Neuroimaging Pedophilia and Fetishism: A Distinct 'Brainprint' of Sexual Preference

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ABSTRACT

Pedophilia is defined as a persistent sexual interest in prepubescent children and has long been the subject of considerable concern due to its association with sexual offending against children. Despite progress in the neuroscientific understanding of pedophilia, the structural and functional mechanisms underlying it remain unclear, as does its distinctiveness from other paraphilic interests in the brain, which have yet to be investigated using neuroimaging. Additionally, much of the extant research has failed to control for criminality, raising concerns over construct validity. The objectives of this project were to compare non-contact-offending pedophilic men (n=9), fetishistic men (n=15), and teleiophilic men (with sexual interests in sexually mature female adults) (n=16) on measures of brain structure, sexual processing, and self-report tools to better understand the neural underpinnings of pedophilia and, for the first time, compare it to another paraphilia: foot fetishism. **Study 1** examined structural maps of gray matter volumes across the brains of our three groups using voxel-based morphometry (VBM), **Study 2** utilized diffusion tensor imaging (DTI) to investigate white matter microstructure, and **Study 3** used a novel fMRI picture task to compare patterns of functional brain activity when viewing sexually salient paraphilic and non-paraphilic stimuli. Interviews surveyed paraphilic interests, sexual compulsivity, criminality, trauma, and demographic variables. The results of our studies support previous research demonstrating structural and functional differences between pedophilic and teleiophilic individuals, and for the first time distinguished a "brainprint" of pedophilia from that of foot fetishism in exclusively non-contact-offending samples. VBM results demonstrated significantly lower gray matter volumes in the two paraphilic groups across several large, widespread clusters, which were most pronounced in the pedophilic group, particularly in frontal and temporal/limbic regions. DTI results demonstrated significant differences in white matter health between teleiophilic men and the two paraphilic groups, with no differences between men with pedophilia and men with foot fetishism. fMRI results showed unique activity patterns during visual sexual processing of preferred stimuli between all three groups, with significant increases in the overall use of neural resources among both men with pedophilia and men with fetishism. Together, these results open the door for a new line of research on paraphilia.

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CONTRIBUTION OF AUTHORS

This dissertation is comprised of a thesis by articles. The research in all three articles was approved by the Research Ethics Boards of the University of Ottawa and the Royal Ottawa Health Care Group. Throughout the project and beginning with the initial research design and ethics application process, members of the research team contributed to the research strategy, objectives, and methodological design – including Dr. Michael Seto, Dr. Andra Smith, Dr. Martin Lalumière, Dr. James Cantor, Susan Curry, and the late Dr. Paul Fedoroff.

For the first article, *Gray Matter Volume Differences between Pedophilic, Fetishistic, and Teleiophilic Men without Histories of Contact Sexual Offenses*, data analysis was completed by myself with the contributions of Dr. Andra Smith, who oversaw data analysis for all three studies. For the second article, *White Matter Differences among Men with Pedophilia, Men with Foot Fetishism, and Men without a Paraphilia*, an honours student, Sofia McRae, and a data analyst at the University of Ottawa, Dr. Lydia Fang, also assisted with data analysis. For the third article, *A 'Brainprint' of Paraphilia: An fMRI Study of the Functional Correlates of Sexual Processing in Fetishism and Pedophilia*, an honours student, Dani Leclair, and Dr. Lydia Fang also contributed to data analysis.

For all three articles, my own contributions included theoretical and methodological formulations, literature review, study coordination, participant recruitment, facilitation of all aspects of the study protocol, data analysis and interpretation, and manuscript preparation and revision. Dr. Andra Smith oversaw the conceptualization and progression of the articles as well as all data analysis, and Drs Michael Seto and Martin Lalumière also contributed to the editing and revision of all three articles.

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CHAPTER 1

General Introduction

This thesis examines neural differences between men with pedophilia, men with foot fetishism, and men without a paraphilia, because it is unclear whether the results of past research are unique to pedophilia or common to *paraphilias* in general, and/or are associated with pedophilia *independent* of sexual offending behaviours against children. To address these gaps, my study team and I carried out three novel investigations of brain structure and function across these groups of men *without* histories of contact-sexual offenses. Our three studies examine differences in gray matter volume, white matter integrity, and functional brain activity during visual sexual processing, respectively.

The general introduction will define pedophilia and paraphilia, highlight the importance of research in this area, discuss sexual offending against children and its conflation with pedophilic sexual interest, review the etiological and mechanistic hypotheses of pedophilia that have been proposed thus far, and summarize the extant neuroimaging studies of pedophilia and fetishism – including its limitations. Our neuroimaging investigations will be presented across three chapters – each of which constitutes a scientific article for publication. The general discussion will then summarize results across the three studies in this thesis, integrate them, and contextualize our data within the current body of knowledge on pedophilia and paraphilia in the brain.

Definition and Prevalence

Pedophilia is a well-known yet often misunderstood sexual interest in which individuals experience recurrent, intense, and persistent sexual attraction towards prepubescent children (Seto, 2008; World Health Organization, 2019; American Psychological Association 2022). Pedophilia is classified under the wider umbrella of paraphilias, which are defined as “atypical” sexual interests (i.e. involving atypical objects, situations, and/or targets). There is an important distinction to be made between pedophilia and pedophilic disorder, and likewise between paraphilia and paraphilic disorder. The former constitute atypical sexual interests (i.e. children for pedophilia and a wider set of atypical interests for paraphilia), while the latter are outlined in diagnostic and statistical manuals more strictly. Specifically, pedophilic and paraphilic disorder both mandate clinically significant distress and dysfunction as a result of the interests (International Classification of Diseases-11, Diagnostic and Statistical Manual of Mental Disorders-5TR). If an affected individual does not report any distress or dysfunction because of their atypical interest, then they would meet criteria for the paraphilic interest but not the paraphilic disorder. The distinction between pedophilia and pedophilic disorder is rendered moot in most exploratory research, as both imply a risk to child welfare, regardless of the distress imposed on the individual with the atypical interest. Additionally, when applied to other paraphilias, the distinction between interest and disorder is often logically considered to represent an escalation in severity, for example: an individual with foot fetishism would not qualify for a paraphilic *disorder* unless the interest caused them significant distress, whereas they would meet criteria for the paraphilic *interest*. This distinction is important as it avoids pathologisation and stigmatization of alternative sexual interests that are not associated with harm to society. On the other hand, this distinction may be less relevant or intuitive when applied to pedophilia given that, severe or mild, this sexual interest poses an inherent risk to children (Blanchard, 2010). It is likely for this reason that, of all paraphilias, pedophilia has received the most research attention.

Pedophilia is also frequently conflated with sexual offending against children, despite one being an interest and one a behaviour, and neither mandating the other. In fact, it is quite a common misconception that all those who engage in sexual offenses against children have pedophilia, when research suggests that only 40-50% of men who sexually offend against children have pedophilia. Research has also proposed that the lifetime prevalence of pedophilia may only be between 0.3-3.8%, with 3-9% of the general male population endorsing sexual fantasies or sexual contact involving prepubescent children at least once in their life (Briere & Runtz, 1989; Templeman & Stinnett 1991; Fromuth et al., 1991; Maletzky & Steinhauser, 2002; Seto & Lalumière, 2001; Seto, 2008; Ahlers et al., 2009; Alanko et al., 2013; Tenbergen, 2015).

Penile plethysmography (a measure of penile size in response to multimodal sexual material, frequently used in the assessment of pedophilic interests) studies of sexual offenders against children have proposed that up to 30% of those with one offense and 61% of those with three or more offenses against children may meet criteria for pedophilia (Blanchard, 2010; Seto, 2009). Other studies have revealed prevalence rates (in a sample of male college students) to be as high as 21% with some degree of interest in children, 9% reporting fantasies about children, and 5% who had masturbated to orgasm to fantasies involving children. In this study, 9% of responders even reported that they would have sex with a child if they had a guarantee that they would never be caught (Briere and Runtz, 1989).

These data paint a striking contrast to the widely held belief that all child sexual offenders have pedophilia. The distinction between individuals who have pedophilia and people who sexually offend against children but do not have pedophilia is important because meeting criteria for pedophilia has relevant implications for risk of recidivism and the mutability of the individual's sexual interest in children.

Despite the seemingly low prevalence of pedophilia in the general population, the disorder poses a unique risk to child welfare. Studies have shown that pedophilia is one of the strongest predictors of sexual recidivism among identified sex offenders (Hanson & Bussière, 1998; Worling & Curwen, 2000; Hanson & Morton-Bourgon, 2005; Lalumière, Harris, Quinsey, & Rice, 2005; Helmus, Ó Ciardha, & Seto, 2015;), and that approximately 50–60% of offenders against children, and more than two-thirds of child pornography offenders, have pedophilia (Seto, Cantor, & Blanchard, 2006; Seto, 2008). Additionally, due to the reluctance to divulge pedophilic interests and the silence of victims, children run an increased risk of repeated, chronic abuse which goes undisclosed and unaddressed for the duration of the child's proximity to their abuser. Several studies (as well as considerable anecdotal evidence) have demonstrated that children are often reluctant to disclose instances of sexual abuse, to deny when asked, and to retract admissions (Malloy, Lyon, & Quas, 2007; McGuire & London, 2017; Hartman et al., 2023). They therefore run an increased risk of being victims of repeat sexual offending and increased distribution and production of child pornography from individuals meeting the criteria for pedophilia who go unnoticed and untreated. A better understanding of the causes and development of pedophilia is crucial for improving our ability to assess and manage this sexual condition and reduce child sexual abuse and exploitation.

Individuals meeting the criteria for pedophilia are overwhelmingly male (Greenfeld, 1996; Motiuk & Vuong, 2002). Among identified child sex offenders (being comprised of both men and women), those who meet criteria for a diagnosis of pedophilia are also more likely to be men. Despite epidemiological and case studies demonstrating a prevalence of female sexual offenders against children upwards of 1-4%, it is unlikely that these female sexual offenders would meet diagnostic criteria for pedophilia (Denov, 2003). Whether this gender gap is a result of biological/developmental, evolutionary, or socio-cultural influences (or, most likely, a combination) is unclear.

The Etiology of Pedophilia

Several studies have investigated the potential etiology of pedophilia. As with many psychological pathologies, the eternal debate between nature (genetic, neurodevelopmental, and biological factors) and nurture (socio-economic and demographic life context) persists. A brief summary of this etiological research is relevant here because pedophilia is widely considered to be multifactorial, with no single causal pathway accounting for all cases. Instead, it appears that a range of endogenous and exogenous influences are likely contributing to the emergence and maintenance of sexual interests in children. Many of these etiological domains converge on neurodevelopmental pathways, making them particularly relevant to our investigations, which use brain imaging to examine potential neurobiological mechanisms associated with pedophilic interest.

Social and contextual influences. Anecdotal and correlational evidence has suggested that the development of a sexual preference for pre-pubertal children may stem from early childhood trauma. Indeed, individuals diagnosed with pedophilia are significantly more likely to have experienced sexual abuse as children (Cohen et al., 2002; Marx et al., 2020). While adult men with histories of sexually offending are more likely to have been sexually abused as children than those without sex-offense histories (Odds Ratio=3.36), those with histories of sexually offending against children are more likely to have been sexually abused as children than those who have sexually offended against adults (Odds Ratio=0.51). However, men with sexual offenses against children appear to have suffered less *non-sexual physical* abuse than men with sexual offenses against adults (Odds Ratio=1.43) (Jespersen, Lalumière, & Seto, 2009). While this comparison is useful in conceptualizing how child sexual abuse may, in part, account for sexually offending against children during adulthood, these historical differences are not consistent or great enough to suffice as sole etiological mechanism. Pedophilia may also be related to inherent power differentials between adult-child dyads, and on the sense of control which comes along with the abuse of that power (Marshall, 1997; Cossins & Plummer, 2018). As such, some researchers have proposed that pedophilia may be better understood as a coping mechanism for low self-esteem and trauma history rather than sexual preference or orientation. This remains a tempting explanation given the differences in prevalence of child sexual abuse in men who later develop pedophilic tendencies, though it does not suffice (Marshall et al., 1999; Maniglio, 2011; Jahnke et al., 2015).

Additionally, the categorization of childhood sexual abuse as solely a social/contextual influence is controversial. Brain imaging research has contributed to this controversy by revealing long-term effects in the brains of individuals who have suffered psychological trauma early in life (including emotional, sexual, and physical abuse and neglect) (Cassiers et al., 2018; Teicher et al., 2016; Cai et al., 2023). This evidence has blurred the line between neurodevelopmental/biological and social/environmental influences on adult behaviour. For example, one fMRI study found that childhood abuse and neglect were both associated with increased functional activity in limbic and fronto-parietal networks, respectively, following visually threatening facial cues in adulthood, but that combined histories of abuse and neglect were associated with hypo-activation in several higher-order and limbic regions (Puetz et al., 2019). A 2009 study using EEG also reported higher degrees of functional connectivity in several cortical areas in childhood trauma survivors compared to adult trauma survivors and individuals with no history of trauma, with functional connectivity positively correlated with age of onset of trauma (Cook et al., 2008).

Structural MRI data have also suggested that people with histories of trauma may have lower cerebellar volumes than those without, with cerebellar volume being positively correlated with age of onset of trauma and negatively correlated with duration of trauma (De Bellis & Kuchibhatla, 2006). In sum, a history of childhood abuse and neglect may have an effect on the development of healthy connectivity and activation patterns in the brain later in life, as well as on anatomy. The mechanism through which these consequences may influence the development of pedophilic interests in abuse survivors and in what way is unknown.

Neurodevelopmental Indices

Several studies have suggested that pedophilia may more accurately be conceptualized as a neurodevelopmental disorder. In support of this hypothesis, research has found significantly higher rates of minor physical abnormalities at birth, shorter stature, lower IQ, higher rates of left-handedness, and shorter gestational periods in men with pedophilia compared to men without (Cantor et al., 2004, 2005a,b, 2007; Blanchard et al., 2007; Dyshniku et al., 2015; McPhail & Cantor, 2015). Additionally, the prevalence of these characteristics increases significantly as a function of younger victim age. These results and others suggest a relationship between the severity/prevalence of neurodevelopmental abnormalities at birth and degree of pedophilic interest, as indicated by lower victim age. Together, this line of thinking proposes that the blueprint for pedophilia may be determined in utero and may be carried out in conjunction with lived experiences after birth. The widespread evidence for pedophilia as a neurodevelopmental disorder takes many forms and involves genetic, neuroimaging, epidemiological, and qualitative research, as outlined below.

