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Emotion regulation in self-reported disinhibition, boldness and meanness

A pilot neuroimaging study correlating activity in the prefrontal cortex during cognitive reappraisal to Triarchic psychopathy measure-scores in healthy males

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Känsloreglering i självrapporterad hämningslöshet, djärvhet och grymhet

Introduktion: I den triarkiska modellen ses psykopati som en kombination av tre personlighetsdrag: djärvhet (boldness), elakhet (meanness) och hämningslöshet (disinhibition); som kan skattas genom "Triarchic psychopathy measure" (TriPM). Förmågan till känsloreglering har föreslagits som en process som skiljer sig hos personer med mer psykopatiska drag. Känsloreglering kan undersökas genom funktionell magnetkameraavbildning (fMRI) av dorsolaterala prefrontala hjärnbarken (dlPFC) under negativt känslomässigt stimuli. Det är inte känt hur känsloreglering är kopplat till underskalorna av TriPM. *Syfte:* Projektet syftade till att undersöka huruvida aktivitet i dlPFC under känsloreglering korrelerade med poäng i de tre underskalorna av TriPM i ett urval av friska män. *Material och metod:* Inklusionskriterier: Ålder 18-30, män, Psychopathy Checklist – Revised-poäng <10. Exklusionskriterier: Kriminellt förflutet, ordinarie kontraindikationer för fMRI. Deltagarna ($n=7$) utförde en uppgift i känsloreglering av känslomässigt negativa bilder under fMRI och fyllde i TriPM. Vi korrelerade aktiviteten i dlPFC till poängen i hämningslöshet, djärvhet och grymhet. *Resultat:* Korrelationen mellan underskalorna av TriPM och aktivitet i dlPFC under känsloreglering var, för hämningslöshet: $\rho=0.29$, $p=0.56$, för grymhet: $\rho=0.29$, $p=0.59$, för djärvhet: $\rho=-0.43$, $p=0.35$. *Slutsats:* Vi såg ingen signifikant korrelation mellan aktivitet i dlPFC och TriPM-poäng inom normalspannet för någon av de tre underskalorna. Förhållandet mellan känsloreglering och underskalorna av TriPM i en normal befolkning är fortfarande ej klarlagt. Vid framtida forskning på psykopatiska drag hos friska män behövs ett större urval.

Emotion regulation in self-reported disinhibition, boldness and meanness

Introduction: In the triarchic model, psychopathy is viewed as a combination of three traits: disinhibition, boldness, and meanness; that can be assessed through the triarchic psychopathy measure (TriPM). The ability to regulate emotion has been proposed as one process that differs in people with higher psychopathic traits. Emotion regulation can be assessed through functional magnetic resonance imaging (fMRI) of activity in the dorsolateral prefrontal cortex (dlPFC) during downregulation of negative emotional stimuli. It is not known how emotion regulation relates to the TriPM subscales. *Aim:* We aimed to assess whether activity in the dlPFC during emotion regulation correlated with the scores in the three subscales of the TriPM in healthy males. *Material and methods:* Inclusion criteria: Ages 18-30, Male, Psychopathy Checklist – Revised-score <10. Exclusion criteria: Criminal history, standard contraindications for fMRI. Participants ($n=7$) performed an emotion regulation paradigm with negative picture stimuli during fMRI and filled out the TriPM. We correlated the activity in the dlPFC to scores in disinhibition, boldness, and meanness. *Results:* TriPM-subscale correlation to dlPFC-activity during emotion regulation was, for disinhibition: $\rho=0.29$, $p=0.56$, for meanness: $\rho=0.29$, $p=0.59$, for boldness: $\rho=-0.43$, $p=0.35$. *Conclusion:* We saw no significant correlation between activity in the dlPFC and TriPM-scores within normal range in any of the subscales. The relationship between emotion regulation and the subscales of the TriPM in normal subjects remains unknown. For future research on psychopathic traits in healthy males, a larger sample will be needed.

Keywords: Emotion regulation, cognitive reappraisal, psychopathy, psychopathic traits, triarchic model, TriPM, Boldness, Meanness, Disinhibition, dorsolateral prefrontal cortex

Abbreviations

dlPFC – dorsolateral prefrontal cortex

BOLD – blood oxygen level dependent

FD – Fearless dominance

fMRI – Functional magnetic resonance imaging

MRI – Magnetic resonance imaging

PCL-R – Psychopathy checklist revised

PFC – Prefrontal cortex

PPI – Psychopathic personality inventory revised

SCI – Self-centred impulsivity

ROI – Region of interest

TriPM – Triarchic psychopathy measure

vmPFC – Ventromedial prefrontal cortex

Introduction

The concept of psychopathy

The concept of psychopathy was popularized by psychiatrist Hervey Cleckley. In his influential book *Mask of sanity*, originally published in 1941 (1), he described the psychopath as a person with superficial charm who masks his/her pathology and only on rare occasions reveals emotional detachment and anti-social deviance. Cleckley's conclusions were based on clinical observations on psychiatric inpatients (2). Since Cleckley, empirical studies on psychopathy have focused mostly on criminal offenders in a forensic setting. One influential clinical measure for psychopathy called the Psychopathy Checklist, and later, the Psychopathy Checklist Revised (PCL-R) was developed by Robert D. Hare (3). For over three decades, Hare's PCL-R has been the standard assessment tool for psychopathy (2,4). The PCL-R distinguishes between two factors: interpersonal/affective and behavioral/lifestyle, where the former encompasses traits such as shallow affect and manipulativeness, and the later factor includes criminality and parasitic lifestyle (2).

