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Multimodal neuroimaging measures and intelligence influence pedophile child sexual offense behavior

Tristram A. Lett^{a,1}, Sebastian Mohnke^{a,1}, Till Amelung^b,
 Eva J. Brandl^a, Kolja Schiltz^c, Alexander Pohl^d, Hannah Gerwinn^d,
 Christian Kärgel^{e,f}, Claudia Massau^{e,f}, Gilian Tenbergen^{g,h},
 Matthias Wittfoth^h, Jonas Kneer^h, Klaus M. Beier^b,
 Martin Walter^{i,j}, Jorge Ponseti^d, Tillmann H.C. Krüger^h,
 Boris Schiffer^{e,f,1}, Henrik Walter^{a,*,1}

^aDepartment of Psychiatry and Psychotherapy, Charité - Universitätsmedizin Berlin, Germany

^bInstitute of Sexology and Sexual Medicine, Charité - Universitätsmedizin Berlin, Germany

^cDepartment of Forensic Psychiatry, Psychiatric Hospital of the University of Munich, Germany

^dInstitute of Sexual Medicine and Forensic Psychiatry and Psychotherapy, Kiel University, Medical School, Germany

^eDivision of Forensic Psychiatry, LWL-University Hospital Bochum, Germany

^fInstitute of Forensic Psychiatry, University of Duisburg-Essen, Germany

^gDepartment of Psychology, State University of New York at Oswego, USA

^hDepartment of Psychiatry, Social Psychiatry & Psychotherapie - Section of Clinical Psychology & Sexual Medicine, Hannover Medical School, Hannover, Germany

ⁱDepartment of Psychiatry and Psychotherapy, University of Magdeburg, Germany

^jDepartment for Behavioral Neurology, Leibniz Institute for Neurobiology, Magdeburg, Germany

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Abstract

Pedophilia is a heterogeneous disorder for which the neurobiological correlates are not well established. In particular, there are no biological markers identifying individuals with high risk to commit child sexual offense (CSO). Pedophiles with CSO (P+CSO; $N = 73$), pedophiles without CSO (P-CSO; $N = 77$), and non-pedophilic controls (NPC; $N = 133$) were assessed using multimodal structural neuroimaging measures including: cortical thickness (CT), surface area (SA), and white matter fractional anisotropy (FA), as well as full scale IQ (FSIQ) performance. Cortex-wise mediation analyses were used to assess the relationships among brain structure,

*Corresponding author.

E-mail address: henrik.walter@charite.de (H. Walter).

¹Authors contributed equally

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FSIQ and CSO behavior. Lower FSIQ performance was strongly predicted with P+CSO (Wald $\chi^2 = 13.0$, $p = 3.1 \times 10^{-5}$). P+CSO had lower CT in the right motor cortex and pronounced reductions in SA spanning the bilateral frontal, temporal, cingulate, and insular regions ($P_{\text{FWE-corrected}} < 0.05$). P+CSO also had lower FA particularly in the corpus callosum ($P_{\text{FWE-corrected}} < 0.05$). The relationship between SA and P+CSO was significantly mediated by FSIQ, particularly in the prefrontal and anterior insular cortices ($P_{\text{FWE-corrected}} < 0.05$). Within P+CSO, left prefrontal and right anterior cingulate SA negatively correlated with number of CSOs ($P_{\text{FWE-corrected}} < 0.05$). This study demonstrates converging neurobiological findings in which P+CSO had lower FSIQ performance, reduced CT, reduced SA, and reduced FA, compared to P-CSO as well as NPC. Further, FSIQ potentially mediates abuse by pedophiles via aberrant SA, whereas the CT and FA associations were independent of FSIQ differences. These findings suggest aberrant neuroanatomy and lower intelligence as a potential core feature underlying child sexual abuse behavior by pedophiles.