Non right handedness. Non-right-handedness is a subtle perturbation which has been noted in higher-than-normal rates in neurodevelopmental conditions including autism (Soper et al., 1986; Markou, Ahtam, & Papadatou-Pastou, 2017), learning disabilities and dyslexia (Cornish and McManus 1996; Abbondanza et al., 2023), and intellectual disability (Papadatou-Pastou & Tomprou, 2015; Hamaoui et al., 2024). It has also been recorded at equally higher rates in individuals with histories of pre- and peri-natal stressors including premature birth, being a twin, and low birth rate (O’Callaghan et al. 1987; Searleman et al., 1988; Marlow et al., 1989; Ross et al. 1992; Coren 1994; Davis and Annett 1994; Williams et al. 1992; Powls et al. 1996; Gutteling, de Weerth, & Buitelaar, 2007; Domellöf et al., 2011; Heikkilä, 2018; van Heerwaarde et al., 2020). It is relevant in neurodevelopmental research because it may be a proxy for subtle perturbations in brain development beginning early in gestation, as suggested by the above associations.

Several studies have likewise demonstrated higher rates of non-right-handedness in men with pedophilia (Bogaert, 2001; Blanchard et al., 2007; Cantor et al., 2004, 2005; Rahman and Symeonides, 2008; Fazio, Lykins, & Cantor, 2014). Estimates put the prevalence of non-right-handedness in the general population at approximately 10% (Satz, 1972; Soper & Satz, 1984; Perelle & Ehrman, 1994; Papadatou-Pastou et al., 2020), with this feature occurring in approximately 15% of men with pedophilia at lowest estimates (Tenbergen et al., 2015). Higher estimates have proposed that the rate of non-right-handedness may be as much as three times more likely in pedophilic men than in teleiophilic men (men who are attracted to sexually mature adults) (Cantor et al., 2005). Blanchard et al (2007) reported non-right-handedness rates of 25.47% (men with pedophilia), 16.47% (men with hebephilia [who are sexually attracted to pubertal-aged children]), and 11.92% (men with teleiophilic interests) in their data.

Short stature. Though the effects have been historically small, research has consistently demonstrated that men with pedophilia are shorter in stature than teleiophilic men (Mellan, Nedoma, and Pondelickova 1969; Taylor et al. 1993; Cantor et al. 2007; Jung et al. 2014; McPhail and Cantor, 2015; Tenbergen, 2015). Short stature is another phenotype associated with early neurological perturbations occurring both in utero and early in life (Becerra García, 2009; Rabbani et al., 2013; Tenbergen et al., 2015).

Prenatal androgen levels. Pre- and peri-natal androgen levels play a role in dictating brain development and cortical organization (Phoenix et al., 1959; Frye et al., 2020) and have also been associated with handedness, finger length, and second-to-fourth-finger length ratios (George, 1930; Rahman, 2005; Tenbergen et al., 2015). Researchers have questioned whether testosterone levels during critical developmental periods in males may be associated with the development of pedophilic interests and behaviours later in life (Tenbergen et al., 2015). One study (Kruger et al., 2019) found that men who had sexually offended against children showed signs of increased prenatal androgen levels compared to non-offending pedophilic men and teleiophilic controls. They also showed differences in genetic indices of dysfunction in androgen systems early in life, and that these indices and levels of prenatal androgen exposure were associated with number of sexual offenses committed.

These findings, which are specific to child sexual abuse but not pedophilia, call into question whether early-life androgen exposure may have more to do with the behavioural aspects of pedophilia than the preferential ones. In line with this idea, reductions in plasma testosterone levels have proven an effective treatment in reducing incidences of sexual fantasy, urges, and behaviours directed at children in pedophilic individuals (Stoleru, 2008). In non-pedophilic samples, higher levels of plasma testosterone have also been found in men guilty of sexual assault and have been associated with higher levels of aggression and impulsivity (Giotakos, 2003).

Lower cognitive function. Cognitive functioning has been one of the most heavily studied areas in pedophilia research, and the most referenced in neurodevelopmental etiological hypotheses. Lower cognitive function has been linked to a variety of early adverse events during neurodevelopment, including acquired brain damage during infancy or early childhood (i.e. traumatic brain injury, hypoxic events, brain tumors, and epilepsy), exposure to teratogenic substances during gestation and/or toxic substances after birth, and several genetic disorders (Gottfried 1973; Needleman et al. 1990; Hayes and Batshaw 1993; Radcliffe et al. 1994; Dennis and Barnes 1994; Frydman 1996; Olson et al. 1998; Neyens et al. 1999; Taylor et al. 1999; Wesseling et al. 2001). Many studies have demonstrated that individuals with pedophilic preferences and/or behaviours tend to have lower cognitive function than their teleiophilic counterparts, whether they be offenders or not. These deficits are present in several areas including executive function, memory, processing speed, and general intelligence.

For example, several studies have shown that both men with pedophilia and non-pedophilic sexual offenders tend to demonstrate general deficits in executive function compared to men without criminal offenses, and men with pedophilia also seem to exhibit additional patterns of cognitive impairment, especially in information processing and response inhibition, compared to both non-pedophilic sexual offenders and non-offending men (Eastvold et al., 2011; Kruger & Schiffer, 2011; Schiffer and Vonlaufen, 2011; Suchy et al., 2009, 2014). However, some have also proposed that while men with pedophilia exhibit specific deficits in these two areas, they may simultaneously score higher on measures of planning and abstract processing compared to both controls and non-pedophilic offenders (Eastvold et al., 2011; Habermeyer et al., 2013).

Cantor et al. (2004) revealed that in men convicted of sexual offenses, lower IQ scores were associated with greater number of child victims and higher IQ scores with greater number of consensual adult sexual partners. Lower IQ scores were also associated with positive phallometric responses to child stimuli, and vice versa for adult stimuli. When compared on the basis of phallometric responses to child versus adult stimuli, men with a sexual interest in children had a significantly lower average IQ score than both hebephilic and teleiophilic men.

Cantor et al (2005) then replicated their earlier finding, specifying that sexual offenders against children tend to have lower IQs than both sexual offenders against adults and non-sexual offenders (who had the highest IQ of the three groups), and that the lower the age-preference of the individual with pedophilic interests, the lower the IQ tended to be. It is important to keep in mind, however, that these studies (and so many like them) were limited to offending populations. Therefore, it remains unclear whether these trends exist in non-offending community members with pedophilic interests. Additionally, these results remain clouded by other studies that have failed to identify any significant differences in executive function (in terms of performance on neuropsychological tests) in men with pedophilia compared to other groups (e.g. Cohen et al., 2002).

Research also shows that men who sexually offend and who have intellectual disabilities tend to exhibit a greater preference for pre-pubertal children, male children, and young children, and are more likely to have had victims with these characteristics than men who sexually offend and are of average intelligence (Rice et al., 2008). Blanchard (2007) found that men with pedophilia had lower IQs (90.75 for pedophilic men, 97.72 for hebephilic men, and 100.1 for teleiophilic men) and a lower level of education (average of 10.75 years for pedophilic men, 11.51 years for hebephilic men, and 12.07 for teleiophilic men) than others in a sample of sexual offenders, though comparisons of IQ and years of education were not significantly different between groups. Nevertheless, the consistently lower IQ and years of education, paired with higher instances of non-right handedness and other indications of altered development in men with pedophilia is intriguing and requires further investigation.

Minor physical anomalies. Minor physical anomalies present at birth are subtle but common. They suggest an interruption of normal prenatal development and sometimes signal concomitant anomalies in brain structure and function. These early gestational physical anomalies are thought to hail from adverse events in-utero including hypoxic trauma (events in which the fetus suffers from a lack of oxygen – ischemia, hemorrhage, etc.), teratogen exposure (drug use, exposure to toxic substances which can penetrate the blood-placental barrier), genetic factors, poor maternal nutrition, infection, or other adverse events occurring during pregnancy (Gilbert-Barness, 2010). They are often harmless to the individual and can take the form of minor deviations in skin formation (i.e. attached earlobes, altered eye-folds), hair texture, head shape and size, mouth anatomy, and the skeletal structure of the fingers and toes (i.e. digit length, curve of fifth finger, differences in palmar creases) (Firestone, 1983). Most develop during the first and early second trimesters (Trixler, Tenyi, Csabi, & Szabo, 2001; Compton & Walker, 2009; Akabaliev, Sivkov, Mantarkov, & Ahmed-Popova, 2011). As the sequence of fetal development occurs in a predictable order, researchers have suggested that the occurrence of minor physical anomalies can help to suggest what periods of development may have been affected.

Research on minor physical anomalies has suggested that they are more common in children with behavioural difficulties (i.e. hyperactivity, impulsivity, conduct issues), as well as in individuals with psychological diagnoses (i.e. schizophrenia, fetal alcohol spectrum disorder, bipolar disorder, and autism spectrum disorder) (Marino, Scholl, Karp, Yanoff, & Hetherington, 1987; Compton & Walker, 2009; Tenyi et al, 2009; Ozgen et al., 2010).

There is controversy as to whether the presence of minor physical anomalies in pathological groups is sexually dimorphic (Weinberg et al., 2007). Some studies have suggested that there is an increased number among males compared to females with schizophrenia (Marcus et al., 1985; Akabaliev and Sivkov, 2003; Sivkov and Akabaliev, 2004). Firestone & Peters (1983) revealed increased incidences of minor physical anomalies in several pathological conditions including individuals with learning disabilities, autism spectrum disorder, and males more than females, with correlations between incidence of physical anomalies and obstetrical complications during gestation as well as incidence of minor physical anomalies in the fathers. However, other studies have either suggested greater prevalence of these anomalies in women with schizophrenia (Lal and Sharma, 1987; Green et al., 1989; Green et al., 1994b) or found no sex-differences (Cantor-Graae et al., 1994; McGrath et al., 1995; Akabaliev and Sivkov, 1998; Gourion et al., 2004a,b; Joo et al., 2005).

In pedophilia, evidence thus far has suggested that contact-offending men with pedophilia have significantly higher numbers of craniofacial anomalies than teleiophilic men who have sexually assaulted adults, and that higher number of these anomalies is correlated with higher rates of left-handedness in pedophilic men (Dyshniku et al., 2015). As evidence of craniofacial anomalies can begin to appear as early as 3-5 weeks into gestation (Miller et al., 2005) and of handedness as early as 10 weeks into gestation (Hepper et al., 1998; McCartney & Hepper, 1999; Hepper et al. 2005; Hepper, Wells, & Lynch, 2005), developmental missteps in these two areas may be indicative of early perturbations to normal fetal development. Several authors have argued that, because many pathological groups show evidence of significantly high numbers of craniofacial anomalies compared to non-pathological controls, the presence of these anomalies may represent a common first-step in the development of multiple psychological pathologies later in life, including pedophilia (Dyshniku et al., 2015). Fazio et al. (2015) also found that not only did men with pedophilia have significantly lower statures than teleiophilic men, but specifically, they had shorter leg-lengths, with average length-differences comparable to samples of individuals with diagnoses of other neurodevelopmental disorders.

Genetic evidence. Preliminary evidence for the role of genetic influences in the development of pedophilia further supports the idea of the first developmental events occurring long before birth and being hereditary in nature. For example, cases of pedophilia may cluster in families with common atypical sexual fantasies and behaviours (Gaffney et al., 1984; Alanko et al., 2010) and there may be significant associations between single-nucleotide polymorphisms (colloquially, genetic markers) linked with several sex-related hormones (androgen, estrogen, prolactin, corticotrophin, serotonin, and oxytocin) and pedophilia, though these associations suffered from small effect sizes and did not remain significant after controlling for multiple comparisons (Alanko et al., 2016).

Men with pedophilia also tend to have more older brothers and greater maternal age (Lalumière et al., 1998; Côté et al., 2002; Rahman and Symeonides, 2008). Additionally, homosexual pedohebephilic men (men with sexual interests in both pre-pubertal and early-pubertal children) tend to have more older brothers and sisters (Blanchard et al., 2020). This finding is in line with the theory of a “fraternal birth order effect”, which proposes that the existence of older brothers increases the likelihood of homosexuality in later-born males (Blanchard & Sheridan, 1992). The fact that teleiophilic and pedohebephilic men are both subject to this effect reinforces the idea that pedophilic interests may also be influenced by genetic factors, especially if one considers pedophilia to be a sexual orientation.

A 2010 study (Alanko et al.) of twins showed genetic associations with sexual interest, fantasy, and behaviour directed at children, though heritability in this study was then only found to explain 14.6% of variance in these variables (Alanko et al., 2013). Another study investigated potential heritability markers for pedophilia in families with high rates of the sexual disorders and found that they had higher numbers of genetic carriers for neurodevelopmental and neurological disorders, blindness, deafness, and epilepsy (Labelle et al., 2012). Epigenetic studies provide another interesting avenue for investigation. Epigenetics refers to the study of how gene expression is regulated via endogenous molecular helper enzymes (Rodenhiser and Mann, 2006). Epigenetics are regulated by environment-gene interactions in parents and have long-lasting effects on the physiology of children. A 2019 study (Kruger et al.) proposed that the high levels of prenatal androgen exposure seen in pedophilic men occurred as a result of epigenetic factors in the parents (i.e. methylation of the androgen receptor gene), reinforcing the idea that atypical sexual preferences may be at least in part heritable.

Head injuries early in life. Research has also consistently demonstrated that men with pedophilia tend to have higher rates of head injuries early in life – when the brain is engaged in pruning and development and is highly vulnerable to injury. Blanchard et al. (2002, 2003) showed that pedophilic offenders had double the likelihood of having sustained a head injury before 13 years old, but not after age 14. As a result of this loss of significant difference after the age of 14, the authors proposed that this may highlight the causative effect of early-life head trauma on cognitive functioning. Early-life (i.e. prior to age 13) head injuries resulting in loss of consciousness, especially, seem to be associated with pedophilia, as well as with diagnoses of attention deficit and hyperactivity disorder, left-handedness, and lower levels of intelligence and education (Blanchard et al., 2002, 2003; Tenbergen et al., 2015).

Summary. Together, these results suggest that the developmental blueprints for pedophilia may be laid out with the contribution of pre- and peri-natal factors affecting typical development and may be aided by the addition of adverse lived experiences in early life.

I find it pertinent to note here that to emphasize neurodevelopmental influences in the etiology of pedophilia is not to imply that there is a singular, deterministic causal trajectory. Rather, such factors are best understood as contributing to an increased risk for the development of sexual interests in children later in life via their interaction with other social, environmental, and behavioral variables that may *not* act through neurodevelopmental pathways. Importantly, the use of neuroimaging to investigate pedophilia does not, in itself, imply solely a neurodevelopmental origin. Structural brain differences, which reflect the outcomes of early-life brain organization and pruning, are indeed consistent with a neurodevelopmental account. However, functional brain patterns may reflect more plastic, experience-dependent processes shaped across the lifecourse. Thus, a neurodevelopmental interpretation of functional imaging findings requires caution unless they are observed in conjunction with structural alterations, as we investigate across our three studies. Ultimately, neurodevelopmental theories offer a crucial lens through which to examine the etiology of pedophilia, but they must be situated within a broader, multifactorial framework that accommodates the interplay of biological and psychosocial determinants across development.

