed with at least one stress-related (mood and/or anxiety disorders) or neurodevelopmental disorder (Attention-Deficit/Hyperactivity Disorder [ADHD] and/or Autism Spectrum Disorder [ASD]). Mood and anxiety disorders were diagnosed using the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I/P). Presence of a neurodevelopmental disorder was indicated based on the Adult Self-Report Scale (ASRS) and the Autism Quotient (AQ-50), and confirmed in a subsequent structured diagnostic interview with the Dutch Interview for the Diagnosis of ASD in adults (NIDA) and/or the Diagnostic Interview for ADHD for Adults (DIVA). As all measurement instruments were administered in Dutch, an adequate command of the Dutch language was a prerequisite for participation (see van Eijndhoven et al. 2022 for more detailed information on inclusion and exclusion criteria).

Based on their respective diagnoses, the patient group could be divided into three diagnostic groups. The stress-related disorder (SD) group included patients diagnosed with at least one anxiety and/or mood disorder and potential comorbid addiction ($N = 42$). The neurodevelopmental (ND) group included patients with a diagnosis of ADHD and/or ASD in the absence of any other psychiatric condition ($N = 9$). Lastly, patients that were diagnosed with at least one stress-related and one neurodevelopmental disorder were included in the comorbid (CM) group ($N = 36$).

Independent samples t-tests for continuous variables and chi-square tests of independence for categorical variables were conducted to determine whether there were significant demographic differences between the patient and the control group.

2.2 Materials – T0

2.2.1 Inventory of Depressive Symptomatology – Self-Report (IDS-SR)

The IDS-SR is a self-report questionnaire to assess depressive symptomatology over the past two weeks (Rush et al., 1986). It consists of 28 constant and two optional items that are rated on a 4-point Likert scale scored from 0-3, with a higher rating indicating increased symptom severity. The respective scores are added up to yield a total score ranging between 0-78. The level of depressive symptom severity is determined based on cut-off scores (0-13 = *none*, 14-25 = *mild*, 26-38 = *moderate*, 39-48 = *severe*, 49 and more = *very severe*). The IDS-SR has good internal consistency, with a Cronbach's alpha of 0.85 (Rush et al., 1986).

2.2.2. Spatial Working Memory (SWM)

Since the most consistent relation between an EC subdomain and coping has been reported with regards to WM, we chose a spatial working memory (SWM) task from the Cambridge Neuropsychological Test Automated Battery (CANTAB) as a performance-based measure of EC. This task has the advantage that it is not confounded by affective information, which allowed us to explore the link between a relatively pure measure of WM and coping. The SWM test is a self-ordered task that assesses the ability to maintain and manipulate visuospatial information in working memory (Cambridge Cognition, n.d.). On a touch screen, participants were presented with colored boxes. They were instructed to open and retrieve differently colored tokens from the boxes and to move them to a column on the right side of the screen. Participants were explicitly instructed not to return to a box from which a token had already been retrieved. Once all of the tokens had been obtained, a new trial with a different problem started. The number of boxes, and accordingly the task difficulty, increased gradually up until eight boxes were presented. Color and position of the boxes changed from trial to trial.

We focused on two key outcome measures that are commonly used as indices of WM capacity and executive control: *Between Errors* indicate the number of times a box from which a token has previously been retrieved is revisited within the same problem. Scores from each problem are summed up to yield a total Between Error score, with higher scores indicating decreased WM capacity. The *Strategy* score measures how often distinct boxes are chosen to begin a new search within the same problem. With an efficient search strategy, the participant should always follow a predetermined search sequence and start at a specific box. Therefore, higher scores indicate a less efficient search strategy and decreased executive control. Strategy scores are obtained for problems with six or eight times only and are summed up to yield a total strategy score (Cambridge Cognition, n.d.).

2.2.3 Behavior Rating Inventory of Executive Function–Adult Version (BRIEF-A)

The self-report version of the BRIEF-A is a standardized measure to assess executive functioning in adults. Participants were asked to indicate how frequently they had experienced executive problems during their daily lives (e.g. “I have trouble making decisions”) within the past month on a 3-point Likert scale (1 = *never* to 3 = *often*). From a total of 75 items, nine non-overlapping clinical scales are derived that form two broader indices: the *Behavioral Regulation Index* (BRI, comprising the scales Inhibit, Shift, Self-monitor and Emotional Control; range: 30 - 90), and a *Metacognition Index* (MI, comprising the scales Plan/Organize, Initiate, Task Monitor, Working Memory, and Organization of Materials; range: 40 - 120). These indices, in turn, are combined into a summed *Global Executive Composite* (GEC; range: 70 - 210). Furthermore, three validity scales are included to detect inconsistencies in the participant’s response style (negativity, infrequency, inconsistency). Based on a large normative sample, standardized T-scores for each of the scales, indices, and the composite score can be derived from the raw scores. Higher scores on all scales indicate greater difficulties and therefore increased executive dysfunction (Roth et al., 2005; Scholte & Noens, 2011). Internal consistency coefficients of the BRIEF-A range between 0.70 and 0.89 for the clinical scales, and 0.96 for the global GEC score. All scales have a test-retest reliability of 0.70 and higher (Scholte & Noens, 2011).