Some argue that there has been a "construct drift" of psychopathy, and claim that Hare's construct focuses too heavily on criminal activity, as opposed to Cleckley's view of the psychopath as not particularly hostile or aggressive (2). Proponents of the use of the psychopathy concept point to the clinical utility of the PCL-R (2). The PCL-R has proved to serve well for risk assessment in forensic settings, but its usefulness in other contexts is questionable (5).

In recent years, we have seen an advancement of new conceptualizations and assessment tools for psychopathic traits (3). Psychometric analysis of the PCL-R suggests that psychopathy should be viewed as a dimensional disorder, existing on a continuum, rather than a categorical disorder (6). One new conceptualization is the Triarchic model, which better adheres to the "dimensional" view of psychopathy (7). Additionally, the Triarchic model could be able to detect a more diverse range of phenotypes, possibly bridging the gap between Cleckley's and Hare's psychopath (7,8).

The triarchic model of psychopathy

In the Triarchic model, psychopathic traits are thought of as a combination of three components: boldness, meanness and disinhibition (7). These categories are thought to correlate closer to the underlying neurophysiological mechanisms behind psychopathy (7). Although these traits may be interrelated, they are phenotypically distinct, as well as thought to be genotypically and developmentally separable (7). However, more research is needed before the genetic and developmental origins of psychopathic traits are clarified.

Disinhibition is associated with low impulse control and manifests itself in actions of impulsivity, irresponsibility and lack of foresight (7). Boldness is characterized by resilience towards stress, thrill-seeking behavior and fearless dominance (7). Persons rated high in boldness are persuasive, assertive and have high social poise. Meanness is associated with cold-heartedness, lack of empathy and a disregard for the outcome of others (7). Meanness can manifest itself in acts of cruelty towards other persons or animals, strategic exploitation of others, and aggressive dominance.

Psychopathic tendencies in the Triarchic model are clinically assessed through a questionnaire called the Triarchic psychopathy measure (TriPM) (7). The TriPM consists of items which are answered true/partly true/partly false/false. The items are grouped in three subscales: boldness, meanness and disinhibition. Examples of items are “I am a born leader” which is ascribed to boldness and “I often rush into things without thinking ahead” which is ascribed to disinhibition.

Some items of these subscales contain aspects that are a part of being a normal person and are not exclusive to psychopathy. It is theorized that these traits in excess together create the psychopathic phenotype.

Generation and regulation of negative emotions

When studying neurophysiology with functional magnetic resonance imaging (fMRI), local differences in blood flow are measured and can be interpreted as local differences in neural activity as the subject processes information (9). Examination of neurophysiology through fMRI has limitations of both spatial resolution and temporal resolution (10). The spatial limitations are due to neural structures being smaller than what can be visualized by the changes in blood flow (9). The temporal limitations are due to the delay of the blood flow

response following the neural event (11). Because of this, fMRI does not give the full picture of the dynamics of the underlying neural activity behind emotions. It is however clear from fMRI-research that some locations can be identified as having a more important role for emotion processing (10).

fMRI studies have consistently identified the amygdala as the most active region when experiencing negative emotions, such as fear and disgust (12). The amygdala is consistently activated following fearful stimuli and this activation decreases after fear extinction therapy (13).

The amygdala receives inhibitory input from many regions of the prefrontal cortex (PFC) (12). Ochsner was one of the first to show in fMRI that there is an increased activity in the PFC during voluntary suppression of negative emotion with an inverse effect on the amygdala (14). This has since then been replicated in a number of studies on diverse populations (15). This suggests that emotions such as fear and disgust are not only primitive reactions to external stimuli. Higher order cognitive functions can influence and generate emotional responses (16). This type of cognitive influence on emotion is often referred to as working top-down (15).

One type of top-down effect on emotions is emotion regulation. Emotion regulation is the ability to cognitively regulate experienced emotion. This can be done by different strategies such as distancing and redirection of attention. The most common studies of emotion regulation focus on the method of cognitive reappraisal of negative stimuli (15). The strategy for cognitive reappraisal usually involves verbal reinterpretation of the content (i.e. “this isn’t real”, “doesn’t affect me”, “fake news”) (14).