Pedophilia and the Brain

Research on sexual interests in children has improved our understanding of the neurobiological, psychophysiological, and behavioural correlates of pedophilia, with more studies needed to investigate the combined contributions of neural and behavioural variables. Indeed, a recent review emphasized that although no single biomarker currently offers diagnostic utility, converging evidence from neuroimaging, arousal measurement, and executive functioning investigations points toward a multi-dimensional profile of pedophilic interest (Jordan et al., 2020). Studies collecting neural, behavioural, and self-report data may be able to shed further light on this topic by elucidating the multifold mechanisms associated with pedophilic interests. Studies using structural and functional MRI have begun to reveal neural differences between men with pedophilia and teleiophilic men. However, pedophilia appears to be etiologically and mechanistically multifaceted (consider the many cogent, evidence-informed, and yet diverse hypotheses and contributing variables discussed above), and study methodologies have been heterogeneous to date; thus, consistent neuroimaging results have been difficult to acquire.

Magnetic Resonance Imaging. Magnetic resonance imaging (MRI) is a multimodal nuclear imaging technique that can provide measurements of both brain structure (anatomy) and function (physiology). MRI uses strong magnetic field gradients and radio waves to generate image contrasts between tissue/fluid types and movement in the body based on molecular composition. MRI is a non-invasive, relatively risk-free technique which does not require the use of x-rays, ionizing radiation, or injection of contrast agents.

In structural MRI, image contrasts can be used to view various aspects of brain morphology with a high level of specificity (1-2mm). In diffusion-weighted imaging (DWI), contrasts are used to view the movement of water molecules in the white matter tracts of the brain to investigate nerve-fibre integrity (specifically, diffusion tensor imaging [DTI]). In functional MRI (fMRI), repeated image contrasts over time are used to identify regions of increased blood flow during neural activity with a temporal resolution of approximately three seconds. In functional connectivity, the temporal coincidence of spatially distant functional events is correlated to infer functional neural networks. When used in combination, these various techniques allow for researchers to quantify brain structure (volumes, density, topography), function (regions or networks of activation in response to external stimuli or at rest), and tractography (the integrity and activity of axon tracts between gray matter regions), and to compare between individuals or groups under various conditions and cognitive demands.

Structural Imaging Data. One method of structural MRI is voxel-based morphometry (VBM) where quantifying volumes of brain structures is possible. A voxel refers to a discrete three-dimensional unit of brain tissue which, in VBM, is quantified by comparing it to surrounding voxels mapped onto a template. This allows for researchers to compare regional gray or white matter volume between brain regions of an individual and in the same regions between participants or groups. Structural MRI can also provide measurements of cortical thickness (gray matter making up the cerebral cortex) and structural connectivity (white matter tracts connecting areas of gray matter) to provide insights into information processing and communication structures, respectively (Symms et al., 2004; Hutton et al., 2008; Bandettini, 2009; Wattjes, 2011).

Despite inconsistent results in the structural imaging research of pedophilia, largely due to confounding demographic and participant-level variables as well as varying imaging protocols, studies have repeatedly identified density and integrity differences in several gray and white matter regions between men with pedophilia and men without (Mohnke et al., 2014; Tenbergen et al., 2015). Reliably, studies have demonstrated lower amygdalar gray matter volume in pedophilic men compared to non-pedophilic men (Schiltz et al., 2007; Poeppl et al., 2015; Schiffer et al., 2017). Other areas of lower gray matter volume, less reliably identified, include the hypothalamus, cerebellum, inferior frontal gyrus, cingulate cortex, insula, precuneus, parahippocampal gyrus, superior and middle temporal gyri, and putamen (Schiffer et al., 2007; Schiltz et al., 2007; Poeppl et al., 2013; Cantor et al., 2015; Poeppl et al., 2015; Schiffer et al., 2017; Klöckner et al., 2021; Scarpazza et al., 2021). However, differences in gray matter macrostructure between pedophilic and non-pedophilic men are not always replicated (Gerwinn et al., 2015).

Gray Matter Volumes. Gray matter volume is positively correlated with the density of neurons and synapses, which are central to information processing and to supporting cognitive functions. Lower gray matter volume is considered disadvantageous because it is associated with poorer cognitive performance and is a common feature of neurodegenerative diseases and brain injury (Seeley et al., 2009; Nave et al., 2019). Neuroimaging researchers have proposed that gray matter differences in men with sexual interests in children may help account for behavioural and preferential differences between pedophilic and non-pedophilic men. Many posit the frontal lobes as being key players in the development of pedophilic interests. Specifically, several researchers have reported orbitofrontal and bilateral dorsolateral prefrontal cortex volume differences between pedophilic and non-pedophilic individuals (Graber et al., 1982; Flor-Henry et al., 1991; Burns and Swerdlow, 2003; Schiffer et al., 2007, 2008a,b). Though the nature of these differences varies from study to study, a majority have found smaller volumes in these areas in pedophilic participants compared to those without pedophilia. The orbitofrontal cortex is associated with behavioural control, specifically in the inhibition of sexual behaviour (Bechara et al., 2000; O'Doherty et al., 2003), introducing the idea that smaller volumes in this area may be related to sexual offending in pedophilic men.

Temporal lobe structural differences have also been repeatedly implicated in neuroimaging research on pedophilia. Several studies have suggested that temporal lobe perturbations (including temporal lesions and hippocampal damage) may be related to hypersexuality and greater diversity of sexually deviant interests in pedophilia (Hucker et al., 1986; Langevin et al., 1988; Mendez et al., 2000).

Research has also suggested that the differential development of sexually dimorphic brain structures during masculinization of the male brain (i.e. increased exposure to testosterone) may preferentially alter brain structures associated with pedophilic preferences and behaviour in some males. However, many of the results of research focusing on these correlates are inconsistent and inconclusive (Cantor et al., 2008; Tenbergen et al., 2015). While several published case studies exist on the subject and provide promising insight, they should be interpreted with caution, as the vast majority of neuropsychological cases with similar injury or disease do not result in pedophilic tendencies, and several case studies have included men with histories of intra-familial child sexual abuse prior to disease onset.

Widespread regions of lower gray matter volume have been reported in men with pedophilia across multiple studies, even after correction for multiple comparisons in whole brain analyses. Schiffer et al. (2007) reported smaller gray matter volumes in the bilateral orbitofrontal cortex, insula, and ventral striatum (putamen), in the precuneus, left posterior cingulate, the superior and right middle temporal gyri, the parahippocampal gyrus, and the cingulate cortex compared to sexual offenders against adults. Schiltz et al. (2007) reported lower gray matter volume in the right amygdala, right septal region, bed nucleus striae terminalis, hypothalamus, and the substantia innominata bilaterally in pedophilic forensic inpatients compared to non-forensic teleiophilic individuals. Poeppl et al. (2013) compared convicted pedophilic offenders to non-pedophilic, non-sexual criminal offenders and noted gray matter volume reductions in the centromedial nuclei group of the right amygdala, extending to the laterobasal nuclei group and the cornu ammonis of the hippocampus, though this did not survive correction for multiple comparisons. They did, however, demonstrate associations between the intensity of pedophilic interests and increased likelihood of sexual recidivism with gray matter volume decreases in the left insular and dorsolateral prefrontal cortices, as well as between a sexual preference for younger-aged children and gray matter decreases in the orbitofrontal cortex and bilateral angular gyri. The most consistent result in studies of gray matter differences between men with pedophilia and men without a paraphilic interest seems to be reduced amygdalar volume (Schiltz et al., 2007; Poeppl et al., 2013; Schiffer et al., 2017).

White Matter Structure. Diffusion tensor imaging (DTI) is another structural MRI method that allows for the investigation of white matter health, integrity, and microstructure. DTI measures the flow of water molecules along white matter tracts, where healthy and intact white matter fibers allow for water molecules to freely flow in their direction of communication and restrict water molecules from flowing across or through them. When white matter is compromised, this directionally dependent flow is diminished in favour of more widespread and random water diffusion. This is measured via fractional anisotropy (FA), which refers to the directionally dependent diffusion of water through tissues on the whole (higher values indicating that water movement is more restricted by white matter structure, as seen in cases of higher tract integrity) (Alexander et al., 2007; O'Donnell & Westin, 2011; Alvez, 2018). Fractional anisotropy also allows for measurement of multiple parameters of water movement through axons such as mean diffusivity (MD; referring to the overall diffusivity of water molecules in all directions, with higher values indicating less directionality, as seen in physical damage to white matter tracts), axial diffusivity (AD; the movement of water molecules along the length of fibers), and radial diffusivity (RD; the movement of water perpendicular to the longitudinal axis of the tract) (De Erausquin & Alba-Ferrara, 2013; Cantor, 2015). These analyses allow researchers to further specify the nature of microstructural differences in white matter between groups and individuals, though they do not allow for inferences regarding the structural connectivity of white matter networks, only the health of these tracts in general.

In order to study the interconnectedness of white matter networks in the brain, a DTI method called probabilistic tractography is employed, consisting of building probability maps of white matter voxel connectivity across space to illustrate the likeliest white matter communication channels from region to region (Parker, Haroon, & Wheeler-Kingshott, 2003; Ciccarelli et al., 2006). Probabilistic tractography can be used in research to establish the strength of connections between white matter seed regions previously identified using FA, yielding information about how effective different functional regions may be at communicating with one another.

While fewer studies have investigated white matter differences in pedophilia, some have suggested that men with pedophilia may differ from teleiophilic men in terms of white matter volume, connectivity, and integrity. There is, however, no consistent finding. In 2008, Cantor et al reported white matter volume differences in the superior fronto-occipital fasciculus and the right arcuate fasciculus in men with pedophilia and with sexual offense histories compared to non-sexual offenders. Follow-up research replicated these results and understood them as representing disrupted communication between these regions in pedophilic individuals (Cantor and Blanchard, 2012). Complementary results in cognitive research on pedophilia have shown that pedophilic individuals and men who sexually offend against children score significantly lower than healthy controls on measures of processing speed (Suchy et al., 2009, 2014; Eastvold et al., 2011; Dillien et al., 2020; Turner et al., 2020). Whether these cognitive sequelae are direct manifestations of white matter deficits in pedophilic individuals remains uncertain, thus, further investigation is required.

In a 2015 study, Cantor et al. also noted widespread patterns of different white matter connectivity in pedophilic sexual offenders compared to non-offending men without pedophilia, identified via probabilistic tractography. Specifically, they noted differences in patterns of white matter connectivity, not a net lack of connectivity, in the pedophilic sample, with a significantly greater connectivity between some regions and significantly less between others. A group difference was identified in a white matter region (a small left-sided cluster of higher FA in pedophilic men through which pass multiple tracts) with sources in the insula/operculum, superior temporal gyrus, temporal pole, occipital cortex, dorsolateral prefrontal cortex, temporal–occipital junction, superior parietal lobule, frontal pole, and thalamus (all on the left). They highlighted that the white matter tracts they identified connected gray matter regions identified by meta-analytic research on sex-processing networks in the brain (including Kühn & Gallinat, 2011; Stoléru et al., 2012; Poeppl, Langguth, Laird, & Eickhoff, 2014).

Other studies have produced conflicting results. For example, Gerwinn et al. (2015) reported no significant differences in white matter integrity between pedophilic and teleiophilic participants, as measured via FA and MD. By contrast, Lett et al. (2018) found that pedophilic individuals with a history of child sexual offending exhibited widespread reductions in FA when compared to both non-offending pedophilic men and men without pedophilia (some of whom had histories of violent or general criminal behaviour). Clearly, more studies are needed to clarify the nature of white matter differences in men with pedophilia.

Functional Imaging Data. Functional MRI (fMRI) measures the flow of oxygenated blood to brain regions to infer neuronal activity. The method relies on the physiological principle that increased use of neurons leads to a higher metabolic rate and need for oxygen, following which oxygenated blood is directed to active regions. The delivery of oxygen-rich blood to active brain structures is known as the hemodynamic response, and occurs following a short and predictable delay of approximately 6 seconds (Liao et al., 2002). fMRI tracks the delivery of oxygenated blood by tracking the magnetic signal of oxyhemoglobin versus that of deoxyhemoglobin. In comparing multiple contrasts over time, fMRI can accurately measure the metabolic needs of brain regions while a participant is engaged in a cognitively demanding task (task-based fMRI) or is at rest (resting state fMRI) (Huettel, Song, & McCarthy, 2004; Buxton, 2009; Glover, 2011). By correlating brain activity in regions of interest with the temporal order of activities performed during scanning (controlling for the delay of the hemodynamic response), task-based fMRI can provide insight into the brain regions necessary to carry out various cognitive tasks (i.e. determining which brain regions are active during the visual processing of sexual stimuli). Measuring brain activity at rest allows for insights into baseline neural network activity when a person is not engaged in a cognitively demanding activity (Lee, Smyser, & Shimony, 2013). Both methods provide opportunities to compare resting state and task-dependent brain function within a single individual over time, between individuals, and between groups of differing pathologies – allowing for insights into the functional mechanisms underpinning cognitive and disease states.

Functional neuroimaging research of pedophilia has yielded heterogeneous results to date and has consisted of many case studies or controlled studies with small sample sizes. Targets for functional comparison have three main themes: a) comparing within-group neural activity between conditions of sexual stimuli (e.g. child vs adult), b) examining between-group differences when viewing the same type of stimuli (e.g. child or adult), and c) comparing between-group functional activity when each group is viewing their preferred stimulus-type (e.g. children for men with pedophilia and adults for teleiophilic men) (Mohnke et al., 2014). The vast majority of studies have identified functional differences in the processing of sexually-preferred stimuli between pedophilic and teleiophilic men, though there has been no consensus on which regions (or collections of regions) differ, and whether these areas are more or less active in pedophilic individuals.

Despite inconsistencies, a majority of studies have identified commonalities in neural activation patterns on whole brain within-group analyses for both pedophilic and teleiophilic men for their sexual demographic of interest. These common areas during preferential sexual processing consist of the fusiform gyrus, occipital cortex, cerebellum, anterior cingulate cortex, and substantia nigra. Importantly, meta-analytic results have suggested that on average, pedophilic men also tended to recruit additional areas including the middle frontal gyrus, superior parietal lobule, hippocampus, and insula (Kühn & Gallinat, 2011; Mohnke et al., 2014; Poeppl et al., 2014). Men with pedophilia also tend to recruit the amygdala more when viewing child stimuli compared to adult stimuli or compared to teleiophilic men viewing adult women (Sartorius et al., 2008; Schiffer et al., 2008a; Poeppl et al., 2011; Ponseti et al., 2012; Polisois-Keating & Joyal, 2013).

These results are important because they may suggest a compensation mechanism occurring during sexual processing in pedophilia, in which the brains of pedophilic men may be recruiting additional areas not typically involved in sexual processing (or over-recruiting areas already involved in sexual processing) in order to make up for underlying deficits in one or more areas (e.g. the amygdala).