2.2.4 Emotional Face Processing Task

The emotional face matching task was conducted during an MRI scanning session to assess the sensitivity of the amygdala in response to negative emotional information. The paradigm was developed by Hariri and colleagues in 2002 and has been shown to reliably elicit amygdala activity (Ahs et al., 2014; Matthews et al., 2008; Wang et al., 2004). The task consisted of two different conditions. In the 'face' condition, participants were presented with three faces and asked to indicate which of the two bottom faces matched the upper one according to the facial expression portrayed. Only negative facial expressions were included. In the 'shape' condition, participants were presented with three elliptical pixelated faces and asked to decide which of the two bottom shapes matched the upper shape with regards to its spatial orientation. Participants completed two 'face' and three 'shape' blocks that consisted of six trials of 30s each.

2.2.4.1 fMRI Acquisition. The fMRI data acquisition settings during the Hariri task have previously been described in a different publication from the MIND-Set study (Duyser et al., 2022):

> fMRI data were collected using a 3T Siemens Magnetom Prisma system with a 32-channel head coil. T2*-weighted echoplanar images with blood-oxygen-level-dependant contrast were acquired during the emotion processing task (repetition time [TR] = 1000 ms, echo time [TE] = 34 ms, slicing: interleaved ascending, voxel size: 2.0 × 2.0 × 2.0 mm, flip angle: 60°). Anatomical images were acquired using a T1-weighted MP-RAGE sequence (TR = 2300 ms, TE = 3.03 ms, voxel size: 1.0 × 1.0 × 1.0 mm, flip angle: 8°, GRAPPA acceleration factor: 2). (Duyser et al., 2022, p.3)

2.3 Materials - T1

2.3.1 DynaCORE

The DynaCORE is a self-report questionnaire that was developed for the EU DynaMORE project (see www.dynamore-project.eu) and comprises a collection of pre-existing measurement instruments as well as newly developed questions related to resilience and experiences during the corona crisis (Veer et al., 2021). The following outcome measures of the DynaCORE were utilized within this project: *Positive Appraisal Style* (PAS), *Behavioral Coping Scale* (BCS), and *Corona-Related Reappraisal* (CRR). All three measures have previously been linked to increased resilience during the COVID-19 pandemic (Kalisch et al., 2020; Veer et al., 2021).

Positive Appraisal Style (PAS) measures the general tendency towards a positive appraisal of stressors. A positive appraisal style is defined by the absence of negative biases while simultaneously refraining from an unrealistic or delusional positive appraisal (Veer et al., 2021). It is assessed with a selection of two items from the brief COPE (Carver, 1997), ten items from the CERQ-short (Garnefski & Kraaij, 2006) and two newly generated questions, yielding 14 items in total. Items from the COPE assess the utilization of certain coping strategies and are rated on a 4-point Likert scale (1 = *not at all* to 4 = *a lot*). Selected items from the CERQ and two further items assessing emotion regulation are rated on a 5-point Likert scale (1 = *never* to 5 = *always*). Due to the non-identical rating scales of the selected items, raw scores were standardized to range between 0 and 1 by means of the 'Proportion of Maximum Scaling' (POMS) method that maintains the relative differences between the observed scores (Little, 2013; Moeller, 2015).

The Behavioral Coping Scale (BCS) assesses typical thinking processes and behaviors in the face of challenges, with a focus on positive coping behavior (Veer et al., 2021). It is measured with eight selected items from the brief COPE. Raw scores are summed up to yield a total BCS score (range 8 - 32) with higher scores indicating greater use of positive coping behavior.

Corona-Related Reappraisal (CRR) measures positive appraisal of the corona crisis specifically and is assessed with two self-generated items that are scored on a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*). Raw scores of both items are summed up to yield a total CRR score (range: 2 - 10). Again, a higher score is indicative of a more positive appraisal of the pandemic.

Lastly, based previously derived subscales of the brief COPE, scores indicating *Emotion*- and *Problem-Focused Coping* were calculated as the sum scores of the respective items (see e.g. O'Rourke et al., 2020).

Part 1: Patient and Control Differences in Executive Control, Amygdala Reactivity, and Coping

3. Data Analysis

We first explored whether there are differences between the patient and the control group with regards to their level of executive control (EC), amygdala reactivity, and coping measures. In all analyses, we first compared the patient and the control group. Subsequently, we investigated whether potential patient/control differences could be attributed to the main diagnoses by comparing the different patient subgroups (SD, ND, CM) and the control (CN) group. Gender, age at T0, and the level of education at T0 were included as covariates. In the analyses comparing the different patient subgroups with the CN group, we additionally included IDS scores to control for depressive symptomatology. All analyses were conducted in IBM SPSS Statistics 25. The sufficiently large sample size and use of Pillai's trace criterion were considered adequate to protect against deviations from normality and homogeneity of the variance and covariance matrices. By means of accounting for multiple comparison testing, p-values were adjusted with a Holm-Bonferroni correction when required.

3.1 Executive Control

To compare spatial working memory (SWM) performance of the groups, we conducted two separate multivariate analyses of covariance (MANCOVA) with the Strategy and Between Error scores as dependent variables. Two further MANCOVAs with the T-scores of the BRIEF-A subscales, indices, and the Global Executive Composite (GEC) as outcome measures were performed. A significant multivariate test was followed up with separate univariate tests to determine which of the BRIEF-A scales contributed to the group differences. When significant differences between the patient subgroups and the control group were detected, subsequent pairwise comparisons were carried out.