Meta-analyses of cognitive reappraisal studies mainly show activation of the dorsolateral prefrontal cortex (dlPFC) and ventromedial prefrontal cortex (vmPFC) and a reduced activity of the amygdala during cognitive reappraisal (15). The low temporal resolution of functional imaging and the interconnectedness of the regions involved presents a limitation when attempting to examine the mechanisms of top-down emotion regulation in detail (17).

One fMRI-study of cognitive reappraisal with the addition of electroencephalographic recording, which overcomes some of the limitations of temporal resolution in fMRI, suggests that dlPFC instigates the process of cognitive reappraisal by activating most notably the vmPFC which then in turn sends inhibitory signals to the amygdala (18). This is consistent

with anatomical findings on non-human primates which show only weak projections from dlPFC to the amygdala with stronger regional connectivity and a strong connection between vmPFC and the amygdala (13). A meta-analysis by Diekhof in 2011 emphasized this connection and activation of the vmPFC, as activity in vmPFC has shown inverse correlation with activity in the amygdala (19).

In contrast, one later meta-analysis of cognitive reappraisal failed to show consistency in activation of vmPFC, suggesting that vmPFC is not central for emotion regulation per se, but specific for certain paradigms (20). The most common paradigm of emotion regulation involves cognitive reappraisal of negative emotion from picture stimuli. These studies have consistently shown activity in the dlPFC (17,21). Activity in the dlPFC can thus be used as an indicator for cognitive reappraisal in experiments under this condition.

Emotion regulation and disinhibition, boldness and meanness

Disinhibition is a trait describing proneness to impulsive reactions (7). A proposed neural correlate for disinhibition is a lower connectivity between the PFC and the amygdala (22). In other words, disinhibition is thought to be associated with weaker top-down emotion regulation. This could lead to a decreased ability to suppress inappropriate impulses.

According to Patrick, boldness and meanness are related by emotional resilience and fearlessness (7). A common explanation for fearlessness is a functional deficit in amygdala reactivity (23). However, strong ability of manipulation through infliction of fear is a common characteristic of persons with psychopathic tendencies, suggesting they have a good understanding of fear in others (24). Therefore, impaired amygdala reactivity might be an insufficient model for the fearlessness component of boldness and meanness. One alternative explanatory model for fearlessness in people with high trait boldness and meanness is that it is associated with a stronger ability of top-down emotion regulation.

Experimental paradigms investigating emotion regulation during fMRI have not been tested in relation to TriPM-scores in a normal population. To support the dimensional view of psychopathic traits, it is important to investigate if neurophysiological differences are detectable in relation to TriPM-scores within normal range. Further, by investigating the neurophysiology of the items in the TriPM individually, we can gather support for the validity of the triarchic model of psychopathy.

Aim

This study aimed to investigate whether disinhibition, boldness and meanness on the TriPM-scale correlated with activity detected by fMRI in the dorsolateral prefrontal cortex during cognitive reappraisal in healthy participants. Specifically, our primary hypothesis was that activity in the dorsolateral prefrontal cortex would correlate negatively to scores in disinhibition in the TriPM-scale. Our secondary hypotheses were that activity in the dorsolateral prefrontal cortex would correlate positively to scores in boldness and meanness in the TriPM-scale.

Materials and methods

Study design

In this pilot study, healthy participants performed an experimental paradigm of cognitive emotional reappraisal of negative picture stimuli in fMRI. They then filled in the TriPM for assessment of the scores in the subscales disinhibition, boldness, and meanness. We then correlated the activity detected in fMRI in the dlPFC to the scores in the three subscales individually.

Parallel to the cognitive reappraisal task, two additional paradigms were examined, one for reward anticipation and one for empathy. They spent a total time of 50 minutes in the fMRI-scanner where the reappraisal task was performed during the last part of the experiment. The participants were evaluated by a psychologist and psychiatrist for the PCL-R rating.

Participants

Recruitment was made via online advertising on Facebook and in case of a late cancelation, convenience sampling. Inclusion criteria were set to match the participants in the upcoming experimental study: 18-30 years old, male, PCL-R <10 (clinical psychopathy >25), right handed, understanding Swedish and normal vision.

Exclusion criteria were: Criminal history, metallic implants in the body, pacemaker, claustrophobia and current or previous neurological or psychiatric disorder. We also excluded psychology students because of a tendency to see through experiments and medical student for a tendency of being desensitized to the pictures used in this study.

We performed fMRI-scans of 6 participants for this study. 1 participant was excluded for not filling in the TriPM form in time. For increased statistical power, we included data of 2 participants from an earlier pilot-project giving a total of 7 participants (see Figure 1).

Figure 1: Flowchart of included participants. Six persons were recruited this autumn. One person did not complete the TriPM. Data from 2 additional participants were available from an earlier experiment.