Between group comparisons of functional activity patterns between pedophilic and teleiophilic men have been heterogeneous, with contradicting studies identifying both increased and decreased activation of a large number of brain areas in both groups (Mohnke et al., 2014; Tenbergen et al., 2015). Walter et al. (2007) found activation decreases in the hypothalamus, dorsal midbrain, dorsolateral prefrontal cortex, and right lateral parietal, right ventrolateral, and right occipital cortices, as well as in the left insula in pedophilic sexual offenders while viewing sexual stimuli compared to non-pedophilic healthy controls. These results were interpreted as the potential basis for impairment in typical sexual attraction toward adults. Additionally, lower activity in the left dorsolateral prefrontal cortex was correlated with higher scores on the child abuse subscale of the Multiphasic Sexual Inventory (Simkins, 1989).

Poeppl et al. (2011) found that when viewing their stimuli of interest (children for pedophilic men and adults for teleiophilic men), the pedophilic group showed more activity in the postcentral gyrus, right middle temporal gyrus, anterior midcingulate cortex, and the bilateral insula, with no regions of higher activity in the teleiophilic group. Similarly, Cazala et al. (2019) found that when viewing child-stimuli, pedophilic men showed more bilateral activation of the lateral occipital and temporal cortices, and activity was correlated with self-reported ratings of sexual arousal. Mannfolk et al. (2023) compared both offending and non-offending pedophilic men to men without pedophilia and found higher activity in widespread clusters in the pedophilic groups compared to the teleiophilic group when viewing children, including in occipital, temporal (bilateral hippocampus), parietal, frontal, cingulate, and left insular cortices, and the thalamus, cerebellum, and bilateral caudate nuclei. They also reported increased reaction times in pedophilic participants when viewing child stimuli, indicating differences in executive function, which was not seen in the teleiophilic group for their stimuli of preference.

Across studies, a few main hypotheses dominate the functional neuroimaging research on the neural correlates of pedophilia. The most recurrent of these posit that the most consistent differences exist between pedophilic men and teleiophilic men in the functioning of the frontal and temporal lobes during sexual processing. Specifically, researchers most often propose that alterations in the activation of key frontal and temporal structures during sexual arousal may contribute to impulsive sexual behaviour, hypersexuality, increased variety of atypical sexual interests, and inappropriate sexual fixation on children (Mendez et al., 2000; Schiltz et al., 2007; Seto, 2008, 2009; Ponseti et al., 2012; Poeppl et al., 2013; Tenbergen, 2015).

Multiple researchers have also proposed that the behavioural aspects of pedophilia may stem from functional differences in frontal lobe structures (e.g. orbitofrontal and dorsolateral prefrontal cortices), while preferential aspects may have more to do with temporal functional alterations (e.g. the amygdala and hippocampal structures) (Seto, 2008, 2009; Poeppl et al., 2013; Tenbergen et al., 2015). Additionally, activation differences during exposure to preferred sexual stimuli have been noted in the caudate nucleus, cingulate cortex, insula, fusiform gyrus, temporal cortex, occipital cortex, thalamus, amygdala, and cerebellum of men with pedophilia compared to teleiophilic men (note: sexual offending history was not an exclusion criterion in this study) (Ponseti et al., 2012). The researchers also noted that these areas had all been previously implicated in research identifying generalized sex-response network in men without pedophilia.

Overall, while the functional imaging data in pedophilia is inconsistent, some common themes emerge: men with pedophilia tend to show functional differences in the processing of their sexually-preferred stimuli compared to teleiophilic men, and these differences are most commonly found in frontal and temporal/limbic regions. Several studies have supported the idea that pedophilic men may over-recruit some brain regions during sexual processing as a compensation mechanism for deficits elsewhere (note: consistently lower amygdalar volumes in pedophilic men, for example). However, this hypothesis has not been universally accepted. With respect to regions of interest, it is encouraging that the majority of functional differences have been identified in frontal and temporal regions. The arguments for preferential differences originating in these regions during sexual processing in pedophilia are compelling given research on the general human sexual response (see the section below: "**The 'Sex-Response Network'**"), which suggests that frontal and temporal areas are the most heavily implicated in the processing of sexually relevant stimuli. Further research is undeniably warranted.

The "Sex-Response Network". As outlined above, imaging studies of sexual arousal have identified a concerted network of areas which, together, are involved in the processing of visual sexual stimuli. Repeated observations have justified the coining of a "sex-response network" (Kühn & Gallinat, 2011; Stoleru et al., 2012; Poeppl et al., 2014; Ruesink & Georgiadis, 2017). This network has been further subdivided into activity during "sexual wanting" and "sexual liking", and is thought to involve the occipitotemporal cortex, superior parietal lobule, ventral striatum, amygdala/hippocampus, orbitofrontal cortex, anterior cingulate cortex, and anterior insula (wanting), and the hypothalamus, anterior and posterior insula, ventral premotor cortex, middle cingulate cortex, and inferior parietal lobule (liking) (Georgiadis & Kringelbach, 2012). These various regions have also been implicated in arousal, reward, memory, cognition, self-referential thinking, and social behaviour (Ruesink & Georgiadis, 2017).

Differences in the sex-response network have been identified in brain structure and function among men with pedophilia, indicating that this collection of regions may be a useful target for between-group comparisons in the future (Cantor et al., 2015; Poeppl et al., 2015; Cantor et al., 2016; Ruesink & Georgiadis, 2017). Research has also suggested that differences in the functioning of this sex-response network in men with pedophilia may be related to poorer connectivity of white matter tracts between various regions therein, warranting further investigation (Cantor et al., 2008). Overall, the sex-response network has been repeatedly identified as a reliable marker of sexual arousal, and studies have begun to identify deviations according to sexual interest. This suggests that it may play an important role in distinguishing the neural correlates of 'typical' versus 'atypical' sexual interests, as in pedophilia and other paraphilias, including fetishism.

What is Fetishism and Why Study it

Thus far, the majority of imaging research on paraphilias has focused on pedophilia. What the literature has not answered is whether suggested differences are unique to pedophilia or shared with other atypical sexual interests (paraphilias). In other words, are the differences described in the previous section specific to pedophilia, or would the same differences be found in men with other paraphilias? Paraphilias can be loosely grouped into "target" and" activity" focused, referring to the subject of the person's sexual interest being either atypical targets (e.g. certain demographic groups, body parts, or non-living objects) (pedophilia would fall into this category) or atypical acts (e.g. exhibitionism, voyeurism, or sadomasochism) (Seto, Abramowitz, & Barbaree, 2008; Addis, 2014).

Fetishism describes a subset of target paraphilias that are specifically focused on body parts and/or non-human objects (American Psychological Association, 2022). Among target fetishes involving human body parts, foot fetishism is the most common, representing approximately 47% of body-part-focused fetishes (which themselves can account for about one third of fetish interests) (Scorolli et al., 2007). Estimates suggest that the overall prevalence of foot fetishism may be as high as 17% for men and 4% for women, with an overall prevalence of approximately 10% in the general population (Holvoet et al., 2017). While foot fetishism and pedophilia are both human-centered target paraphilias, foot fetishism is much less stigmatized and is not associated with criminal offending.

Fetishism and the Brain. Despite the fact that fetishism and specifically, foot fetishism, seems to be relatively common, no controlled neuroimaging studies to date have systematically investigated it. This lack of research likely stems from the fact that foot fetishism alone (i.e. without additional psychopathology or sexual impulsivity issues) is an innocuous sexual interest with the possibility of consensual interactions with sexually mature adults and no forensic implications. Fetishism is also not understood from a neuropsychological perspective – especially among non-offending individuals. The few studies that do discuss cognitive or executive functioning in individuals with paraphilic interests mention fetishism as part of a broader paraphilic or hypersexual sample, often with interests closely linked to impulse control differences or antisociality (e.g. sexual sadism disorder or hypersexuality). They also focus on offending populations with various paraphilic interests, which complicates generalization to non-offending fetishistic men and makes it unclear whether findings reflect paraphilic interest or criminality (Haas, 2010; Reid et al., 2011; Gosselin & White, 2021).

Therefore, we do not know how fetishism is represented functionally or structurally in the brain, or if systematic neural differences even exist between men with fetish interests and men without. The lack of neuroimaging literature on fetishism has important implications for the characterization of neural differences in pedophilia. As no other target paraphilias have been included as comparison groups in existing neuroimaging studies of pedophilia, it is impossible to determine whether any identified differences are unique to pedophilia or common to target paraphilias in general. There is also no research precedent to suggest that neurobiological and neuropsychological differences observed in pedophilia would *also* be observed in men with fetishism, other than that they both report atypical sexual interests. This gap in the literature presents an important research target for future studies which would allow for better scope, greater specificity, and higher validity in the interpretation of results.

Extant Literature: The Missing Pieces

In fact, as a whole, neuroimaging research on pedophilia to date has presented the field with an intriguing yet unclear picture of its neural correlates and etiology. This may be in part due to a lack of methodological stringency and failure to control for sufficient extraneous variables.

Same-Sex Attraction. For instance, the majority of neuroimaging studies of pedophilia have included pedophilic men with both female and male victims and both heterosexual and homosexual non-pedophilic men as controls. Due to potential systematic differences in brain structure and function between heterosexual and homosexual men (Savic & Lindstrom, 2008; Safron et al., 2017; Wang et al., 2020; Votinov et al., 2021), combining these two groups within study samples may threaten the validity of results. Additionally, previous research has suggested that homosexual men with pedophilia may only make up approximately 10% of this population (though some researchers have suggested that this may be as high as 40%), hindering the external validity and applicability of results from studies that combine these two groups in their samples (Freund & Watson, 1992; Hall & Hall, 2007).

Criminality. Historically, studies have also repeatedly failed to account for criminality in their study samples. Importantly, previous neuroimaging research has consistently shown neural differences, especially in impulse control, between men with and without histories of criminal offending (Luukkainen et al., 2012; Hoskin & Ellis, 2015; Meldrum et al., 2018). As such, group differences between pedophilic men and teleiophilic men in studies that did not control for criminal history may be the result of the neural correlates of criminality and poor impulse control rather than pedophilia. This misinterpretation of the true construct underlying group differences in pedophilia research (i.e. higher rates of criminality in pedophilic groups versus teleiophilic groups) is a recurring theme in the field and raises concerns regarding the validity of previous results (e.g. as seen in Poeppl et al., 2013). Happily, recent work has more intentionally distinguished between men with pedophilia who offend and those who do not (see Weidacker et al., 2022; Storch et al., 2023; Ara-García, Martí-Vilar, Badenes-Ribera, & González-Sala, 2025), with results suggesting predictable differences in impulse control (with poorer impulse control in contact-offending men with pedophilia).

In fact, recent research has increasingly examined men who commit exclusively non-contact sexual offenses against children, such as those involving child sexual exploitation material (CSEM). Evidence has suggested that, while these men share certain characteristics with those who commit contact-sexual offenses against children, they also form a distinct subgroup. Babchishin et al. (2018) reported that men with online-only offenses tended to present with fewer antisocial traits, greater sexual preoccupation, and stronger indicators of pedophilic interest compared to those with contact-offenses, supporting the view that their offending is more strongly driven by their paraphilic sexual interests than by generalized criminality. Similarly, Gottfried et al. (2020) reported that men who offended online generally demonstrated higher psychosocial stability and had a lower risk for physical contact offending. Most recently, a meta-analysis by Baskurt et al. (2025) found that recidivism rates among men with online-only offenses were generally low, particularly for contact reoffending, reinforcing the heterogeneity of this population and underscoring the need for distinguishing between these two groups moving forward. Criminality should be rigidly controlled for in group assignment to ensure that group differences are not being erroneously attributed to pedophilia when in reality, they may be resulting from criminality. This may be accomplished in a pedophilic population by selecting individuals who have either never been charged with a crime, which may be difficult and limit the generalizability of results. Alternatively, criminality may be partially controlled for by selecting participants who have only been charged with non-contact offenses (e.g. possession and distribution of child pornography). In this way, pedophilic participants could be compared with teleiophilic community-members (who also view pornography) without invoking as many systematic neural differences from criminality and related constructs (like poor impulse control and antisocial personality traits). Additionally, men with histories of child pornography offenses tend to be less antisocial, have more limited general offense histories, have fewer psychopathic traits, be more prosocial, have lower recidivism rates, be at lower risk for *contact* sexual offending than men with histories of contact sexual offenses, and be more comparable to non-offending community members (Seto, 2008, 2013; Henshaw, Ogloff, & Clough, 2017).

Socio-Demographic Confounds. Additional demographic factors which could lead to systematic differences between groups include age, level of education, socio-economic-status, history of trauma/adverse childhood experiences, psychiatric comorbidities, psychoactive medication use, behavioural impulsivity, sexual compulsivity, multiple paraphilic interests, antisocial personality traits, and juvenile delinquency. As a whole, pedophilia research to date has not consistently screened for these factors, thereby allowing for confounding group differences to persist and to potentially affect the validity of results.

Distinguishing Pedophilia from Other Paraphilia. With respect to study design, the vast majority of neuroimaging research on pedophilia has also failed to include a third group of non-pedophilic but *paraphilic* individuals, such as men with fetishism. This lack of methodological stringency and specificity may be a contributing factor to the inconsistency of neuroimaging results thus far. The inclusion of this third group would allow for researchers to refine the scope of their results and make inferences regarding the distinctiveness of brain differences to pedophilia rather than to paraphilias as a larger group. The three-way comparison of pedophilic – fetishistic – teleiophilic individuals would allow for a greater level of specificity and greater substantiation for asserting that resulting data are unique to pedophilia.

Objectives

The overarching aim of this dissertation was to contribute to the growing body of neuroimaging research on pedophilia by addressing key methodological gaps and testing the scope and robustness of previously reported brain differences. By exclusively recruiting men without histories of violent or contact-sexual offending and by including a paraphilic comparison group which has never been studied with neuroimaging – men with foot fetishism – we sought to clarify and compare the neural correlates of multiple paraphilic interests independent of criminality.

Study 1 used voxel-based morphometry (VBM) to investigate gray matter volume differences between men with pedophilic, men with foot fetishism, and men without paraphilic interests, and all without histories of violent or contact sexual offenses. We sought to determine whether previously identified gray matter differences were robust, and whether these might also be present in men with foot fetishism.

Study 2 used diffusion tensor imaging (DTI) to examine whether non-contact offending men with pedophilic interests exhibit differences in white matter structural connectivity compared to teleiophilic controls. We also included a group of men with foot fetishism to investigate whether such structural differences are unique to pedophilia or shared more broadly across paraphilias.

Study 3 employed functional MRI to assess brain responses to a novel task of visual sexual processing. This task enabled us to integrate neuroimaging data with behavioural measures of sexual interest, and to investigate the neural dynamics of preferred sexual stimulus processing in men with pedophilic and fetishistic interests. By examining responses across these groups, we aimed to determine whether functional patterns previously attributed to pedophilia were specific to that interest or also present in another atypical sexual preference.

Across our three studies, I sought to clarify the relationship between neural patterns and sexual interest, independent of offending behaviour, by focusing on individuals without histories of contact offenses. In doing so, I aimed to help disentangle the neurobiology of pedophilic interest from that of antisocial or offending behaviour, and to describe novel structural and functional ‘brainprints’ for two paraphilic groups, pedophilia and fetishism.