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1. Introduction

Pedophilia is a common disorder that denotes the sexual preference for immature (prepubescent) children. The prevalence of pedophilia is difficult to estimate considering the sensitivity of the topic and potential under-reporting. It has been estimated that the frequency of pedophilia is less than 5% (Seto, 2008). Two population-based cohort studies reported the frequency of sexual interest of males in children 12 years and younger is 0.2-0.3%, and 3.0-3.3% in children 15 years or younger (Ahlers et al., 2011; Santtila et al., 2015). However, the results from these cohort studies may underestimate as two studies reported approximately 9% of males have experienced sexual fantasies involving children (Alanko et al., 2013; Briere and Runtz, 1989), with 3.8% of these males admitting sexual contact with children (Alanko et al., 2013). These are considerably high numbers since pedophilia is an important major risk factor for sexual offense against children (CSO) (Mann et al., 2010). However, it is important to distinguish between pedophilia as a sexual preference, and CSO as criminal behavior.

The most consistent finding in pedophilia research to date is lower intelligence in pedophiles that have committed CSO (P+CSO) (Blanchard et al., 2007; Cantor et al., 2004; Tenbergen et al., 2015). The association between P+CSO and lower IQ has been suggested to be independent of sample heterogeneity (such as referral status by lawyer or parole officers), and it is unlikely due to faking of teleiophilia (i.e. the sexual preference for adults) by more intelligent pedophiles (Blanchard et al., 2007; Schiffer and Vonlaufen, 2011; Seto et al., 2011). Lower IQ may be due to the neurodevelopmental perturbations that contribute to pedophilia (Blanchard et al., 2003; Cantor et al., 2004; Kruger and Schiffer, 2011; Mohnke et al., 2014; Schiffer and Vonlaufen, 2011). However, it is unclear if these neurodevelopmental findings are specific to pedophilia or CSO (or the combination of the two) since most studies were conducted in pedophiles with a history of CSO (Mohnke et al., 2014; Tenbergen et al., 2015).

Evidence for a neurodevelopmental basis of pedophilia is supported by magnetic resonance imaging (MRI) studies. Three independent MRI investigations found reduced amygdala volume using voxel-based morphometry in P+CSO men (Mohnke et al., 2014; Schiffer et al., 2007; Schiltz et al.,

2007). However, these studies had small sample sizes, and reduced amygdala volume was not replicated in three subsequent studies (Cantor and Blanchard, 2012; Cantor et al., 2008; Gerwinn et al., 2015; Mohnke et al., 2014). There is also evidence of white matter abnormalities including decreased white matter fractional anisotropy (FA) in the left superior fronto-occipital fasciculus and aberrant seed-based connectivity from this region using probability tractography (Cantor et al., 2015). This finding mirrors previous studies in which pedophiles had decreased volumes in the left superior fronto-occipital fasciculus and the right arcuate fasciculus (Cantor et al., 2008). However, negative findings have also been reported in a small sample using tract-based spatial statistics (Gerwinn et al., 2015). To the best of our knowledge, CT and SA have not been considered separately in MRI investigations of pedophilia. Since CT and SA are independent features of cortical volume with distinct genetic influences (Dickerson et al., 2009; Panizzon et al., 2009; Wierenga et al., 2014), examining these phenotypes separately may provide more specific insight into biological mechanism in pedophilia. Furthermore, almost all of the structural MRI studies have exclusively investigated pedophilic sexual offenders (P+CSO), thus prohibiting clear conclusions whether effects are attributable to sexual preference *per se* or to CSO behavior.

Our study had the following aims: (1) to comprehensively assess structural brain morphology using more recent MRI-based analysis approaches such as whole-brain analyses of CT, SA, and white matter fractional anisotropy (FA), (2) to differentiate between P+CSO, pedophiles who have not committed CSO (P-CSO) and non-pedophilic controls (NPC) in a large neuroimaging sample, and (3) to examine a potential neurobiological mechanism in which intelligence may mediate the association between aberrant cortical morphology and CSO behavior.

2. Experimental procedures

2.1. Participants

Male participants were recruited within the NeMUP (www.nemup.de/index_eng.html) research collaboration among five clinical sites (Charité - Universitätsmedizin Berlin, Hannover Medical School, Universities of Duisburg-Essen,

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