Abbreviations: fMRI= functional magnetic resonance imaging, TriPM = triarchic psychopathy measure

Cognitive reappraisal paradigm

During fMRI, participants received 64 sets of an instruction immediately followed by an image on a screen placed in clear sight in front of them (see Figure 2). The instruction consisted of an arrow pointing either downwards or sideways. When seeing an arrow pointing

downwards, the participants were instructed to suppress their emotional response when watching the upcoming image. When seeing an arrow pointing sideways they were to instead maintain the emotion they experienced. Half of the pictures were of negative emotional valence (e.g. people in pain), and half of the pictures were of neutral emotional valence (e.g. commonplace objects) ($n=32+32=64$).

Figure 2: The set-up for each set in the paradigm Each of the events in the paradigm consists of a series of an instruction followed by stimuli and self-evaluation.

The instructions were distributed randomly in relation to the emotional content of the pictures. The two types of instruction, and stimuli combined to four different conditions of the experiment (see Figure 3). The participants did not know the valence of the picture before seeing it. After each set of command and picture, participants were asked to grade their success in following instructions on a scale from 0-7.

Maintaining neutral	Maintaining negative
Downregulating neutral	Downregulating negative

Figure 3: The conditions of the experiment. The experiment is set up to create four different conditions for the participants.

Triarchic psychopathy measure

The scores in boldness, meanness and disinhibition was attained through the self-report TriPM questionnaire. The TriPM is designed to capture psychopathic traits on three dimensional scale way according to the Triarchic model of psychopathy (7). We used the Swedish version of the TriPM, which has not yet been validated. The form consists of items belonging to either of the 3 categories: boldness (e.g. “I am a born leader”), meanness (e.g. “I don’t mind if someone I dislike gets hurt”) and disinhibition (e.g. “I often rush into things without thinking ahead”). There are 56 items in total: 18 for boldness and 19 for meanness, and disinhibition. The items are answered by false/partly false/partly true/true giving a score of 0-3, with a reversed scoring in items directed towards lower likelihood of the trait.

The TriPM-form is attached to this report as Appendix A.

Stimuli

The pictures were downloaded from the International affective picture system (IAPS) database (<http://csea.php.ufl.edu/media.html>). The pictures are classified as neutral or negative and have been used extensively in research as a standardized set of pictures for studying emotion (25).

Data collection

TriPM-data collection

The questionnaire was filled in by the participants either at home or parallel to our experiment. All scores were handled electronically. Subscale-scores were obtained by summarizing the items in the three subscales individually. There were no missing responses of individual items.

fMRI-data recording

A 3-T Discovery (General Electric) MR-scanner with an 8-channel head coil was used for the experiment. T1-weighted structural images (Settings: FOV = 24.0 cm, Slice Thickness = 1.0

mm, TE = 3.1 ms, TR = 7.9 ms, Angle = 12°, Frequency = 240 Hz) were acquired for use in the fMRI-data preprocessing. Functional images (Settings: FOV = 23.0 cm, slice thickness = 3.0 mm, TE = 28.0 ms, TR = 2550.0 ms, angle = 80°, frequency = 96 Hz) were acquired using blood-oxygen level dependent (BOLD) contrast.

fMRI data pre-processing

Imaging data were preprocessed and analyzed using standalone SPM12 (Statistical parametric mapping 12). Data preprocessing was done in five steps. *Slice Timing*: Corrects the differences in image acquisition time between slices. *Realign and unwarp*: Realign a time-series of images acquired from the same subject. Image number 2 was selected as a reference and all subsequent images were realigned. The aim was to remove primarily movement artifacts. The first scan of each session was realigned with the first scan of the first session. Then the images within each session were realigned with the first image of the session. Air-filled cavities create a severe geometric distortion. This produces a “wrapped” image going from elongated to flattened that changes with movement similar to a distorting mirror. Hence when there was movement in the data this was needed to minimize variance. *Co-registration*: Aligning functional and structural information to map the functional data into anatomical space. *Normalization*: Co-registering the subjects image to a standard template to overcome brain shape variability and allows for inter-subject comparison. *Smoothing*: Convolving of the image with a Gaussian kernel to suppress noise.

Statistical methods

The statistical computing was done in R (26).

TriPM data

The mean and range were calculated for total score and each subscale. Subscale scores were plotted using boxplots showing median, interquartile range, and full range, in order to show the distributions of scores. Outliers were defined as lying outside 1.5 times the interquartile range.

Self-reported ratings of success

Mean ratings were plotted for each condition and participant. The self-reported ratings of success were analyzed with a multilevel regression model and compared between conditions. The multilevel regression model is appropriate for repeated measures nested within each participant since it allows variance to be assigned to participants as well as conditions.

fMRI-data analysis

In the functional images, the space of the brain was divided into entities of volume called voxels (i.e. 3D-pixels or volume pixels). A general linear model was used to compare conditions within each participant. A threshold value of a significance level of 0.05 was set for detecting activity in each voxel individually.

We estimated the activity in a specific region of interest (ROI). We used this approach because it allows the testing of a specific hypothesis with less need to correct for multiple comparisons. We picked the right dlPFC as our region of interest and received coordinates from an article by Golkar et al (27). We constructed a spherical ROI centered around these coordinates. The ROI-estimates were analyzed with a *t*-test comparing the conditions of downregulation vs maintain, giving us the overall effect of emotion regulation in the ROI in this study.

