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**Neuronalne mechanizmy kontroli poznawczej i teorii umysłu u
mężczyzn ze skłonnościami pedofilnymi**

**Rozprawa na stopień doktora nauk medycznych i nauk o zdrowiu
w dyscyplinie nauki medyczne**

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Neuronal basis of cognitive control and theory of mind in men diagnosed with pedophilia

Summary

Introduction

Pedophilic disorder (PD) is characterized by a tendency to engage in preferential sexual activity with children and leads to child sexual abuse in some men with this diagnosis. It is estimated that about 50% of men with PD commit hands-on child sexual abuse (CSO+ group), while the remaining 50% use only child pornography (hands-off sexual abuse), or abstain completely from sexual activity with minors (CSO- group).

The above suggests that there are factors other than the mere presence of PD that may increase the risk of committing a hands-on child sexual abuse. In recent years, more and more studies have highlighted factors that differentiate between men in the CSO+ group and those in the CSO- group. Such factors may include deficits in the ability to recognize mental states of others (theory of mind; TOM), as well as impairments in the cognitive control processes responsible for inhibiting responses, or resolving cognitive conflicts, including the conflict of emotional interference - a situation in which an emotional distractor is presented during a cognitive task.

The goal of the doctoral project

The doctoral project was divided into two stages.

Stage I – Validation study of the Nencki Children Eyes Test procedure.

The goal of the first stage was to develop an experimental procedure to measure TOM skills related specifically to children for later use in stage II – a study of men with PD. In the stage I, the Nencki Children Eyes Test (NCET), which includes images of children's eyes region, was created, validated and adapted for use with functional magnetic resonance imaging (fMRI). This study also used the Reading Mind in the Eyes Test (RMET), which included photographs of the adult's eyes region. Adults working (WC) and non-working with children (NWC) participated in the validation study of the NCET/RMET experimental task.

At this stage, the following research objectives and hypotheses were formulated:

Objective 1: Compare the ability to recognize mental states of children and adults between the WC and NWC groups.

H1: Individuals in the WC group show higher accuracy in NCET, compared to those in the NWC group. No between-group differences are present in the other conditions.

Objective 2: Compare brain activity related to the ability to recognize mental states of children and adults between the WC and NWC groups.

H2: Individuals in the WC group show increased activity of the inferior frontal gyrus (IFG) and posterior superior temporal sulcus (pSTS) when performing the NCET, compared to the NWC group.

Stage II – Study of men with pedophilic disorder.

The purpose of the second stage of the study was to describe behavioral and neural differences related to theory of mind and cognitive control processes between the CSO-, CSO+, and healthy control (HC) groups.

The NCET/RMET task was used to investigate between-group behavioral differences in theory of mind and neural correlates of theory of mind processes. Additionally, the affective Go/No-Go task was also used to investigate between-group differences in inhibition, emotional interference with cognitive processes, and emotional interference with inhibition.

At this stage, the following research objectives and hypotheses were formulated:

Objective 3: Compare the ability to recognize mental states of children and adults between the CSO+, CSO- and HC groups.

H3: Men in the CSO+ group show lower accuracy during recognition of adult mental states (RMET) than the CSO- and HC groups, but not during recognition of children's mental states (NCET).

Objective 4: Compare brain activity related to the ability to recognize mental states of children and adults between CSO+, CSO- and HC groups.

H4: There are between-group differences in the activity of brain areas associated with mental state recognition (IFG and pSTS) during the NCET/RMET task.

Objective 5: Comparing response inhibition abilities between the CSO+, CSO-, and HC groups.

H5: Men in the CSO+ group commit more errors in NoGo trials than men in the CSO- and HC groups.

Objective 6: Compare brain activity related to inhibition, emotional interference with cognitive processes and emotional interference with inhibition, between the CSO+, CSO- and HC groups.

H6: CSO+, compared to the CSO- and HC groups, shows decreased activity of brain areas (DLPFC, ACC, OFC) related to inhibition, emotional interference with cognitive processes and emotional interference with inhibition.

For objectives 7 and 8, it was not possible to formulate hypotheses based on previous research, thus instead, research questions were formulated.

Objective 7: Compare differences in the effect of emotional interference on inhibition processes between the CSO+, CSO- and HC groups.

Q1: Are there between-group differences in the number of errors in NoGo trials, dependent on the valence of the presented distractors?

Objective 8: Compare differences in the effects of inhibitory processes, emotional interference with cognitive processes, and emotional interference with inhibitory processes on response time in the CSO+, CSO-, and HC groups.

Q2: Are there between-group differences in reaction times to Go stimuli, related to inhibition, emotional interference with cognitive processes, and emotional interference with inhibition?

Validation study of the Nencki Children Eyes Test procedure

Method

The NCET/RMET task was used in the study. The task comprised 4 types of blocks: recognition of Adult Mind (AM), recognition of Adult Sex (AS), recognition of Child Mind (CM) and recognition of Child Sex (CS).

Nineteen subjects (10 women) in the WC group and 19 subjects (10 women) in the NWC group participated in the study. All subjects were asked to perform the NCET/RMET task during fMRI.