3.2 Amygdala Reactivity

3.2.1 fMRI Pre-processing and Analysis

Pre-processing and first- and second-level analysis of the fMRI data were carried out in SPM12 (Wellcome Department of Imaging Neuroscience, London, United Kingdom). A detailed description of the pre-processing parameters can be found in Duyser and colleagues (2022). Single-subject parameter estimates for the faces vs. shapes contrast, indicating regions of increased activity for the faces relative to the shapes, were obtained in a first-level analysis by means of a one-sample t-test (threshold $p < .05$, family-wise error [FWE] correction). The individual contrast images were subsequently entered into separate second-level analyses for the patient and the control group to determine the group-specific mean activity for the faces vs. shapes contrast across the whole brain. Again, a one-sample t-test with a threshold $p < .05$, FWE correction, and an additional threshold extent of ten contiguous voxels was applied. Lastly, as an indicator of reactivity to negative emotional information, parameter estimates (beta weights) for the faces vs. shapes contrast were extracted from the left and right amygdala by using the MarsBaR toolbox with regions of interest from the Automatic Anatomical Labeling (AAL) atlas (Brett et al., 2002; Duyser et al., 2022).

3.2.2 Statistical Analysis

Two MANCOVAs with the left and right amygdala beta weights for the faces vs. shapes contrast as dependent variables were conducted to compare the groups with regards to their level of amygdala reactivity. The analyses were repeated with the subjective level of stress before the Hariri task as an additional covariate.

3.3 Coping

To compare coping and reappraisal use between the groups, separate univariate ANOVAs with Positive Appraisal Style (PAS), Behavioral Coping Scale (BCS), Corona-Related Reappraisal (CRR), Emotion-Focused Coping, and Problem-Focused Coping as dependent variables were conducted. Again, significant differences between the patient subgroups and the control group were followed up by pairwise comparisons.

4. Results

Examination of potential demographic differences showed that the patient and the control group did not differ in age (*t*[135] = -.26, *p* = .795 at T0, *t*[135] = -.15, *p* = .878 at T1), gender (χ2[1] = 2.37, *p* = .123 at T0, χ2[1] = 1.47, *p* = .226 at T1), and the level of education (χ2[3] = 6.30, *p* = .098 at T0, χ2[3] = 6.02, *p* = .110). The patient group reported a significantly higher level of depressive symptomatology than the patient group at T0 (*t*[109.3] = -19.13, *p* < .001; see Table S1 in the supplementary materials for corresponding means and standard deviations).

4.1 Executive Control

Comparison of the SWM scores showed that there were no significant group differences for the Strategy and the Between Error scores neither between the patient and the control group *(F*[2,128] = 1.21, *p* = .300, ηp² = .019), nor between the different patient subgroups and the control group (*F*[6,250] = 1.59, *p* = .151, ηp² = .037). See Table S2 and Figure S1 in the supplementary materials for the adjusted means and standard errors.

Regarding the self-perceived level of EC, as assessed by the BRIEF-A, the multivariate test revealed a significant difference between the patient and the control group (*F*[12,118] = 22.30, *p* < .001, ηp² = .694). Subsequent univariate test results showed that the patient group had significantly higher scores than the control group on every outcome measure, indicating increased executive dysfunction in patients overall (see Table 1). The multivariate tests further revealed a significant difference on the BRIEF-A measures when comparing the different patient subgroups and the control group (*F*[36,348] = 2.41, *p* < .001, ηp² = .200). Subsequent univariate tests confirmed that there was a significant group difference for each of the twelve outcome measures (see Table S3 in the supplementary materials).

Pairwise comparisons showed that the control group had significantly lower scores than each of the three patient groups on the Initiate, Working Memory, and Organization of Materials subscales, as well as on the BRI, the MI and the GEC measures. Regarding the Self-Monitor, Plan/Organize, and the Task-Monitor subscales, the control group reported significantly lower scores than the ND and CM groups, while they did not differ from the SD group. For the remaining subscales, the control group similarly reported significantly lower scores than some, but not all of the three patient groups. Lastly, the SD, ND, and the CM group did not significantly differ on any of the BRIEF-A outcome measures, indicating that all patients experienced a similar level of executive dysfunction (see Figure S2 in the supplementary materials).

4.2 Amygdala Reactivity

The multivariate tests revealed no significant differences in left or right amygdala reactivity between the patient and the control group neither before (*F*[2,128] = .23, *p* = .797, ηp² = .004) nor after controlling for stress ratings prior to the task (*F*[2,127] = .13, *p* = .559, ηp² = .009). The same results were observed when comparing the different patient subgroups and the controls (*F*[6,248] = 1.57, *p* = .155, ηp² = .037; see Table S4 in the supplementary materials for adjusted means and standard errors).

Table 1

Comparison of BRIEF-A Scores in the Patient and the Control Group

	Adjusted Mean (SE)		*F*(1,129)	ηp²
	Patients	Controls		
Inhibition	67.44 (4.86)	51.65 (4.89)	57.40**	.308
Shift	73.89 (4.61)	51.40 (4.64)	129.65**	.501
Emotional Control	63.12 (4.16)	44.99 (4.19)	103.62**	.445
Self-Monitor	59.25 (4.73)	45.74 (4.76)	44.52**	.257
Initiate	71.40 (4.76)	45.74 (4.79)	158.18**	.551
Working Memory	74.43 (4.27)	49.78 (4.30)	181.56**	.585
Plan/Organize	63.71 (4.81)	41.55 (4.84)	115.56**	.473
Task-Monitor	69.10 (4.71)	49.80 (4.74)	91.65**	.415
Organization of Materials	65.08 (5.12)	49.17 (5.15)	52.65**	.290
Behavioral Regulation Index (BRI)	68.63 (4.04)	47.49 (4.06)	149.37**	.537
Metacognition Index (MI)	72.15 (4.53)	46.52 (4.56)	174.51**	.575
Global Executive Composite (GEC)	71.93 (4.05)	46.64 (4.08)	212.47**	.622

Note. Multivariate and univariate ANCOVAs comparing BRIEF-A scores between the patient group (*N* = 88) and the control group (*N* = 49). Means were adjusted for gender, age, and the level of education. Higher scores on all BRIEF-A scales indicate greater dysfunction.