Hypotheses

Study 1: We predicted group differences in gray matter volumes between the pedophilic group and the other two groups. Specifically, we predicted smaller gray matter volumes in the amygdala and other limbic structures, as well as in frontal regions including the orbitofrontal cortex and the dorsolateral prefrontal cortex, in line with previous gray matter investigations of pedophilic men and with regions identified in the Sex Response Network (Schiffer et al., 2007; Schiltz et al., 2007; Poeppl et al., 2013; Cantor et al., 2015; Poeppl et al., 2015; Schiffer et al., 2017; Klöckner et al., 2021; Scarpazza et al., 2021).

Study 2: We predicted significant white matter differences between pedophilic men and the other two groups, with no differences between fetishistic and teleiophilic men. Specifically, we predicted that we would see white matter microstructure differences between pedophilic men and the other two groups in areas previously identified by Cantor et al., 2008 (volume differences); 2015 (FA differences); and Cantor & Blanchard, 2012 (volume differences), including the fronto-occipital fasciculi, arcuate fasciculi, internal and external capsules, corona radiata, and thalamic radiations.

Study 3: We predicted group differences in functional responses to the picture task, with the pedophilia group having unique activity patterns in response to their preferred stimuli (girls and feet respectively) compared to the other two groups. Specifically, we predicted that men with pedophilia would recruit additional brain areas in frontal, temporal, and parietal regions (i.e. the middle frontal gyrus, superior parietal lobule, hippocampus, and insula) compared to both non-pedophilic and fetishistic men during the sexual processing of their preferred stimuli, representing a potential compensation mechanism for deficits elsewhere (i.e. decreased amygdalar activity) (Sartorius et al., 2008;

Schiffer et al., 2008a; Kühn & Gallinat, 2011; Poeppl et al., 2011; Ponseti et al., 2012; Polisois-Keating & Joyal, 2013; Mohnke et al., 2014; Poeppl et al., 2014). We also predicted that each group would have longer response times and rate their preferred image category (adult women for teleiophilic men, children for pedophilic men, and feet for fetishistic men) significantly higher than the other categories of images, reflecting their self-reported sexual preferences.

Integrating Hypotheses across All Three Studies: Overall, I expected to see structural and functional differences between pedophilic men and the other two groups, with these differences concentrated in frontal and limbic regions (or in white matter tracts connecting these) – in line with past research. I did not expect to see significant structural or functional differences between the brains of fetishistic men and teleiophilic men. I expected to see unique patterns of functional activity in the pedophilic group compared to the other two groups, and that functional activity would be highest in this group overall when viewing their preferred sexual stimuli, constituting compensation for underlying structural differences. I also expected that the regions with the most functional activity in the pedophilic groups would be those identified in the previous two structural investigations as having either lower gray matter volume, poorer white matter integrity, or both.

CHAPTER 2

Study 1 (*manuscript in preparation*): Gray Matter Volume Differences between Pedophilic, Fetishistic, and Teleiophilic Men without Histories of Contact Sexual Offenses

Abstract

Pedophilia is a paraphilic, or ‘atypical’ sexual interest involving sexual attraction to prepubescent children. It is highly stigmatized, can be very distressing to the person with the paraphilia, and is associated with a higher risk of sexual offending against children. To understand the neurobiological underpinnings of pedophilia, this MRI study used voxel based morphometry (VBM) to investigate gray matter volumes. This specificity design included three groups of men: those with pedophilia but without contact sexual offenses (n=9), adult-attracted (teleiophilic) men (n=16) and, for the first time in any brain imaging study, men with another paraphilic interest: foot fetishism (n=15). VBM results demonstrated lower gray matter volume in both men with pedophilia and men with foot fetishism compared to teleiophilic men. There were unique patterns of volume differences among the two paraphilic groups. Men with pedophilia had the lowest volumes in frontal and limbic regions including the amygdala. Men with fetishism had the lowest volumes in somatosensory and motor regions. There was significant overlap between the two paraphilic groups, with the most common volume pattern that emerged being pedophilic group < fetishistic group < teleiophilic group. These results suggest that previously identified volume differences between pedophilic and teleiophilic men may not be entirely unique to pedophilia, but may be in part shared with another paraphilic interest. This study

provides evidence to warrant further brain imaging research into paraphilias, including pedophilia and foot fetishism.

Introduction

Neuroimaging research on pedophilia has focussed much of its attention on differences in gray matter volume and density between men with pedophilia and men without. Overall, studies of gray matter in pedophilic men (typically who had histories of contact sexual offending) have identified lower gray matter volumes in regions across the brain but concentrated in frontal and temporal regions compared to men without pedophilia (Mohnke et al., 2014; Tenbergen et al., 2015). For example, studies have identified lower gray matter volume in the frontal lobes (Schiffer et al., 2007; Cantor et al., 2015; Poeppl et al., 2015; Schiffer et al., 2017; Klöckner et al., 2021; Scarpazza et al., 2021), limbic system and temporal lobes (Schiltz et al., 2007; Poeppl et al., 2013; Cantor et al. 2015; Poeppl et al., 2015, Schiffer et al., 2017; Klöckner et al., 2021; Scarpazza et al., 2021). Abé et al (2021) did not investigate gray matter volume but found lower cortical surface area across several frontal and limbic regions in pedophilic men compared to teleiophilic men.

Over and above these differences, studies have less reliably identified gray matter volume differences across the brain in areas including the cerebellum, parietal lobes, and occipital lobes. Some of the most consistent volume differences have been found in the amygdala, with three studies identifying smaller amygdala volume in pedophilic men compared to teleiophilic controls: Schiltz et al., 2007 (right amygdala), Schiffer et al., 2017 (bilateral), Poeppl et al., 2013 (right amygdala). Not all studies of gray matter volumes in pedophilia have identified reductions: Cantor et al., 2008 found no differences in cortical thickness or overall cortical surface area between men with pedophilia (and with sexual offense histories) and teleiophilic men (with both sexual and non-sexual offense histories), and Gerwinn et al., 2015 found no differences in gray matter volumes (whole brain corrected for family wise error) between heterosexual and homosexual pedophilic and teleiophilic men.

Volume differences in the frontal and temporal lobes / limbic system have spurred theories of the etiology of pedophilia. One theory is that pedophilia is related to alterations in the frontal lobe which affect executive function and cognitive processes (the frontal-dysexecutive theory; Graber et al., 1982). Another theory is that it is related to alterations in temporal and limbic areas which affect emotional and sexual processing (the temporal-limbic theory; Hucker et al., 1986). A third theory is that pedophilia is related to a combination of alterations across both regions, accounting for atypical sexual urges (temporal) and behavioural disinhibition (frontal) (the dual dysfunction theory; Cohen et al., 2002). Considering the history of gray matter volume differences in the neuroimaging literature thus far, the dual dysfunction theory appears to have some support, however results are still mixed.

Limitations in the previous neuroimaging research on pedophilia dictate that current and future studies should make conscious efforts to control for confounding variables such as criminality, mental health and neurological disorders, major socio-economic differences, and substance/medication use. Studies with larger sample sizes and more statistical power are also needed to reinforce or rebuke past results in small samples, though recruitment of men with pedophilia (especially if controlling for the aforementioned confounds) is notoriously challenging. Lastly, previous studies of pedophilia have failed to include paraphilic comparison groups to determine whether identified differences are unique to pedophilia or common to paraphilic sexual interests more generally.

Current Study

Our study set out to address limitations in the existing literature and to replicate and reinforce the growing body of evidence suggesting that gray matter volume differences exist between pedophilic and teleiophilic men. Specifically, we sought to confirm that volume differences persist in non-contact offending samples, lending further credence to the hypothesis that structural brain differences are demonstrative of pedophilia, independent of sexual offending behaviours. We additionally aimed to explore, for the first time, the structural gray matter correlates of foot fetishism (a paraphilia and atypical sexual interest not inherently associated with risk to others) and to compare this sample to pedophilic and teleiophilic men, providing a first investigation of the structural correlates of paraphilic interest other than pedophilia.

We predicted that we would see group differences in gray matter volumes between the pedophilic group and the other two groups. Specifically, we predicted smaller gray matter volumes in the bilateral amygdala and other limbic structures, as well as in frontal regions including the orbitofrontal cortex and the dorsolateral prefrontal cortex, in line with previous research.

Method

This study included 40 participants: 9 men with pedophilia, 15 men with foot fetishism, and 16 teleiophilic community controls. The following methods related to participant characteristics and recruitment are also used in **Study 2** & **3**, as they used the same samples.

Our goal was to recruit 30 participants per group for a total of 90 participants, but this was not accomplished due to several challenges (see Limitations section). Participants were included in the study if they met the following criteria:

i. At least 18 years of age;
ii. Exclusively or predominantly heterosexual;
iii. Capable of providing informed consent and participating in all aspects of the study;
iv. MRI compatible (including the absence of metal foreign bodies, history of seizures, recent tattoos, claustrophobia, uncorrectable poor eyesight, chronic pain which would preclude laying supine);
v. No history of moderate to severe head injury or concussions with a loss of consciousness for >1 minute;
vi. Have not been charged or convicted of a violent offense or contact sexual offense, or with multiple (4+) non-violent convictions;
vii. No substance use problems (in accordance with DSM-5 criteria);
viii. No diagnoses of psychotic disorders;
ix. No diagnoses of major mental disorders other than depression, ADHD, and anxiety-related disorders. Psychotropic medications were allowed only if they were ADHD medications, anti-depressants, or anti-anxiety medication;
x. No paraphilias other than those which qualify them for the study group, classified as being as strong as or stronger than the paraphilia being studied.

We only included cisgender men in this study because pedophilia (and paraphilias in general) is much more common in men than in women (Seto, 2008). We excluded individuals who were not heterosexual, had histories of severe head trauma, substance use disorders, or severe psychiatric comorbidities (i.e., bipolar, schizophrenic, and neurodevelopmental disorders) because these conditions are associated with predictable differences in brain structure and function, therefore their presence was minimized in our samples to ensure that groups were as similar as possible.

We initially planned to exclude participants with any mental disorders or psychiatric medication use, including depression and anxiety, but early recruitment efforts indicated excluding these disorders severely limited our recruitment capacity (see section on limitations) and was also going to provide a sample that was not representative of the population. Pedophilic participants reported the most mental health comorbidities, and this group would have been almost impossible to recruit had we not modified our inclusion criteria in this way. This experience is consistent with Fox et al's (2022) finding of an association between paraphilias and psychological disorders such as anxiety or depression in men.

We also initially attempted to only include right-handed participants because of reliable differences in neural structure and function between right- and left-handed individuals, especially in brain asymmetry. However, a dearth of eligible pedophilic participants led us to include two left-handed pedophilic men who otherwise met all inclusion criteria. There is an association between non-right-handedness and pedophilia, thus it is unsurprising that excluding on this basis would lead to recruitment issues (Cantor et al., 2005; Fazio, Lykins, & Cantor, 2014).

We excluded men with 4+ non-violent offenses or any history of contact criminal offenses to avoid high levels of criminality in our samples. We chose to include pedophilic men with histories of non-contact crimes related to child sexual exploitation material to increase our recruitment capacity and because these offenders tend to be more comparable to non-criminal community controls on several variables (Seto, 2025).

Pedophilic participants were only selected if they acknowledged a recurrent, persistent, and intense interest in prepubescent children. Fetishistic participants acknowledged a recurrent, persistent, and intense sexual interest in women's feet and denied any concomitant interest in prepubescent or pubescent children. Individuals could have multiple paraphilic interests, but we excluded any individuals with stronger paraphilic interests than pedophilia or foot fetishism, respectively. Teleiophilic participants said they were attracted to adults and did not report recurrent, persistent, or intense paraphilic interests of any kind. We recruited pedophilic participants from an outpatient sexual behaviour clinic, and fetishistic and teleiophilic individuals from the community via posters (at the research hospital and university campus) and online advertising. We did not ask for permission to access the clinical files of pedophilic participants referred from the sexual behaviour clinic (e.g., to confirm their diagnoses.)

The procedure consisted of a preliminary phone screening interview to assess eligibility and assign to a study group, followed by an in-person interview and scanning session. During both the phone and the in-person interview, the interviewer informed participants that if they revealed that they had physically or sexually abused a child, and if this information had not already been reported, that the information would be reported to police or the local child protection agency. Consent was provided orally and in writing and all participants expressed their understanding of mandatory reporting requirements. During the in-person session, the interviewer used a structured script to confirm the information provided during the phone screening and asked the participant to complete several questionnaires. Interview questions and questionnaires assessed variables that could impact the interpretation of group differences, such as sociodemographic and behavioural variables (i.e., age, education level, substance use, brain injury, antisocial behaviour). We also assessed level of interest in various paraphilic behaviours and sexual compulsivity to explore how these may differ between the three groups. Measures were all self-report and were completed by the participant, with the interviewer helping as needed. Participants were remunerated for their participation. Questionnaires are listed below, and were included based on good reliability and validity in previous studies:

i. A demographic questionnaire.

ii. A measure of interest in many different paraphilias and the frequency with which participants engage in the corresponding paraphilic behaviours (Paraphilias Scale, Seto et al., 2012).

   a. Validation studies have shown good internal consistency (Seto et al., 2021) and convergent validity with self-reported paraphilic behaviours (Bouchard et al., 2017; Chivers et al., 2014; Dawson et al., 2016; Seto et al., 2012; Seto et al., 2025). Seto et al., 2025 also showed configural invariance across genders (women and men) and sexual orientations for gender (woman or man) and provided additional evidence for a stable four-factor structure.

iii. A measure of hypersexuality and sexual preoccupation (Sexual Compulsivity Scale, Kalichman & Rompa, 1995).

a. Internal consistency ranges from Cronbach's α = .59 - .92, temporal stability coefficient = .95 for 2 weeks and ranges from .64-.80 for three months, the tool demonstrates convergent validity with other related measures and discriminant validity with unrelated variables, and criterion validity was shown with several behavioural outcomes associated with sexual compulsivity (Hook et al., 2010).

iv. Measures of childhood antisocial behaviour and early life criminality (Childhood and Adolescence Taxon Scale – Self Report (CATS-SR), Harris, Rice, & Quinsey, 1994; Self-Report Early Delinquency Scale (SRED), Moffitt & Silva, 1988).

a. The CATS-SR shows good internal consistency (Cronbach's α = 0.73 for male juvenile offenders), discriminant validity between offending and non-offending samples (area under the curve [AUC] = 0.96 for male juvenile offenders compared to non-offending school-aged males), convergent validity with related measures, discriminant validity with unrelated measures, and criterion-related validity with related behavioural variables and psychiatric diagnoses (Pechorro et al., 2020).

b. The SRED has a robust five-factor structure accounting for 45.2% of score variance, and reliability analysis of the factors showed Cronbach's α values of 0.7-0.9 (acceptable to excellent) (Charles & Egan, 2005).

v. A measure of traumatic indices in childhood including abuse and neglect (Adverse Childhood Experiences (ACEs) Questionnaire, Felitti et al., 1998)

a. Internal consistency ranges from Cronbach's α = 0.64-0.76, internal item validity ranges from Cronbach's α = 0.28-0.70, and strong concurrent criterion validity with outcomes related to early adverse experiences (Kovács-Tóth et al., 2023).