This was followed by behavioral data analysis and analysis of brain activity measured by fMRI. In the behavioral data analysis, analysis of variance was performed for accuracy and reaction times measured in the NCET/RMET task. A between-group fMRI analysis was also performed to illustrate differences in brain activity during the recognition of children's and adults' mental states.

Results

Adults in the WC group, compared to those in the NWC group, were significantly better at recognizing children's mental states (CM condition; NCET). Simultaneously, no between-group differences were observed in the recognition of adult mental states (AM condition; RMET). Moreover, significant between-group differences were also observed in the fMRI analysis. The WC group, compared to the NWC group, had significantly higher right IFG activity during the recognition of children's mental states (CM > CS; NCET). The WC group also showed significantly higher bilateral IFG and right pSTS activity in the NCET (CM > CS) task compared to the RMET (AM > AS) task. An inverse relationship in the posterior part of the right pSTS was observed in the NWC group. Participants in this group showed significantly stronger activity of this area in the RMET (AM > AS) condition compared to the NCET (CM > CS) condition. Based on the above results, the NCET/RMET procedure was shown to be sensitive enough for use in the next stage of the doctoral project.

Study of men with pedophilic disorder

Method

Three groups of men were recruited for the study - 18 men with PD, with a history of hands-on child sexual abuse (CSO+); 20 men with PD, without a history of hands-on child sexual abuse (CSO-); 19 men for the HC group.

Participants performed the NCET/RMET task and the affective Go-NoGo task during two fMRI sessions. In the affective Go-NoGo task, along with stimuli requiring a response (Go trials) and stimuli requiring an inhibition (NoGo trials), pictures (distractors) were presented either neutrally or negatively valenced.

For all behavioral analyzes, an analysis of covariance was used with age and number of years of education as control variables.

NCET/RMET task

For the NCET/RMET task, accuracy was analyzed and planned contrasts analysis was applied to examine behavioral between-group differences in the recognition of children's and adults' mental states.

This was followed by a between-group analysis of fMRI data restricted to areas active during the recognition of mental states. Additionally, an analysis of areas of interest (ROI) obtained based on a meta-analysis of studies using RMET-type procedures was performed.

Affective Go-NoGo task

For the affective Go-NoGo task, reaction times in Go trials and the number of errors in NoGo trials were analyzed. For the number of errors in the NoGo trials, planned contrast analysis was also used to examine between-group differences in inhibition and emotional interference with inhibition.

A between-group analysis of whole-brain fMRI data and ROI analysis were also conducted to examine intergroup differences in areas of DLPFC, OFC, and ACC.

Results

NCET/RMET task

Men in the CSO+ group, compared to the other groups, had significantly lower accuracy in recognizing adult mental states (AM condition; RMET). In recognizing children's mental states (CM condition; NCET), men in the CSO+ group performed significantly worse only than the CSO- group. No differences were observed in the recognition of children's mental states between the CSO+ and HC groups. Analysis of fMRI data showed no intergroup differences.

Affective Go-NoGo task

Analysis of the number of errors in the NoGo trials showed that men in the CSO+ group made significantly more errors than the other groups did. Emotional distractors increased the number of errors in all groups at a similar level. Nevertheless, analysis of reaction times in the Go trials showed that in the CSO- and HC-groups, emotional distractors caused slowing of reaction - the typical effect of emotional interference. Such slowing was not observed in the CSO+ group.

Analysis of the fMRI data showed that the CSO+ group, compared to the other groups, had decreased right DLPFC activity during blocks in which negative pictures were presented, compared to blocks in which neutral pictures were presented. In addition, the CSO- group, compared to the CSO+ and HC groups, showed increased right middle temporal gyrus activity during response inhibition.

Conclusions

1. Adults who work with children are characterized by a better ability to recognize children's mental states than those who do not work with children.
2. Compared to adults who do not work with children, those who work with children are characterized by higher activity of the inferior frontal gyrus and posterior superior temporal sulcus during recognition of children's mental states, which may reflect the increased importance of children's mental states to those who work with them.
3. Men in the CSO+ group are characterized by a reduced ability to recognize the mental states of adults and children. Men in the CSO- group do not differ from men in the HC group in theory of mind abilities.
4. No differences in brain activity were observed between the CSO+, CSO- and HC groups during recognition of mental states of adults and children.
5. Men in the CSO+ group are characterized by impaired inhibition ability, while men in the CSO- group do not differ from the HC group in terms of inhibition.
6. Men in the CSO+ group show reduced activity of the dorsolateral prefrontal cortex during the presentation of external negatively valenced distractors, showing impaired integration of emotion and cognition, or reduced cognitive control in a negative emotional context. CSO- males show increased activity of the medial temporal cortex during response inhibition processes, which is a potential compensatory mechanism.
7. Negatively valenced distractors cause a similar disturbance of inhibition processes in all the studied groups.
8. The CSO+ group is characterized by an impairment in the integration of emotion and cognition – negatively valenced distractors do not slow down the speed of reaction in this group.