* significant at the .05 level, ** significant at the .001 level after Holm-Bonferroni adjustment for multiple comparisons.

4.3 Coping

Results showed that the patient group reported significantly lower PAS and CRR scores than the control group. There were no group differences between patient and the control group with regards to any of the other coping measures (see Table 2). When comparing the different patient subgroups and the control group, the analyses revealed significant group differences only for the PAS scores (*F*[3,125] = 2.79, *p* = .043, ηp² = .063). After applying multiple comparison correction, however, these group differences were no longer significant (see Table S5 in the supplementary materials). Thus, there were no pairwise differences between SD, ND, CM and the control group on any of the coping measures.

Table 2

Comparison of Coping Scores in the Patient and the Control Group

	Adjusted Mean (SE)		*F*(1,129)	ηp²
	Patients	Controls		
Positive Appraisal Style (PAS)	.40 (.06)	.52 (.06)	20.65**	.138
Behavioral Coping Scale (BCS)	18.93 (1.63)	19.64 (1.64)	1.04	.008
Corona-Related Reappraisal (CRR)	5.00 (.68)	5.87 (.68)	8.95*	.065
Emotion Focused Coping	14.08 (1.34)	14.80 (1.34)	1.60	.012
Problem Focused Coping	9.82 (.89)	10.29 (.89)	1.50	.011

Note. ANCOVAs comparing coping (Positive Appraisal Style [PAS], Behavioral Coping Scale [BCS], Corona-Related Reappraisal [CRR], Emotion-Focused Coping, Problem-Focused Coping) between the patient group (N = 88) and the control group (N = 49). Means were adjusted for gender, age, and the level of education. Higher scores indicate more frequent coping or reappraisal use. Range of the outcome variables: PAS 0-1, BCS 8-32, CRR 2-10, Emotion- Focused Coping 6-24, Problem-Focused Coping 4-16.

* significant at the .05 level, ** significant at the .001 level after Holm-Bonferroni adjustment for multiple comparisons.

5. Discussion

We explored whether psychiatric patients and a healthy control group differed from each other with regards to their level of EC, amygdala reactivity, and coping. Compared to the control group, patients reported significantly lower subjective EC, while they did not demonstrate deficits on a spatial working memory task. Furthermore, the level of subjective executive dysfunction did not differ between patients in different diagnostic groups, indicating a transdiagnostic deficit in self-perceived EC in psychiatric patients with stress-related and neurodevelopmental disorders. The observation of increased subjective executive dysfunction in the absence of performance-based EC deficits is in line with recent findings showing that BRIEF-A scores were more strongly associated with emotional distress than performance-based measures of EC (Løvstad et al., 2016; Shwartz et al., 2020). Accordingly, it has been suggested that the BRIEF-A might not be a pure measure of cognitive functioning but additionally be sensitive to emotional symptom load (Løvstad et al., 2016; Shwartz et al., 2020). Thus, while we controlled for depressive symptomatology, it is possible that other factors related to emotional distress partly explain the diverging results with the SWM task. Nonetheless, these findings also highlight the importance of considering different modalities of EC measures. Inclusion of a subjective EC measure did not only facilitate the assessment of a broad range of problems, but was further valuable due to its high ecological validity. The BRIEF-A captures problems in real-world functioning that strongly contrast the controlled test environment of an EC task and are therefore highly relevant to the reality of patients' lives (Shwartz et al., 2020).

The lack of observable deficits on the SWM task in the patient group, however, is at odds with the notion of an underlying impairment in DLPFC processing. Depressive symptomatology, in particular, is commonly associated with DLPFC hypoactivity and was highly expressed in our patient sample (Koenigs & Grafman, 2009; Nejati et al., 2021; Siegle et al., 2007). Given that SWM tasks are assumed to rely on the DLPFC (Lee et al., 2000), the presence of SWM deficits as an indicator of inefficient DLPFC recruitment in the patient group seemed likely. However, evidence on SWM deficits in psychiatric patients is generally mixed and thus far inconclusive. While several findings have demonstrated impaired SWM performance in patients with stress-related and neurodevelopmental disorders, other studies have not been able to confirm this in both inpatient and outpatient settings (Grant et al., 2011; Rock et al., 2014; Sweeney et al., 2000; Weiland-Fiedler et al., 2004). Nevertheless, the possibility remains that the outpatient setting of the present study resulted in the inclusion of psychiatric patients with a generally higher level of functioning and thereby potentially less objectively quantifiable EC deficits.