Scores on self-report questionnaires were compared via between-group one way ANOVAs. Mean scores are presented in **Table 2.1**. The self-report questionnaire of general paraphilic interests and behaviours (Paraphilias Scale) included questions about sexual interest and activity with both children and feet. To investigate the degree to which group-specific interests may have been driving average scores and group differences on these questionnaires, analyses were completed for the full questionnaires and again with all questions relating to children or feet removed. Both are reported in **Table 2.1**.

The second part of the procedure consisted of additional MRI compatibility screening, explanation of the imaging procedure, and MRI scanning. Instructions were repeated from a script created by the study coordinator and designer. Participants were informed that they would be in the scanner for approximately 30 minutes and that they would be in verbal contact with the MRI technologist and study coordinator via earphones between each sequence, including a reiteration of instructions and confirmation of understanding. We informed participants that staff could not see what was going on in their brain in real time. Participants were guided through the protocol by staff and instructed to lie as still as possible throughout.

Data Acquisition

We acquired the MRI data using a Siemens 3.0T Magnetom Biograph PET-MR scanner. Participants laid supine on the bed of the scanner with their head immobilized in a 12-channel head coil. A conventional T1-weighted spin echo localizer was acquired to confirm positioning and to prescribe the T1-weighted 3D multi-echo magnetization prepared rapid acquisition gradient echo (MEMPRAGE) sequence (TR/TE 11.2/21 ms, flip angle 60°, field of view (FOV) 26x26 cm^2, 256x256 matrix, slice thickness 1.5mm) for structural analyses (van der Kouwe, Benner, Salat, & Fischl, 2008)

Data Analysis

T1-weighted images were processed through MATLAB, using Statistical Parametric Mapping software (SPM12) and the Computational Anatomy Toolbox (CAT12) (https://neuro-jena.github.io/cat//index.html). T1 weighted images were segmented into gray matter, white matter, and cerebrospinal fluid compartments using CAT12's adaptive maximum a posteriori (AMAP) approach with partial volume estimation. Segmented images were then spatially normalized to the Montreal Neurological Institute (MNI) standard space. To account for volume changes introduced during normalization, the normalized gray matter images were modulated by the Jacobian determinants derived from the spatial normalization step, preserving the total amount of gray matter. The modulated gray matter images were then smoothed with an 8 mm full-width at half-maximum (FWHM) Gaussian kernel to enhance the signal-to-noise ratio and accommodate inter-individual anatomical variability.

Quality assurance was performed using CAT12's built-in tools, including checks for image homogeneity and sample homogeneity, to identify and exclude any outliers or artifacts. No data was excluded following quality checks. Statistical analyses were conducted using the general linear model (GLM) framework in SPM12. Group comparisons were performed to identify regional gray matter volume differences, incorporating total intracranial volume (TIV) as a covariate. Statistical significance was determined using a voxel-wise threshold of whole brain $p < 0.005$ (uncorrected), with a cluster-level family-wise error (FWE) correction at $p<0.05$ applied to account for multiple comparisons. Given our small sample sizes, regions significantly different with cluster-level false discovery rate (FDR) correction at $p<0.05$ were also reported and are identified as such.

We conducted whole-brain analyses rather than limiting our investigation to regions of interest (ROIs) identified in previous research. We did this for three reasons: First, past results are heterogeneous, likely due to several limitations, which are identified in the **General Introduction** and include confounding demographic and participant-level variables, varying imaging protocols, and small sample sizes. As a result, basing ROIs off of past research would result in a high number of identified regions – essentially including most major functional areas. Next, based on previous research indicating that structural differences may exist in pedophilic men among brain regions involved in the Sex Response Network, we sought to investigate whether volumes in these regions may also differ among our three groups. However, again, this processing network is made up of several areas and would include most of the brain – rendering an ROI analyses moot. Last, our study included a novel group of men with foot fetishism – a population that has never before been investigated using neuroimaging. Therefore, we had no precedent to inform a priori ROI investigations in this sample, justifying a whole-brain exploratory approach.

Regions of interest identified in our hypothesis for Study 1 are highlighted in the **Results** section below, including the amygdala and orbitofrontal cortex.

Results

Demographics and Questionnaire Data

Demographic and questionnaire results are reported in **Table 2.1**. It should be noted that the self-report questionnaire of general paraphilic interests and behaviours (Paraphilias Scale) included questions relating to sexual activity with both children and feet, which we expected could lead to inflated scores for the pedophilic and fetishistic groups, respectively. To investigate the degree to which group-specific interests were driving scores on this measure, analyses were completed for the full questionnaire and again with all questions relating to children or feet removed. Both are reported in **Table 2.1**.

Table 2.1: Interview and Questionnaire Results

Factor	Levels	Pedophilic (PED)	Fetishistic (FET)	Teleiophilic (TEL)	
N		9	15	16	
Handedness					
	Right	7	15	16	
	Left	2	0	0	
Mental Health Diagnoses					
	Depression/Anxiety	6	6	2	
	OCD	2	0	0	
	ADHD	2	0	0	
Psychiatric Medications					
	Antidepressant	6	5	1	
	ADHD	3	1	0	
		PED Mean (SE)	**FET Mean (SE)**	**TEL Mean (SE)**	**P Value**
Age		49.44[a] (5.32)	37.4[a,b] (4.02)	29.63[b] (3.20)	**0.009**
Alcohol (drinks per week)		4.44 (2.57)	3.20 (0.98)	1.93 (0.64)	0.421
Head Injuries (number of minor concussions)		3	4	3	0.725
Education (Highest level accomplished)		2.13 (.295)	2.64 (.133)	2.63 (.125)	0.104

Income Bracket (CAD$, Coding below)		1.62 (.744)^{b}	3.13 (.350)^{a}	2.25 (.370)^{a,b}	**0.033**
<$25,000	1				
$25,001-50,000	2				
$50,001-75,000	3				
$75,001-100,000	4				
$100,001+	5				
Lifetime Number of Sexual Partners					
	Female	14.33 (6)	12.53 (2.59)	11.60 (3.70)	0.896
	Male	0.3 (0.38)	0.6 (0.41)	0 (0)	0.279
Stimulus of Interest Ratings (/10)					
	Feet	0.56 (0.37)^{b}	8.6 (0.32)^{a}	0.81 (0.27)^{b}	**<.001**
	Children (girls)	6.44 (0.58)^{a}	0 (0)^{b}	0 (0)^{b}	**<.001**
Paraphilic Interest General		2.04 (.176)^{a,b}	2.58 (.149)^{a}	1.99 (.193)^{b}	**0.038**
Paraphilic Interest (*child & feet items removed*)		1.76 (0.19)^{b}	2.58 (0.18)^{a}	2.08 (0.21)^{a,b}	**0.029**
Paraphilic Behaviour General		1.23 (.059)^{b}	1.46 (.049)^{a}	1.26 (.068)^{b}	**0.025**
Paraphilic Behaviour (*child & feet items removed*)		1.21 (0.05)	1.42 (0.06)	1.30 (0.07)	0.128
Childhood Antisociality		9.44 (2.056)	6.33 (.785)	5.75 (.574)	0.061
Childhood Delinquency		19.62 (4.84)	19.80 (2.43)	16.06 (1.25)	0.465
Sexual Compulsivity		2.11 (.249)^{a}	1.67 (.141)^{a,b}	1.31 (.077)^{b}	**0.003**
Adverse Childhood Experiences		2.89 (.611)	1.93 (.452)	1.13 (.424)	0.066

Superscripts indicate statistical significance (e.g., a, b, c) within a row. Means sharing the same superscript did not differ significantly at p < 0.05 with current sample sizes. Significant omnibus p values are bolded.

Structural Imaging Results

Whole brain omnibus between-group results showed significant gray matter volume differences between all groups. Both the pedophilic and the fetishistic groups showed widespread patterns of lower gray matter volume compared to the teleiophilic group, who did not show any regions of lower gray matter volume compared to the other two groups. Post hoc multiple comparisons showed that the pedophilic group had the most widespread patterns of low gray matter volume, with several regions that were also lower in volume compared to the fetishistic group. There were no areas of lower gray matter volume in the fetishistic group when compared to the pedophilic group.

Figure 2.1 shows the between group results for all three groups, with regions of lower gray matter volume for the pedophilic and fetishistic groups overlaid in different colours to visualize differences and overlap between the two. **Figure 2.2** shows the superficial views of lower cortical gray matter volume in the pedophilic group compared to the teleiophilic group. **Figure 2.3** shows regions of lower gray matter volume in the pedophilic group compared to the teleiophilic group. **Figure 2.4** shows the superficial views of lower cortical gray matter volume in the fetishistic group compared to the teleiophilic group. **Figure 2.5** shows regions of lower gray matter volume in the fetishistic group compared to the teleiophilic group. **Figure 2.6** shows cross-sectional views of the regions of lower gray matter volume in the pedophilic group compared to the fetishistic group through the brain from bottom to top. **Figure 2.7** shows the areas of lower gray matter volume in the pedophilic group compared to the fetishistic group. **Figure 2.8** shows the overlap between regions of low gray matter volume in both paraphilic groups compared to the teleiophilic group.

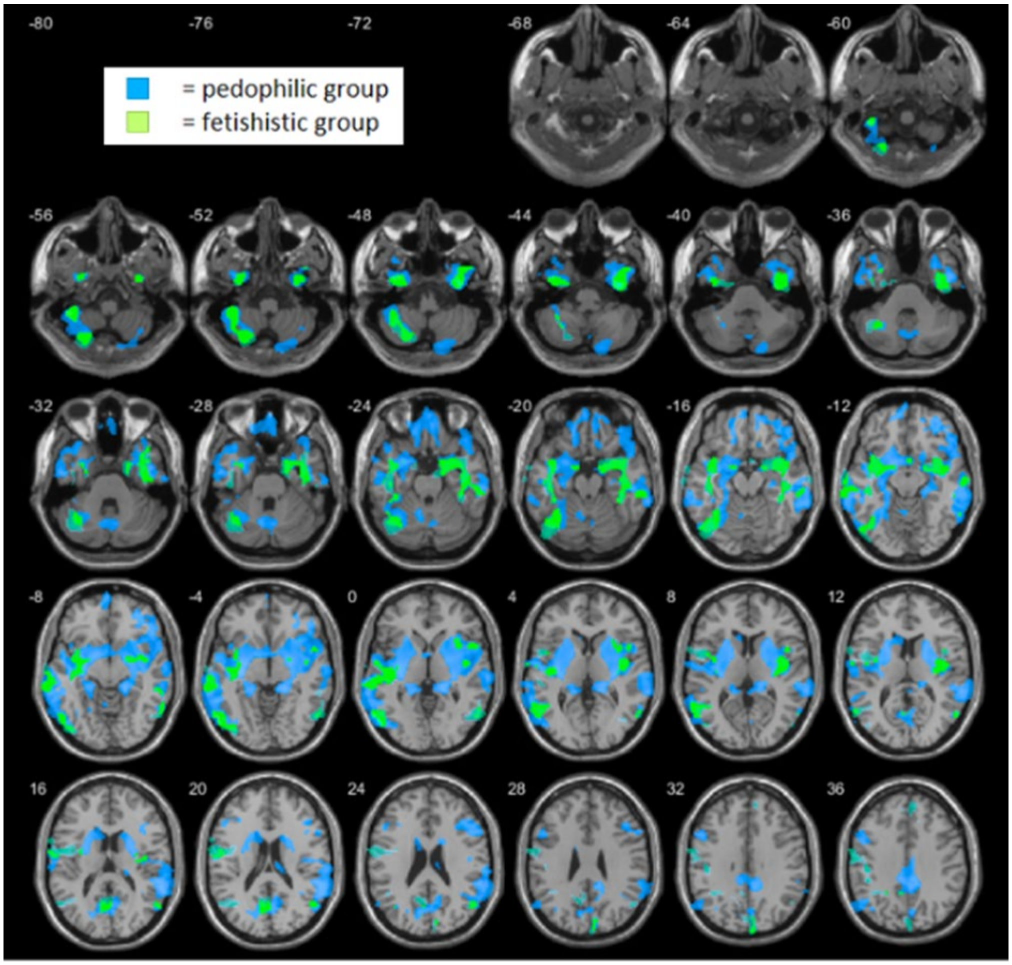

Figure 2.1. Omnibus F Test results of significant volume differences among all groups. Coloured areas show regions of lower gray matter volume in the pedophilic (blue) and fetishistic (green) groups, respectively, compared to the teleiophilic group.

Table 2.2: Regions of lower gray matter volume in pedophilic participants compared to teleiophilic participants.

Comparison	Cluster size (voxels)	Region (AAL)	MNI Coordinates X	Y	Z	*T*	*p*-value
PED<TEL	71546	L. Parahippocampal Gyrus	-30	-18	-6	5.68	<0.001 FWE
		R. Middle Temporal Gyrus	60	-44	18		
		L. Middle Temporal Gyrus	-54	-68	-2		
		L. Middle Occipital Gyrus	-53	-72	-2		
		R. Amygdala	23	-3	-5		
		R. Parahippocampal Gyrus	18	-36	-5		
		L. Cerebellum Lobule (6)	-41	-44	-57		
		R. Fusiform Gyrus	36	-12	-45		
		R. Middle Orbitofrontal Gyrus	32	51	-9		
		L. Amygdala	-15	2	-11		
		R. Putamen	32	-18	6		
	5298	R. Cuneus	5	-68	20	4.73	<0.001 FWE
		L. Cuneus	-5	-68	18		
		R. Middle Cingulate Gyrus	3	-42	38		
		L. Middle Cingulate Gyrus	-3	-36	39		
		R. Posterior Cingulate Gyrus	11	-42	30		
		L. Precuneus	-18	-77	17		
		R. Precuneus	6	-74	35		
		L. Inferior Parietal Lobule	-41	-45	50		
		L. Supplementary Motor Area	-15	-2	50		
	1783	L. Inferior Frontal Operculum	-51	14	33	4.33	0.024 FDR
		L. Middle Frontal Gyrus	-33	27	26		
		L. Inferior Frontal Triangularis	-51	27	21		
	1388	R. Declive of the Cerebellum (8)	8	-66	-30	3.98	0.042 FDR
		L. Declive of the Cerebellum (8)	-8	-65	-30		
		L. Culmen of the Cerebellum	-9	-53	-24		
		L. Cerebellar Vermis (4&5)	-2	-53	-11		
		R. Cerebellar Vermis (7)	3	-77	-27		
	1528	R. Cerebellar Crus (2)	15	-84	-47	3.71	0.035 FDR
		R. Cerebellar Tonsil (8)	38	-60	-50		

PED = pedophilic group; FET = fetishistic group; TEL = teleiophilic control group. FWE = family-wise error; FDR = false discovery rate. MNI = Montreal Neurological Institute Atlas (MNI152). AAL = Automated Anatomical Labelling Atlas 3, Version 1 (AAL3v1). L = left; R = right.