To test our hypotheses, we correlated the activity in our ROI in each participant to the individual scores in boldness, meanness and disinhibition using Spearman's rank correlation. Spearman's correlation is appropriate when handling small data sets since it is less sensitive to outliers, and does not assume a normal distribution.

Ethical considerations

There are no known harmful effects caused by exposure to the magnetic field of an MR-scanner. However, high volumes of sound might cause hearing loss if safety precautions are not followed properly. For this reason, we made sure that the earplugs and headphones were fitted properly before starting the experiment.

Participants may experience nausea and discomfort during fMRI. All participants were given information about the procedure and possible adverse effects. Since the tube is narrow claustrophobia was an exclusion criterion.

There is a risk for incidental findings when undergoing an fMRI. All participants were informed of this. The pictures were examined by a radiologist and patients with significant abnormalities would be referred to a specialist. This can be beneficial for the patient if the findings are of relevance but can also have negative effects such as unnecessary investigations which are time and resource consuming and cause stress and anxiety in the patient.

In a bigger picture of the field of psychopath studies, results may have consequences that could spread wide into civil society, regarding treatment of both convicted criminals and “predisposed” individuals. It is the author’s opinion that these broader questions are better suited for other professions and forums. However, researchers in this field should remain cautious on how they interpret their findings as well as how they choose to convey the results to non-medical experts.

The low immediate risks involved in the experiment and the potential gain in knowledge lead to the conclusion that the benefits outweigh the risks.

Ethical approval was obtained from the Regional Ethical Review Board in Stockholm (Etikprövningsnämnden Stockholm), Reference number: 2014/1192-31/1.

Results

Participants

The seven participants were 19-41 years old (median=30 y.o.). Three participants were older than 30 years old, which was the upper limit of inclusion criteria, due to convenience sampling. One participant had ADHD.

TriPM Results were within normal range

Scores on the TriPM spanned from 39 to 77 (mean=60.1) consistent with a healthy, non-criminal sample (8). The highest scores were seen in boldness, ranging from 19 to 42

(mean=32.0). The lowest scores were seen in meanness, ranging from 2 to 24 (mean=12.7). In disinhibition, scores ranged from 5 to 34 (mean=15.5). The distribution of scores is illustrated in figure 4.

Figure 4: TriPM-subscale scores. Heavy lines represent the median score on the subscales of the TriPM individually. Whiskers represent outside quartiles.

Success ratings were lower when downregulating negative stimuli

Participants reported a lower success rate when downregulating their emotional response compared to maintaining it (-1.44, 95% CI -1.82, -1.06, $p < 0.0001$). Further they rated themselves more successful after receiving neutral stimuli compared to negative stimuli (0.95, 95% CI 0.58, 1.34, $p < 0.0001$) (see Figure 5).

Increased dlPFC-activity during cognitive reappraisal

The data from the fMRI showed an increased activity in the dlPFC during cognitive reappraisal compared to maintaining (mean=0.21, $p=0.07$, 95% CI=-0.04, ∞) (see figure 6).

Figure 5: Self-reported success of regulation. Grey lines show individual means. Black line shows group mean. **A:** During the condition of maintaining for negative and neutral stimuli. **B:** During the condition of downregulation for negative and neutral stimuli.

Figure 6: Activity in the dlPFC during emotion regulation. **A.** The anatomical location of the right dorsolateral prefrontal cortex. **B.** Boxplot of the activity in the dlPFC when downregulating compared to maintaining. Heavy line represents group median Whiskers represent outside quartiles.

No significant correlation between TriPM-scores and dlPFC-activity

Between disinhibition and activity in the dlPFC we saw a nonsignificant correlation in a positive direction, contrary to our primary hypothesis (Spearman's $\rho=0.29$, $p=0.56$) (see Figure 7a). Between boldness and activity in the dlPFC we saw a nonsignificant correlation in a negative direction, contrary to our secondary hypothesis (Spearman's $\rho=-0.43$, $p=0.35$) (see Figure 7b). Between meanness and dlPFC-activity we saw a nonsignificant positive correlation, consistent with our secondary hypothesis (Spearman's $\rho=0.29$, $p=0.59$) (see Figure 7c).

Figure 7: Scatterplot of the distribution of TriPM scores to activity in the dlPFC.
A. Disinhibition. B. Boldness C. Meanness. Abbreviations: dlPFC = dorsolateral prefrontal cortex.

Discussion

This study was an early attempt at correlating activity in the dlPFC, a neural correlate to emotion regulation, thought to be related to some aspects of psychopathic traits, to the subscales of the TriPM in a normal population. We observed expected activation in the dlPFC during downregulation of negative stimuli. The validity of the experiment was further supported by participants ratings of success, which were higher for the maintain condition compared to the downregulate condition, indicating an effect of the instruction. We did not find any significant correlation between boldness, meanness or disinhibition and activity in the dlPFC.