This might further relate to our finding showing that the patient and the control group did not differ in their level of amygdala reactivity to negative emotional information. Specifically, we were not able to replicate the robust finding of increased amygdala reactivity in patients with stress-related disorders (Brotman et al., 2010; Fitzgerald et al., 2017; Viering et al., 2021). We suggest that the absence of performance-based SWM deficits might be indicative of a relatively higher level of prefrontal top-down control over the amygdala, thereby decreasing observable alterations in amygdala reactivity in the patient group. Interestingly, a previous study in the present patient cohort has demonstrated decreased connectivity between the DLPFC and the posterior parietal cortex, comprising the frontoparietal network, during stress. While not providing evidence for DLPFC hypoactivity per se, these findings implicate a role of the DLPFC in diminished top-down stress regulation across the present patient cohort (van Oort et al., 2020). Although seemingly at odds with the suggestion of preserved prefrontal top-down control over the amygdala, it is possible that top-down abilities decrease as a factor of stress and suffice under normal condition. Furthermore, the ability to participate in the follow-up study might have led to a sub-sample of participants with a higher level of functioning relative to the complete patient cohort.

Lastly, with regards to coping, we found that psychiatric patients reported a lower positive appraisal style and decreased corona-related reappraisal compared to the control group. The groups did, however, not differ with respect to their level of behavioral coping, problem-, and emotion-focused coping. Again, we did not detect any differences between patients in the different diagnostic groups, indicating that the reduced use of reappraisal-related coping strategies represents a transdiagnostic phenomenon in psychiatric patients. Previous findings have shown that poorer EC is associated with the use of coping strategies that are less cognitive demanding, such as emotion-focused coping (O'Rourke et al., 2020). In line with that, reappraisal might be considered more cognitively demanding than the behavioral coping strategies assessed in this study. As a consequence, the presence of a psychiatric disorder and related subjective cognitive deficits might be more likely to interfere with reappraisal and promote the preference for other coping strategies that align with one's individual cognitive resources. The precise nature of the relation between EC performance, amygdala reactivity, and coping will be more closely investigated in the following part.

Part 2: The Relationship Between Executive Control, Amygdala Reactivity, and Coping

6. Data Analysis

6.1. The Relation Between Executive Control And Coping

To investigate the relation between EC and coping, linear regression analyses with self-report and performance-based EC measures as independent variables and coping measures as outcomes variables were conducted. In all analyses, the following covariates were controlled for: gender, age, and the level of education at T0.

First, we investigated the association between self-reported levels of EC, as measured by the Global Executive Composite (GEC) T-score of the BRIEF-A, and coping. Subsequently, we tested the associations between the Between Errors and Strategy scores of the SWM and coping. Separate analyses were carried out with PAS, CRR and BCS as outcome variables. Emotion- and Problem-Focused Coping scores were no longer included in the analyses.

To determine whether the relation between EC and coping was differently affected in psychiatric patients and healthy controls, the above mentioned analyses were repeated with group (patient/control) added as a moderator variable.

All analyses were performed in SPSS. Mediation and moderation analyses were conducted using the PROCESS macro for SPSS (Hayes, 2017). Residuals were normally distributed and independent, and homoscedasticity and multicollinearity diagnostics were within an acceptable range.

6.2 The Mediating Effect of Amygdala Reactivity

To investigate whether the relation between EC and coping is mediated by amygdala reactivity, separate mediation analyses with the abovementioned self-report and performance-based EC measures (GEC T-scores, Between Errors, Strategy scores) as independent variables and coping measures as dependent variables (PAS, CRR, BCS) were performed. The beta values obtained from the left and right amygdala, which indicate an increase in amygdala activation in response to the faces relative to the shapes in the emotional matching task, were entered as mediating variables (see Figure 4 for an overview of the tested mediation models).

7. Results

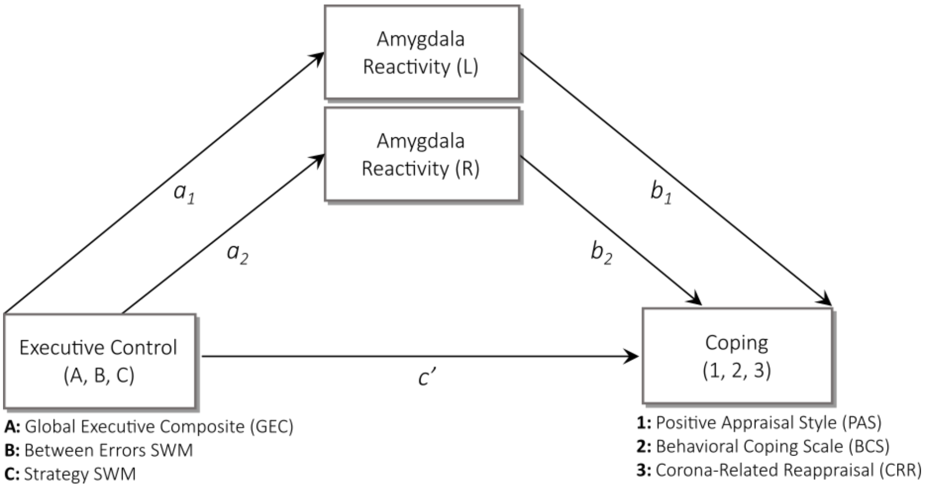
7.1 The Relation Between Executive Control And Coping

The linear regression models assessing the association between GEC and coping were statistically significant for all three coping variables ($F[7,129] = 4.05$, $p < .001$, $R^2 = .18$ for PAS, $F[7,129] = 2.88$, $p = .006$, $R^2 = .14$ for CRR, and $F[7,129] = 4.97$, $p = .001$, $R^2 = .21$ for BCS). GEC was significantly negatively associated with PAS and CRR, but not with BCS. Thus, an increase in self-reported executive dysfunction was related to less frequent PAS and CRR.