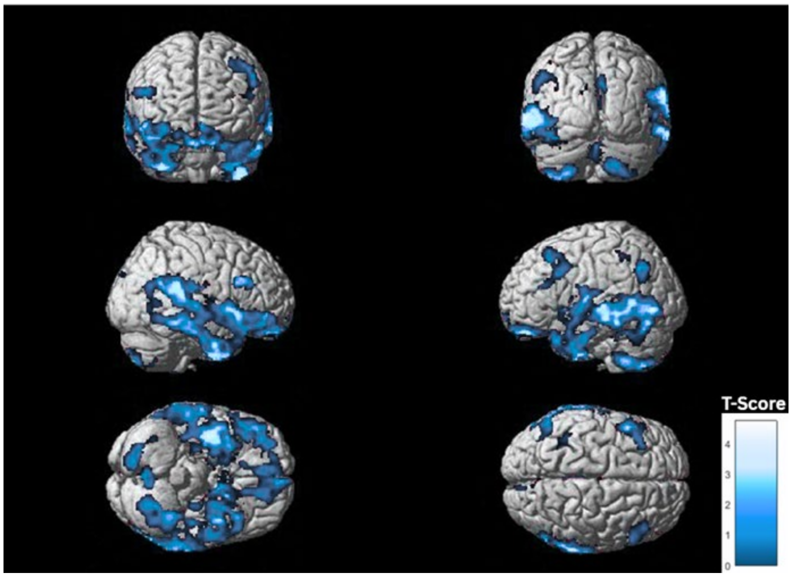

Figure 2.2. T-test results of Pedophilic – Teleiophilic between-group analysis. Coloured areas show regions of significantly lower gray matter volume in the pedophilic group across different views of the cortex.

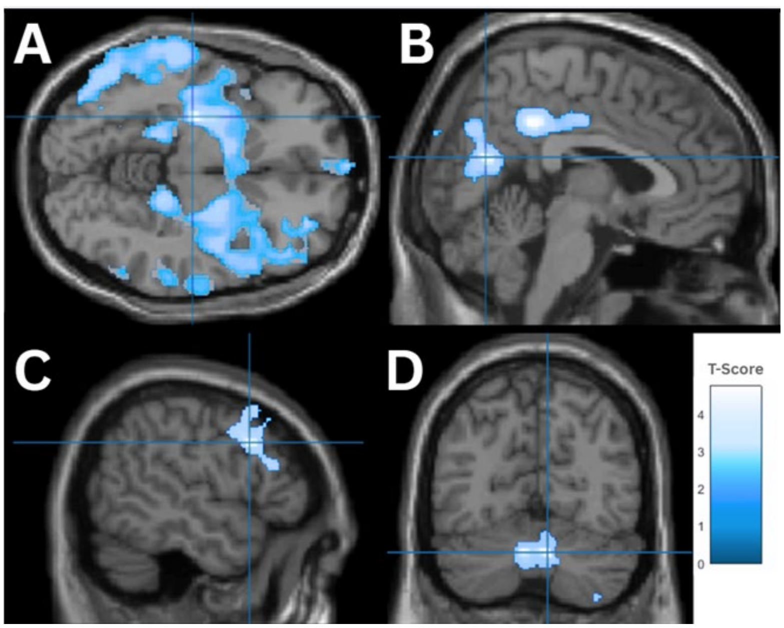

Figure 2.3. T-test results of Pedophilic – Teleiophilic between-group analysis. Coloured areas show regions of significantly lower gray matter volume in the pedophilic group in both cortical and sub-cortical structures. **A.** L.R. Parahippocampal Gyrus, L.R. Middle Temporal Gyrus, L. Middle Occipital Gyrus, L.R. Amygdala, L. Cerebellar Lobule, R. Fusiform Gyrus, R. Putamen, R. Middle Orbitofrontal Gyrus. **B.** L.R. Cuneus, L.R. Middle Cingulate Gyrus, R. Posterior Cingulate Gyrus, L.R. Precuneus, L. Inferior Parietal Lobule, L. Supplementary Motor Area. **C.** L. Inferior Frontal Operculum, L. Middle Frontal Gyrus, L. Inferior Frontal Triangularis. **D**. L.R. Declive of the Cerebellum (8), L. Culmen of the Cerebellum, L.R. Cerebellar Vermis, R. Cerebellar Crus (2), R. Cerebellar Tonsil (8).

Table 2.3: Regions of lower gray matter volume in fetishistic participants compared to teleiophilic participants.

Comparison	Cluster size (voxels)	Region (AAL)	MNI Coordinates X	Y	Z	*T*	*p*-value
FET<TEL	7317	L. Inferior Occipital Gyrus	-39	-84	-6	5.47	<0.001 FWE
		L. Fusiform Gyrus	-42	-69	-17		
		L. Middle Temporal Gyrus	-54	-66	-2		
		L. Angular Gyrus	-56	-62	12		
		L. Middle Occipital Gyrus	-44	-77	9		
	9758	R. Fusiform Gyrus	39	-38	-18	5.19	<0.001 FWE
		R. Middle Temporal Gyrus	57	-63	0		
		R. Inferior Temporal Gyrus	41	-3	-38		
		R. Amygdala	41	-2	-26		
		R. Parahippocampal Gyrus	23	0	-29		
	10219	L. Postcentral Gyrus	-26	-20	54	5.01	<0.001 FWE
		L. Precentral Gyrus	-29	-5	65		
		L. Supplementary Motor Area	-17	-6	65		
		L. Paracentral Lobule	-9	-14	66		
		R. Supplementary Motor Area	12	-9	53		
		L. Rolandic Operculum	-50	5	8		
		L. Inferior Parietal Lobule	-44	-38	36		
		L. Superior Frontal Gyrus	-26	5	69		
	6370	L. Inferior Temporal Gyrus	-42	-21	-23	4.24	<0.001 FWE
		L. Superior Temporal Gyrus	-54	-27	3		
		L. Middle Temporal Pole	-39	-3	-24		
		L. Amygdala	-36	6	-12		
		L. Fusiform Gyrus	-38	-36	-21		
		L. Parahippocampal gyrus	-30	0	-30		
		L. Middle Temporal Gyrus	-60	-27	-12		
	1398	L. Precuneus	-5	-63	18	4.22	0.040 FDR
		R. Cuneus	9	-83	26		
		R. Precuneus	2	-84	36		
	1548	L. Superior Medial Frontal Gyrus	-8	33	50	4.04	0.032 FDR
		R. Superior Medial Frontal Gyrus	14	30	41		

PED = pedophilic group; FET = fetishistic group; TEL = teleiophilic control group. FWE = family-wise error; FDR = false discovery rate. MNI = Montreal Neurological Institute Atlas (MNI152). AAL = Automated Anatomical Labelling Atlas 3, Version 1 (AAL3v1). L = left; R = right.

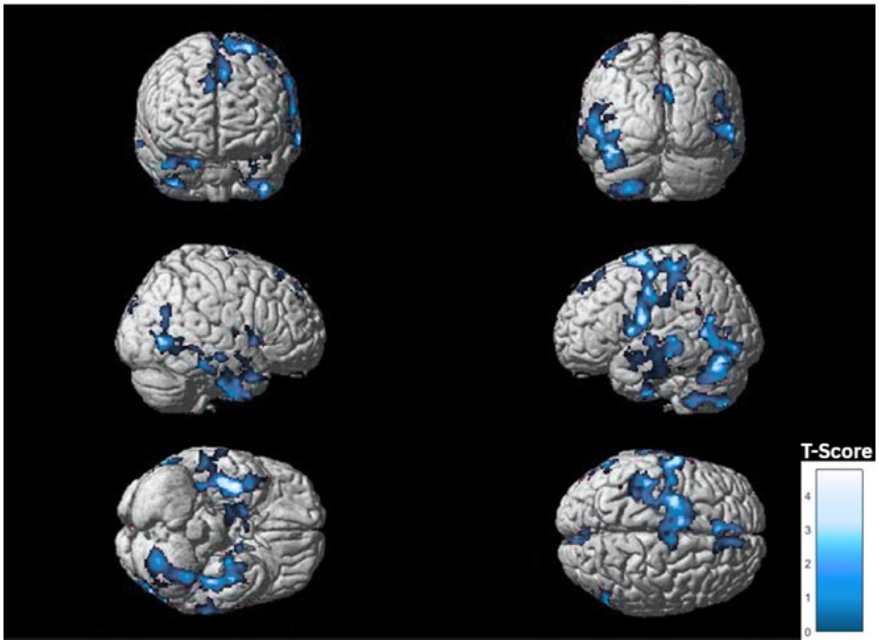

Figure 2.4. T-test results of Fetishistic – Teleiophilic between-group analysis. Coloured areas show regions of significantly lower gray matter volume in the fetishistic group across different views of the cortex.

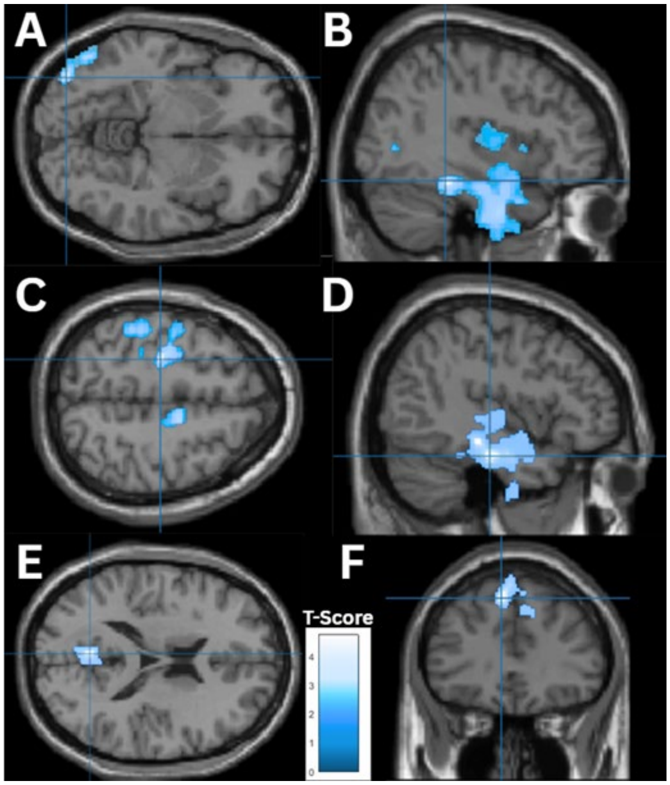

Figure 2.5. T-test results of Fetishistic – Teleiophilic between-group analysis. Coloured areas show regions of significantly lower gray matter volume in the fetishistic group in both cortical and sub-cortical structures. **A.** L. inferior occipital gyrus, L. Fusiform Gyrus, L. Middle Temporal Gyrus, L. Angular Gyrus, L. Middle Occipital. **B.** R. Fusiform Gyrus, R. Middle Temporal Gyrus, R. Inferior Temporal Gyrus, R. Amygdala, R. Parahippocampal Gyrus. **C.** L. Postcentral Gyrus, L. Precentral Gyrus, L.R. Supplementary Motor Area, L. Paracentral Lobule, L. Rolandic Operculum, L. Inferior Parietal Lobule, L. Superior Frontal Gyrus. **D.** L. Superior, Middle, & Inferior Temporal Gyri, L. Middle Temporal Pole, L. Amygdala, L. Fusiform Gyrus, L. Parahippocampal gyrus. **E.** L.R. Precuneus, R. Cuneus. **F.** L.R. Superior Medial Frontal Gyrus.

Table 2.4: Regions of lower gray matter volume in pedophilic participants compared to fetishistic participants.

Comparison	Cluster size (voxels)	Region (AAL)	MNI Coordinates			*T*	*p*-value
			X	Y	Z		
PED<FET	19571	R. Thalamus	17	-30	8	4.02	(0.05 uncorrected) 0.002 FWE
		R. Parahippocampal Gyrus	18	-38	2		
		L. Amygdala	-29	-17	-6		
		R. Caudate Nucleus	24	-2	15		
		R. Amygdala	21	-3	-2		
		L. Caudate Nucleus	-17	3	3		
		L. Hippocampus	-33	24	-32		
		L. Cerebellar Declive (4&5)	-5	-59	-18		

PED = pedophilic group; FET = fetishistic group; TEL = teleiophilic control group. FWE = family-wise error; FDR = false discovery rate. MNI = Montreal Neurological Institute Atlas (MNI152). AAL = Automated Anatomical Labelling Atlas 3, Version 1 (AAL3v1). L = left; R = right.

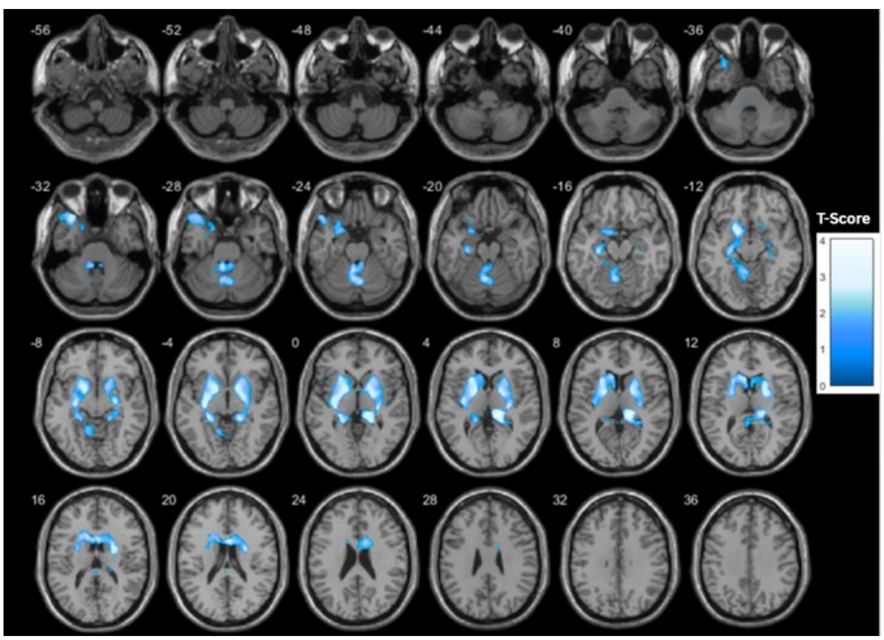

Figure 2.6. T-test results of Pedophilic – Fetishistic between-group analysis. Coloured areas show regions of significantly lower gray matter volume in the pedophilic group through cross-sectional axial slices of the brain in both cortical and sub-cortical structures.