Discussion of results

The relationship between emotion regulation and psychopathic traits is complex, exemplified by how our hypotheses points in opposite directions for different aspects of psychopathy. An article by Robertson et al on emotion regulation and aggression reviews evidence showing that both over- and under-regulation of emotions increase the likelihood of aggressive behavior (28). This serves as an obstacle when trying to untangle the role of emotion regulation in relation to psychopathic traits in a normal, non-psychopathic population.

This study showed no significant correlation between activity in the dlPFC during emotion regulation and scores in any of the subscales of the TriPM within normal range. Contrary to our primary hypothesis, we saw a nonsignificant effect in the positive direction between disinhibition and activity in the dlPFC. For boldness, we saw a nonsignificant effect in the negative direction between scores in to activity in the dlPFC, contrary to our hypothesis. Meanness had a nonsignificant effect in the positive direction, the only effect that went in the hypothesized direction.

The positive association between disinhibition and activity in the dlPFC during emotion regulation runs counter to a core aspect of the theoretical construct behind disinhibition, proposed by Patrick, namely a lack of emotional restraint (7). Our hypothesis regarding boldness was more speculative in nature but we do not find any aspect of the theoretical construct of boldness which would explain a negative correlation to activity in the dlPFC during emotion regulation (7).

This study does not attempt to question the role of emotion regulation in high trait disinhibition, boldness or meanness. Our unexpected results could be indicative of a different role of emotion regulation in low trait disinhibition or boldness compared to high trait disinhibition or boldness. To our knowledge, no earlier studies have examined neurophysiological differences along the spectrum of TriPM scores within normal range. Given the small data set, no firm conclusions can be drawn from these results. There are studies suggesting that the relationship between top-down regulation and boldness, meanness and disinhibition could follow our hypothesized directions also in the general population.

Machiavellianism is a concept with close kinship to psychopathy, which overlaps both meanness and boldness in terms of lack of empathy, proneness to deceive or to exploit others (29). One recent study correlated amygdala activity during cognitive reappraisal to Machiavellian traits in a community sample. They found that more Machiavellian persons displayed a larger decrease in activation of the amygdala when downregulating their emotional response to negative stimuli than persons with less Machiavellian traits. This could support the idea that meanness and boldness traits result partly from emotional regulation, rather than emotional deficiency, and that differences can be detected in the general population.

Another scale for measuring psychopathic traits, the psychopathic personality inventory revised (PPI-R), identifies factors fearless dominance (FD) and self-centered impulsivity (SCI). A study correlating these two factors to the Difficulties in Emotion Regulation Scale (DERS) found that DERS-score correlated negatively to FD and positively to SCI (31). FD and SCI on the PPI-R correlate to boldness and disinhibition on the TriPM respectively, both in forensic and community samples (32). This is in line with our original hypothesis that disinhibition is associated with weaker emotion regulation and boldness associated with stronger emotion regulation and that these differences might exist also in the general population with TriPM-scores within normal range.

Strengths and limitations

A strength in this study was that we used a neurophysiological correlate for emotion regulation rather than just a self-report scale. A recent study examining a similar task of emotion regulation of negative stimuli, through electrocortical recording rather than fMRI, and self-reported emotional effect found a discordance between self-reported emotional affect

and the physiological data for persons rated high in boldness (33). They showed that participants who scored high in boldness rated their emotional response stronger compared to other participants without showing the expected changes in physiological data (33). This supports the use of neurophysiological correlates if possible when doing research on emotion regulation and psychopathic traits.

This study included healthy participants from a normal population. By restriction of range, the differences in reported psychopathic traits were small. The narrow range of psychopathic traits produced a risk that observable neurophysiological differences would be smaller than in an unrestricted sample. To see significant results, a larger sample would be needed. This could not be done in this project due to limited time and resources. Additionally, a small data set is susceptible for random variance. In our data set of TriPM-scores, high scores in boldness were coincidentally associated with low scores in disinhibition. This could serve as a collinearity effect on this test since increased activity in the dlPFC for a person rated low in boldness simultaneously would show increased activity in the dlPFC in a person rated high in disinhibition.

There is also a concern about whether our sample is representative of the general population. This study was done only on male participants and all participants were young adults. Additionally, our participants rated higher in boldness than in meanness and disinhibition. This could be because persons with low boldness are unlikely to be appealed to by the idea of volunteering to be a part of a research experiment of this nature.

In this study, we used the Swedish translation of the TriPM, which has not yet been validated. This can present an issue when comparing our results to similar international studies in the future.

Notably, in this study we only examine the capacity to regulate emotion. This leaves out a perhaps more important aspect when speaking of psychopathic traits, which is the tendency to cognitively regulate emotion. Capacity of emotion regulation is relevant in this context if there is an abnormal tendency to do so in everyday life (15). One view is that capacity follows tendency and vice versa, due to mutual reinforcement (15). This could be true in a large enough sample of the general population, but it has been questioned whether this can be generalized to various psychopathologies such as psychopathy (15). If emotion regulation is an integral part of psychopathic traits, capacity and tendency are both necessary. We do not have a conclusive answer on how to interpret findings of high capacity and low tendency in a

person without any indication of clinical psychopathy. This presents an issue when trying to draw conclusions from a study of cognitive reappraisal in a normal population.