Regarding the association between the SWM Between Error scores and coping, the linear regression model was significant for BCS ($F[7,129] = 4.83$, $p < .001$, $R^2 = .21$ for BCS), but not for PAS and CRR ($F[7,129] = 2.37$, $p = .050$, $R^2 = .16$ for PAS, $F[7,129] = 1.51$, $p = .170$, $R^2 = .08$ for CRR). However, Between Error scores were not significantly associated with any of the coping variables. The same was observed with regards to the SWM Strategy scores. The linear regression model was statistically significant for BCS ($F[7,129] = 4.65$, $p < .001$, $R^2 = .20$ for BCS), but not for PAS and CRR ($F[7,129] = 2.29$, $p = .062$, $R^2 = .11$ for PAS, $F[7.129] = 1.48$, $p = .181$, $R^2 = .07$). Again, Strategy scores were not associated with either of the three coping variables (see Table 3 corresponding regression coefficients and significance values).

Figure 1

The Mediating Effect of Amygdala Reactivity on the Association Between Executive Control and Coping



Note. Mediation model illustrating the direct effect of executive control (Global Executive Composite score from the BRIEF-A, Between Errors and Strategy scores from the Spatial Working Memory [SWM] task) on coping (Positive Appraisal Style, Behavioral Coping Scale, Corona-Related Reappraisal) and the indirect effect via left and right amygdala reactivity.
a1, a2, b1, b2 and c′ indicate path coefficients.

Table 3

Regression Coefficients for the Association Between Executive Control and Coping

	PAS			CRR			BCS		
	B	β	*p*	*B*	β	*p*	*B*	β	*p*
GEC	-.003	-.274	.003*	-.028	-.266	.004*	-.030*	-.111*	.174
SWM									
Between Errors	-.001	-.078	.900	-.004	-.045	.900	-.021	-.096	.900
Strategy	-.001	-.020	1.000	-.001	-.005	1.000	-.017	-.024	1.000

Note. Linear regression analyses on the between executive control (Global Executive Composite [GEC] scores of the BRIEF-A, Between Errors and Strategy scores of the Spatial Working Memory task [SWM]) and coping (Positive Appraisal Style [PAS], Corona-Related Reappraisal [CRR], and the Behavioral Coping Scale [BCS]). Gender, age, and the level of education were entered as covariates (*N* = 137). Higher scores on the BRIEF-A and SWM scores indicate a greater level of dysfunction.
*significant at the .05 level after Holm-Bonferroni adjustment for multiple comparisons.

7.1.1 Group Differences In The Relation Between Executive Control And Coping

All of the tested models explained statistically significant variance in PAS, BCS and CRR (see Table S6 in part 2 of the supplementary materials). However, a significant moderation effect of group was observed only for the association between the self-reported GEC score and BCS ($F[1,127] = 9.25$, $p = .009$, R^2 *change* = .05; see Table 4 for coefficients and significance values). In the control group, an increase in GEC scores, indicating higher executive dysfunction, was significantly associated with an increase in BCS (*B* = .213, *p* = .016). In the patient group, the opposite effect was observed: in increase in GEC was significantly associated with a decrease in BCS (*B* = -.074, *p* = .048, see Figure 3).

To assess whether the association between GEC scores and BCS in the patient group was affected by the presence of depressive symptomatology in our patient sample, additional post-hoc analyses were carried out that can be found in part 3 of the supplementary materials.

Table 4

Coefficients for the Moderation Effect of Group on the Association Between Executive Control and Coping

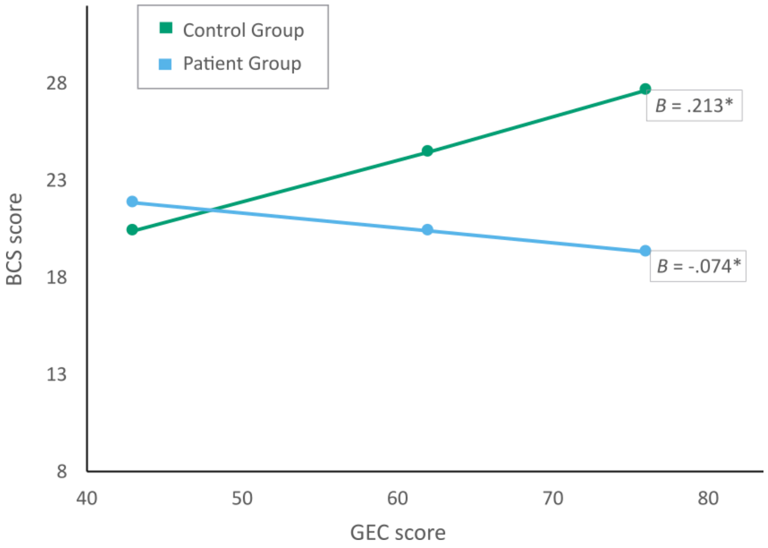
	PAS		CRR		BCS	
	B	*p*	*B*	*p*	*B*	*p*
GEC *Group	.001	1.000	-.009	1.000	-.287*	.009*
BE*Group	-.001	1.000	.001	1.000	.005	1.000
ST*Group	.003	1.000	-.007	1.000	-.022	1.000

Note. Moderation analysis on the effect of group (patient/control) on the association between executive control (Global Executive Composite [GEC] scores of the BRIEF-A, Between Errors and Strategy scores of the Spatial Working Memory task [SWM]) and coping (Positive Appraisal Style [PAS], Corona-Related Reappraisal [CRR], and the Behavioral Coping Scale [BCS]). Gender, age, and the level of education were entered as covariates (*N* = 137). Higher GEC and SWM scores indicate a greater level of dysfunction.

*significant at the .05 level after Holm-Bonferroni adjustment for multiple comparisons.

Figure 2

Moderation Effect of Group on the Association Between Global Subjective Executive Control and Behavioral Coping



Note. The moderating effect of group (patient/control) on the association between subjective executive control, as assessed by the BRIEF-A Global Executive Composite (GEC) score, and the Behavioral Coping Scale (BCS). In the control group, an increase in GEC scores (indicating greater dysfunction) is significantly associated with an increase on the Behavioral Coping Scale, indicating a more frequent use of positive behavioral coping strategies. In the patient group, an increase in GEC scores is associated with a decrease in BCS.

* significant at the .05 level.

7.2 The Mediating Effect of Amygdala Reactivity

While replicating our previous findings on a direct association between GEC and PAS, as well as PAS and CRR, the three independent variables (GEC, Between Errors, Strategy) were generally not significantly associated with amygdala reactivity, apart from one exception: we detected a significant association between the Between Error scores from the SWM task and right amygdala reactivity (*B* = .003, β = .254, *p* = .03), showing that an increase in Between Errors, and therefore worse SWM performance, was associated with an increase in right amygdala reactivity. However, there was no significant association between left or right amygdala reactivity and any of the coping variables (PAS, BCS, CRR). Therefore, none of the associations between EC and coping were mediated by left or right amygdala reactivity on a neural level (see Tables S7-S7b in part 2 of the supplementary materials).

After consideration of our findings indicating that amygdala reactivity does not mediate the association between EC and coping, we were interested in exploring an alternative model that tested an interaction, rather than a mediating effect, between amygdala reactivity and EC in their association with coping. Therefore, in additional post-hoc analyses, we investigated whether EC moderates the association between amygdala reactivity and coping. The analyses and results can be found in part 3 of the supplementary materials.

8. Discussion

The present study aimed to examine the relation between EC and coping in a naturalistic cohort of psychiatric patients and healthy controls. Furthermore, we explored whether the link between EC and coping was affected by amygdala reactivity to emotional information on a neural level. We hypothesized that 1) subjective self-reported EC and performance on a spatial working memory task would both be associated with the use of behavioral coping strategies and reappraisal, and 2) expected that this relation would be mediated by amygdala reactivity. Partly confirming out first hypothesis, the results showed that only subjective global EC, but not SWM performance, was associated with a positive appraisal style (PAS) and positive reappraisal of the COVID-19 pandemic (CRR) across participants, while it was not generally associated with the use of behavioral coping strategies (BCS). Specifically, we demonstrated that individuals with increased levels of subjective executive dysfunction reported lower levels of PAS and CRR. Moreover, rejecting our second hypothesis, the relation between EC and coping was not mediated by amygdala reactivity.

The Relation Between Executive Control And Coping

Our findings on the association between subjective EC and coping imply that subjective real world EC is more relevant in predicting coping abilities than standardized test performance. However, this indication is not in line with previous findings that have established a link between WM performance and overall emotion regulation abilities, including cognitive reappraisal (McRae et al., 2012; Schmeichel & Tang, 2015; Schmeichel et al., 2008). Here, we focused on a self-report measure that assessed reappraisal use as the upregulation of positive emotions in daily life. Previously reported associations with WM performance were based on an assessment of reappraisal ability, which was operationalized as reduced expression or experience of emotions during a reappraisal task and thereby measured the downregulation of negative emotions. Indeed, it has been suggested that reappraisal frequency is less strongly associated with EC performance than reappraisal ability (McRae et al., 2012; Schmeichel et al., 2008; Toh & Yang, 2021). Thus, it seems possible that we captured distinct qualities of reappraisal that are differentially linked to subjective EC and WM capacity.

Group Differences In The Relation Between EC And Coping

The link between subjective EC and both PAS and CRR was not affected by the patient/control status of the participants. However, we observed opposing group effects when considering the association between subjective EC and BCS: an increase in subjective executive dysfunction was associated with a decrease in behavioral coping in the patient group, whereas it was associated with an increase in behavioral coping in the healthy control group. We previously argued that the reduced levels of PAS and CRR reported by psychiatric patients might be attributable to the increased cognitive demands of reappraisal as compared to the behavioral coping strategies assessed. Applying this reasoning to the healthy control group, the tendency to increasingly rely on behavioral coping strategies as subjective EC abilities decrease could be considered a healthy adaptation to their declining cognitive resources. In the patient group, individuals appear to rely less on behavioral coping strategies as subjective executive dysfunction increases. This might, thus, reflect worse adaptation to their decreased cognitive abilities or indicate a general deficit in coping as EC declines. It is important to note, however, that results from post-hoc analyses indicated an overlap between depressive symptomatology and subjective EC in determining behavioral coping outcomes. Therefore, in line with previous reports indicating sensitivity of the BRIEF-A to psychological distress variables (Løvstad et al., 2016; Shwartz et al., 2020), it is important to disentangle the effects of subjective EC and psychological distress more thoroughly in the future.