Clinical applications

The results from this study, being done on healthy males, have limited clinical applications. However, further understanding of psychopathic traits in a normal population can contribute to the general understanding of psychopathy. Increased knowledge of the mechanisms behind psychopathic traits and how they manifest on a subclinical level can help nuance the picture of psychopathy and may in the future help in evaluating not only high-risk reoffenders, but medium- and low-risk reoffenders as well. Additionally, examining the neurophysiological differences across the dimension of psychopathic traits might provide clues to the developmental origins of psychopathy.

Future studies

Future studies on the role of emotion regulation in boldness, meanness, and disinhibition should use a larger sample. TriPM-scores is not the only factor contributing to registered activity under this paradigm. A larger sample would help in reducing random variance and potential confounders.

Using the amygdala as an additional region of interest can also be considered. In this study, we look at dlPFC as a representative for emotion regulation and assume a decreased activity in the amygdala based on previous research (14). Additionally, it would be possible to compare the size of the downregulating effect of the dlPFC on the amygdala to the subscales of the TriPM.

This study was part of a larger project in psychopathy research called genes and brain (GeBra). In a study under the GeBra-project, this paradigm of emotion regulation together with other experimental paradigms for other proposed neural correlates will be tested on a population of diagnosed psychopaths as well as a healthy comparison group.

Conclusion

We found no correlation between activity in the dlPFC during emotion regulation and boldness, meanness or disinhibition. The effects we saw in this study did not follow the direction that we hypothesized for disinhibition and boldness. Our unexpected results could be indicative of a not yet understood mechanism behind low psychopathic traits compared to high, or the result of random variance due to a small sample.

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Appendix A

Formulär: TriPM

Studie- ID: _____

Individ-ID: _____

Datum: _____

Anvisningar: Det här formuläret innehåller påståenden som olika personer kan använda för att beskriva sig

själva. Efter varje påstående följer fyra alternativ ☐ S ☐ s ☐ f ☐ F Dessa fyra alternativ innebär:

☐ S = Sant ☐ s = Delvis sant ☐ f = Delvis falskt ☐ F = Falskt

För varje påstående, fyll i den cirkel som bäst beskriver dig. Inget svar är rätt eller fel; välj bara det svar som bäst beskriver dig.

Fyll i så: ☐ Inte så: ☒ ☐ ☐

Kom ihåg: Fyll bara i en cirkel per påstående. Om du gör ett misstag, kryssa över det felaktiga svaret med X och fyll sedan i det rätta alternativet. Svara på alla påståenden. Var vänlig fyll i omgående och tillbringa inte för mycket tid på något enskilt påstående.

1. Jag är optimistisk större delen av tiden.	☐ S ☐ s ☐ f ☐ F
2. Det är viktigt för mig hur andra människor känner.	☐ S ☐ s ☐ f ☐ F
3. Jag agerar ofta utifrån omedelbara behov.	☐ S ☐ s ☐ f ☐ F
4. Jag har ingen stark längtan att hoppa fallskärm från ett flygplan.	☐ S ☐ s ☐ f ☐ F
5. Jag har ofta uteblivit från saker som jag har lovat att närvara vid.	☐ S ☐ s ☐ f ☐ F
6. Jag skulle njuta av att vara med i en biljakt i hög hastighet.	☐ S ☐ s ☐ f ☐ F
7. Jag är väl rustad för att hantera stress.	☐ S ☐ s ☐ f ☐ F
8. Jag har inget emot om någon jag ogillar blir sårad.	☐ S ☐ s ☐ f ☐ F
9. Mina impulsiva beslut har orsakat problem med nära och kära.	☐ S ☐ s ☐ f ☐ F
10. Jag blir lätt skrämmd.	☐ S ☐ s ☐ f ☐ F
11. Jag sympatiserar med andras problem.	☐ S ☐ s ☐ f ☐ F
12. Jag har uteblivit från jobbet utan att bry mig om att ringa.	☐ S ☐ s ☐ f ☐ F
13. Jag är född till ledare.	☐ S ☐ s ☐ f ☐ F