The Role Of Amygdala Reactivity

Regarding the involvement of the amygdala, we did not find evidence in support for the hypothesis that amygdala reactivity to emotional information mediates the association between EC and coping on a neural level. Specifically, we were not able to replicate the findings by Drabant and colleagues (2009) who reported a negative association between reappraisal use in daily life and amygdala reactivity to negative emotional information. Noticeably, however, we detected a significant association between the Between Error scores from the SWM task and right amygdala reactivity. An increase in Between Errors, indicating worse SWM performance, was associated with a lateralized increase in emotional reactivity in the right amygdala. As a consequence of the relatively small variability in Strategy scores and overall homogenous SWM performance across the sample, we might not have observed a likewise association between Strategy scores and amygdala reactivity. Nonetheless, our findings corroborate previous reports pointing towards a link between WM performance and amygdala reactivity, which, however, emphasized the left amygdala as a more sensitive predictor of WM performance (Schaefer et al., 2006). Notably, the left amygdala has been shown to be preferentially engaged in the processing of negative emotional information (Baas et al., 2004) and we observed a corresponding tendency towards higher reactivity of the left relative to the right amygdala in our sample. Nonetheless, regarding the link with SWM performance, our findings agree with those reported by Cohen and colleagues (2016) who observed a reduction in right amygdala activation in response to aversive pictures after a high-frequent attentional EC training. Therefore, while tentative in nature, our findings suggest that emotion processing in the right rather than the left amygdala might be sensitive to top-down control exerted by prefrontal brain regions that are engaged in EC tasks. In this case, we cautiously suggest a role of the DLPFC in governing the allocation of neural resources to emotion processing in the (right) amygdala that remains to be confirmed in future research.

Despite the observed association between SWM performance and amygdala reactivity, we conclude that the proposed mediation model cannot sufficiently explain differences in coping. As an alternative to capture the presumed competition between prefrontal executive control networks and the amygdala, we decided to conduct post-hoc tests in which we explored whether EC moderates the association between amygdala reactivity and coping. However, we did not find support for an interaction effect between EC and amygdala reactivity. Thus, taken together, our results do not provide evidence for an interdependent effect of EC and amygdala reactivity on coping.

Limitations and Suggestions for Future Research

This study is one of the first to investigate the relationship between EC, coping and amygdala reactivity in psychiatric patients. The naturalistic and multimorbid nature of the patient cohort represents a strength of this study, as it facilitates the detection of transdiagnostic mechanisms underlying psychopathology (Krueger & Eaton, 2015; Insel, 2014). Nonetheless, this study also has multiple limitations. First, the patient group was overall characterized by a high level of depressive symptomatology and included only a small subset of individuals diagnosed exclusively with one or more neurodevelopmental disorder. Furthermore, as patients were recruited from an outpatient setting, the generalizability of our results to other patient populations is limited. The outpatient setting, however, also permitted us to gain insight into the subjective level of EC and coping in the patients' usual home setting, thereby increasing the ecological validity of our findings. Lastly, we relied on a behavioral measure of SWM performance. In order to gain further insight into the neural mechanisms underlying the association between EC and amygdala reactivity, it will be important to obtain complementary neuroimaging measures in the future.

We further suggest a more comprehensive assessment of EC on a behavioral level. Given the oftentimes inconsistent pattern of EC deficits observed among patient populations, it has been suggested that psychopathology is more strongly associated with global, rather than specific EC impairments (Snyder et al., 2015). In line with that, recent findings have advocated for the adaptation of a latent variable approach, which highlights the shared variance among different EC tasks as a common underlying EC factor (Toh & Yang, 2021). This common EC factor has previously been linked to reappraisal ability (Toh & Yang, 2021), indicating that it might be a promising approach to promote understanding of the link between EC and coping in psychiatric patients.

Implications

Our findings emphasize the importance of considering subjective executive impairments in clinical practice for two substantial reasons: first, despite normal performance on a spatial working memory test, we observed a transdiagnostic deficit in self-reported EC across psychiatric patients. Second, reduced subjective EC at baseline was linked to a decreased Positive Appraisal Style and Corona-Related Reappraisal during the follow-up assessment across patients and healthy controls. Previously, beneficial effects of WM training on emotion regulation have been documented across a variety of populations, including patients with stress-related disorders (see Barkus, 2020 for a review). Thus, it would be interesting to explore whether these findings translate to reappraisal skills in multimorbid patient populations, and to determine whether potential reappraisal gains are linked to an improvement in subjective EC. Moreover, in light of the reported association between SWM Between Errors and right amygdala sensitivity, it would we valuable to extend the findings by Cohen and colleagues (2016) and examine the additional feasibility of WM training to decrease amygdala reactivity to emotional information. Alternatively, reappraisal skills could be targeted directly in order to promote a more habitual reframing of events in a positive and accepting way. For instance, there is converging evidence indicating a beneficial effect of mindfulness-based trainings on reappraisal use, which might be feasible for psychiatric patients (Garland et al., 2009; Kaunhoven & Dorjee, 2021).

Conclusion

Psychiatric patients are especially vulnerable to experience negative effects when being exposed to stressful events. In order to mitigate the impact of stressful events in the future, it is essential to identify the cognitive and neural determinants of coping. Here, in light of the COVID-19 pandemic, we highlighted the relevance of transdiagnostic deficits in subjective EC as a potential predictor of coping abilities. While further indicating a link between SWM performance and sensitivity of the right amygdala to emotional information, the impact of commonly observed alterations in amygdala reactivity on coping in psychiatric patients remains to be clarified. Future insight into the relation between EC, amygdala reactivity, and coping will advance our understanding of how top-down versus bottom-up cognitive control processes might interact and impact coping abilities. Moreover, this might facilitate the development of tools to strengthen coping abilities and eventually contribute to increasing resilience and mental well-being in the long-term.

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