☐ S = Sant
 ☐ s = Delvis sant
 ☐ f = Delvis falskt
 ☐ F = Falskt

14. Jag njuter av att slåss. ☐ S ☐ s ☐ f ☐ F
15. Jag rusar in i saker utan att tänka efter. ☐ S ☐ s ☐ f ☐ F
16. Jag har svårt att få saker att utvecklas så som jag vill. ☐ S ☐ s ☐ f ☐ F
17. Om jag blir förolämpad ger jag igen på samma sätt. ☐ S ☐ s ☐ f ☐ F
18. Jag har råkat illa ut för att jag har varit borta för mycket från skolan. ☐ S ☐ s ☐ f ☐ F
19. Jag har fallenhet för att påverka människor. ☐ S ☐ s ☐ f ☐ F
20. Det stör mig inte att se någon annan lida. ☐ S ☐ s ☐ f ☐ F
21. Jag har god självkontroll. ☐ S ☐ s ☐ f ☐ F
22. Jag fungerar väl i nya situationer, även när jag är oförberedd. ☐ S ☐ s ☐ f ☐ F
23. Ibland gillar jag att köra med människor. ☐ S ☐ s ☐ f ☐ F
24. Jag har tagit pengar från någons handväska eller plånbok utan att fråga. ☐ S ☐ s ☐ f ☐ F
25. Jag ser inte mig själv som talangfull. ☐ S ☐ s ☐ f ☐ F
26. Jag hånar andra människor bara för att ställa till det. ☐ S ☐ s ☐ f ☐ F
27. Människor missbrukar ofta mitt förtroende. ☐ S ☐ s ☐ f ☐ F
28. Jag är rädd för mycket färre saker än de flesta andra. ☐ S ☐ s ☐ f ☐ F
29. Jag ser ingen poäng med att oro mig för om det jag gör sårar någon annan. ☐ S ☐ s ☐ f ☐ F
30. Jag håller avtalade möten. ☐ S ☐ s ☐ f ☐ F
31. Jag blir ofta snabbt uttråkad och tappar intresse. ☐ S ☐ s ☐ f ☐ F
32. Jag kan återhämta mig från sådant som skulle traumatisera andra. ☐ S ☐ s ☐ f ☐ F
33. Jag sympatiserar med andras känslor. ☐ S ☐ s ☐ f ☐ F
34. Jag har lurat människor för att få pengar av dem. ☐ S ☐ s ☐ f ☐ F
35. Det oroar mig att ge mig in i en obekant situation utan att känna till alla detaljer. ☐ S ☐ s ☐ f ☐ F

☐ S = Sant
 ☐ s = Delvis sant
 ☐ f = Delvis falskt
 ☐ F = Falskt

36.	Jag har inte mycket sympati för människor.	☐ S ☐ s ☐ f ☐ F
37.	Jag hamnar i trubbel för att jag inte tar hänsyn till konsekvenserna av mina handlingar.	☐ S ☐ s ☐ f ☐ F
38.	Jag kan övertyga människor att göra som jag vill.	☐ S ☐ s ☐ f ☐ F
39.	För mig är ärlighet verkligen det bästa mottot.	☐ S ☐ s ☐ f ☐ F
40.	Jag har skadat människor för att se dem lida.	☐ S ☐ s ☐ f ☐ F
41.	Jag gillar inte att ta ledningen i grupper.	☐ S ☐ s ☐ f ☐ F
42.	Ibland förolämpar jag människor med avsikt för att få en reaktion från dem.	☐ S ☐ s ☐ f ☐ F
43.	Jag har tagit saker från en butik utan att betala för dem.	☐ S ☐ s ☐ f ☐ F
44.	Det är lätt att göra mig generad.	☐ S ☐ s ☐ f ☐ F
45.	Saker och ting är roligare om de innebär en viss fara.	☐ S ☐ s ☐ f ☐ F
46.	Jag har svårt för att vänta tålmodigt på sådant som jag vill.	☐ S ☐ s ☐ f ☐ F
47.	Jag håller mig borta från fysisk fara så gott jag kan.	☐ S ☐ s ☐ f ☐ F
48.	Jag bryr mig inte särskilt mycket om det jag gör sårar andra.	☐ S ☐ s ☐ f ☐ F
49.	Jag har förlorat en vän på grund av att jag har gjort ansvarslösa saker.	☐ S ☐ s ☐ f ☐ F
50.	Jag kan inte mäta mig med de flesta andra.	☐ S ☐ s ☐ f ☐ F
51.	Andra har sagt till mig att de är bekymrade över min brist på självkontroll.	☐ S ☐ s ☐ f ☐ F
52.	Det är lätt för mig att relatera till andra människors känslor.	☐ S ☐ s ☐ f ☐ F
53.	Jag har rånat någon.	☐ S ☐ s ☐ f ☐ F
54.	Jag oroar mig aldrig över att göra bort mig inför andra.	☐ S ☐ s ☐ f ☐ F
55.	Det stör mig inte när människor runtomkring mig är sårade.	☐ S ☐ s ☐ f ☐ F
56.	Jag har haft problem på jobbet på grund av att jag varit oansvarig.	☐ S ☐ s ☐ f ☐ F
57.	Jag är inte speciellt bra på att påverka människor.	☐ S ☐ s ☐ f ☐ F

☐ S = Sant ☐ s = Delvis sant ☐ f = Delvis falskt ☐ F = Falskt

58. Jag har stulit något från ett fordon.

☐ S ☐ s ☐ f ☐ F