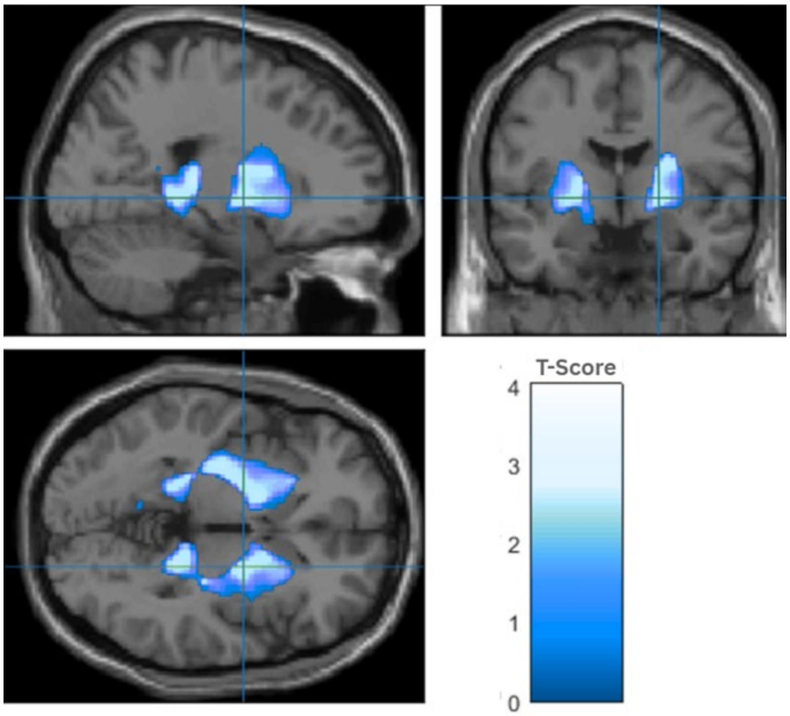

Figure 2.7. T-test results of Pedophilic – Fetishistic between-group analysis. Coloured areas show regions of significantly lower gray matter volume in the pedophilic group in both cortical and sub-cortical structures. All images: R. Thalamus, R. Parahippocampal Gyrus, L.R. Amygdala, L.R. Caudate Nucleus, L. Hippocampus, L. Cerebellar Declive (4&5).

Table 2.5: Shared regions of lower gray matter volume in pedophilic and fetishistic participants, both compared to teleiophilic participants.

Comparison	Cluster size (voxels)	Region (AAL)	MNI Coordinates X	Y	Z	*T*	*p*-value
[FET&PED] < TEL	2766	L. Middle Occipital Gyrus	-39	-81	-3	4.63	0.007 FWE
		L. Middle Temporal Gyrus	-54	-66	-2		
		L. Fusiform Gyrus	-42	-69	-15		
	1618	L. Cerebellum (7)	-39	-42	-57	3.89	0.034 FDR
		L. Cerebellum (8)	-24	-69	-50		
	6219	R. Fusiform Gyrus	42	-3	-38	3.86	<0.001 FWE
		R. Amygdala	23	-3	-8		
		R. Inferior Temporal Gyrus	47	-14	-35		
		R. Cerebellum Crus (2)	35	-6	-53		
	3679	L. Fusiform Gyrus	-39	-3	-24	3.37	0.001 FWE
		L. Middle Temporal Gyrus	-72	-33	-9		
		L. Inferior Temporal Gyrus	-53	-27	2		
		L. Amygdala	-36	-3	-12		
		L. Precentral Gyrus	-30	0	30		
		L. Superior Temporal Gyrus	-56	-9	0		
		L. Superior Temporal Pole	-39	3	-15		

PED = pedophilic group; FET = fetishistic group; TEL = teleiophilic control group. FWE = family-wise error; FDR = false discovery rate. MNI = Montreal Neurological Institute Atlas (MNI152). AAL = Automated Anatomical Labelling Atlas 3, Version 1 (AAL3v1). L = left; R = right.

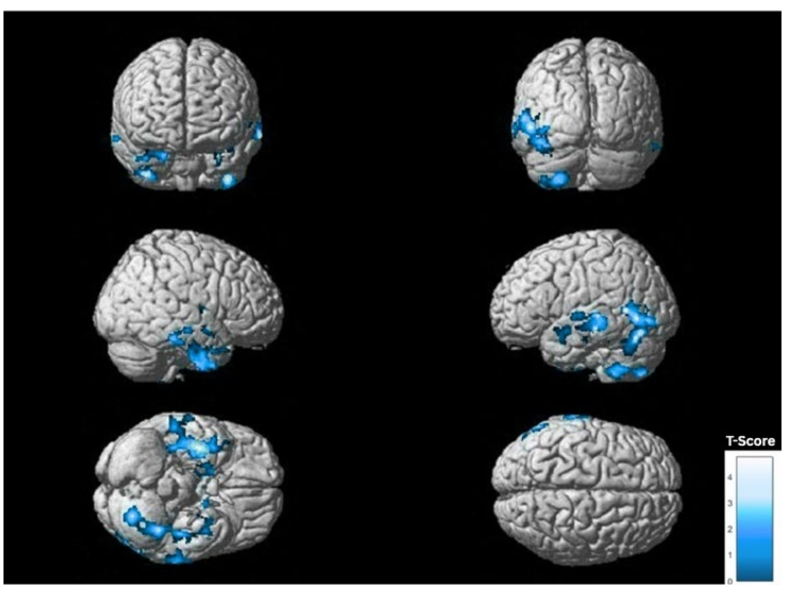

Figure 2.8. Conjunction T-test results of [Pedophilic & Fetishistic] – Teleiophilic between-group analysis. Coloured areas show only the regions of significantly lower gray matter volume that were common to both paraphilic groups compared to the teleiophilic group, across different views of the cortex.

Discussion

Our results are in line with those of previous gray matter volume investigations of men with pedophilia. We observed significantly lower gray matter volumes across large and widespread clusters in both men with pedophilia and men with fetishism compared to men without a paraphilia. Gray matter volumes were smallest and differences were most widespread in men with pedophilia, followed by men with fetishism. There were no areas of lower gray matter volume in teleiophilic men compared to either of the paraphilic groups, nor in men with fetishism compared to men with pedophilia.

Significance of Gray Matter Volume Differences:

Gray matter is made up of cell bodies and constitutes the cortical and subcortical structures of the brain that are responsible for all human behaviours. Topographic functional specialization of gray matter across the brain allows researchers to correlate regional alterations in anatomy and physiology to changes in behaviour and functioning. Gray matter structure can also be measured to infer comparative brain health between groups, with greater volumes being positively correlated with overall health, and cognitive and executive function (Takeuchi et al., 2017; Nave et al., 2019; Otsuka et al., 2022). Conversely, gray matter volume reductions are consistently observed in neurodegenerative conditions such as Alzheimer's disease, Parkinson's disease, frontotemporal dementia, and in individuals with traumatic brain injury (Beyer et al., 2007; Frings et al., 2014). Multiple studies have identified lower gray matter volumes in men with pedophilia, with the most pronounced and reliable differences identified in frontal and temporal brain regions, as seen in the present study.

Cognitive and Emotional Processing and Behavioural Coordination:

We observed lower gray matter volumes in the frontal cortex in men with pedophilia and men with fetishism, both compared to controls. In particular, orbitofrontal cortex volume was smallest in pedophilic men compared to teleiophilic men, but was not smaller than fetishistic men, indicating the following volume pattern in this region: pedophilic group^{b} < fetishistic group^{ab} < teleiophilic group^{a} (superscripts that differ indicate a statistically significant difference at the thresholds indicated in tables 2.2 – 2.5).

Orbitofrontal cortex differences have also been observed between pedophilic and teleiophilic men by Schiffer et al., 2007 (bilaterally), Poeppl et al., 2013 (associated with preference for younger children), Klöckner et al., 2021 (bilaterally), and Poeppl et al., 2015 (meta-analysis – volume correlated with victim age). The orbitofrontal cortex has been implicated in the sex response network (Stoléru et al., 2012), and authors who have observed gray matter volume reductions in this area in pedophilic men have highlighted that the region is involved in reward, behavioural inhibition, executive functioning, compulsive sexual behaviours, and moral reasoning. Thus, alterations in this area may have important downstream effects on sexual interests and behaviours involving inappropriate targets.

Our observation of lower orbitofrontal cortex (OFC) volume in pedophilic men – potentially followed by fetishistic men – is particularly notable in the context of parallel volume differences in the amygdala, thalamus (significant differences between all three groups), putamen, cingulate cortex, and hippocampal/parahippocampal regions (significant differences between the pedophilic and teleiophilic groups), which also followed this tiered pattern (pedophilic < fetishistic < teleiophilic). Collectively, these regions constitute the basal ganglia–thalamo–cortical circuit, a network implicated in the coordination of reward-dependent behaviours via thalamic relays between the basal ganglia (including the putamen), prefrontal areas involved in higher-order decision-making, behavioural inhibition, and judgment (notably the OFC), and limbic structures involved in motivation, sexual preference and drive, and emotion processing (e.g., amygdala, cingulate cortex, hippocampus) (Alexander et al., 1990; Doya, 2008; Lee et al., 2025). Reduced gray matter volume across this circuit may underlie alterations in sexual, cognitive, and emotional processing, ultimately affecting reward-driven behaviour and potentially contributing to functional differences in neural activity during sexual processing and response coordination (as seen in Leeming et al., in press).

Visual Perception and Motor Control:

Gray matter volumes in regions responsible for the visual processing of objects (in the occipital cortex), including human bodies and faces (the fusiform gyrus) were equally low in both paraphilic groups compared to the teleiophilic group. The fusiform gyrus has been repeatedly identified as playing a role in the sexual processing of human bodies and faces and is active during cue-induced sexual arousal in men (Redouté et al., 2000; Mouras et al., 2003; Feretti et al., 2005; Kühn & Gallinat, 2011; Seok et al., 2016).

The precuneus has also been implicated in sexual processing research and is a reliable component of the sex-response network, with proposed involvement in visuospatial imagery, self-referential processing, and integration of visual and emotional information (Polisois-Keating & Joyal, 2013). The precuneus may also be related to moral decision-making and judgment (Greene and Haidt, 2002), and studies have identified smaller gray matter volumes in this region in men with pedophilia compared to teleiophilic men (Schiffer et al., 2007; Klöckner et al., 2021).

The cerebellum is also involved in sexual processing and motor coordination and was smallest in the pedophilic group, followed by the fetishistic group, with considerable overlap (Stoléru et al., 2012). Lower cerebellar volumes in men with pedophilia have also been observed by Schiffer et al (2007) and Klöckner et al (2021), who highlighted its important role in coordinating cognitive, emotional, and motor processes and contributing to behaviour.

The precentral gyrus, paracentral lobule, and postcentral gyrus (motor and somatosensory regions) were all significantly smaller in the fetishistic group compared to the teleiophilic group, with no differences identified in the pedophilic group compared to the two other groups, suggesting the following order of volumes: fetishistic group < pedophilic group < teleiophilic group. These regions were also identified as dominating the functional profile of visual sexual processing in men with foot fetishism by Leeming et al 2025 (in press) and have been implicated in the sex-response network (Stoléru et al., 2012).

Limitations:

Challenges related to stigma and fear of legal or social repercussions likely contributed to difficulties in recruiting participants with pedophilic interests, even with our thorough informed consent process and transparency about mandatory reporting (e.g. for offending behaviours against children, not interests alone). Compounding this issue, the COVID-19 pandemic interrupted data collection for 18 months and introduced lasting obstacles to recruitment and scanning. Furthermore, several sample-specific factors unique to the pedophilic group limited participant eligibility after screening. These included higher rates of neurological, neurodegenerative, and neurodevelopmental conditions; serious psychiatric diagnoses; use of anti-androgen medications; histories of contact sexual offenses; same-sex attraction; and significant head trauma. These exclusions contributed to a relatively small pedophilic sample size, which reduced statistical power and complicated the process of matching groups by age and other demographic variables.

As a consequence of these constraints, some inclusion criteria were adjusted post-pandemic, allowing for the inclusion of two left-handed participants in the pedophilic group. In addition, although psychiatric comorbidities were present among some participants (most prevalent in the pedophilic group), care was taken to exclude individuals with severe diagnoses such as psychosis, bipolar disorder, or significant personality pathology. Still, the groups differed in terms of depression, anxiety, OCD, and ADHD, as well as associated pharmacological treatments. Where feasible, participants in the teleiophilic and fetishistic groups with similar conditions were recruited to help mitigate confounding effects. Future studies with greater access to eligible pedophilic participants would allow for tighter control over these variables and more robust group comparisons.

Lastly, we used the newest AAL 3v1 atlas (Rolls et al., 2020) for neuroanatomic labelling, as new developments have provided better accuracy and characterization of functional regions. These may differ slightly from other studies which used older atlases, hindering comparability between studies – though large functional regions should remain relatively stable between atlas versions.

Conclusion:

We observed lower gray matter volumes in both paraphilic groups compared to teleiophilic men, with the most extensive and pronounced reductions seen in the pedophilic group. These volume differences were localized to regions central to reward processing, decision-making, emotion regulation, cognitive control, and action planning. A consistent stepwise pattern emerged – pedophilic < fetishistic < teleiophilic – supporting a dimensional model of structural differences across sexual interests. These findings align with previous literature and correspond with differences in white matter integrity and functional activation during visual sexual processing observed in the same participants (Leeming et al., in press, a, b).

Although some prior work has suggested that gray matter volume differences in pedophilic men may be attributable to criminality rather than pedophilic interest per se (for instance Schiltz et al., 2007), our results in men without histories of contact sexual offenses indicate that these structural markers may indeed be direct correlates of sexual interest in children. Furthermore, the presence of similar volume reductions in fetishistic men suggests that such alterations may reflect a broader neural phenotype shared across multiple paraphilic interests.

Together, these findings contribute to a growing body of evidence that paraphilic sexual interests may be associated with systematic variations in brain structure and function. Future research with larger and more diverse samples will be critical to clarifying the specificity of these differences.

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CHAPTER 3

Study 2 *(submitted to Journal of Neuroimaging):* White Matter Differences among Men with Pedophilia, Men with Foot Fetishism, and Men without a Paraphilia

Abstract

Pedophilia (a paraphilic sexual attraction to prepubescent children) is highly stigmatized, can be very distressing to the person with this paraphilia, and is associated with a higher risk of sexual offending against children. To understand the neurobiological underpinnings of pedophilia, this brain imaging study used diffusion tensor imaging (DTI) to investigate white matter integrity. Three groups of men were included in a specificity design: self-identified individuals with pedophilia but without contact sexual offenses (n=9), adult-attracted (teleiophilic) participants (n=16) and, for the first time in any brain imaging study, men with foot fetishism (n=15). DTI results demonstrated lower white matter integrity in both men with pedophilia and men with foot fetishism compared to teleiophilic men, with no differences between the two paraphilic groups. These preliminary results suggest that previously identified differences between men with pedophilia and men attracted to adults may in fact be reflective of paraphilia more generally rather than pedophilia specifically, and that the specific 'brainprint' of pedophilia remains to be discovered. This study provides evidence to warrant further brain imaging research into paraphilias, including pedophilia and foot fetishism.

Introduction

Background:

Paraphilia is defined as sexual interests involving unusual or socially atypical targets or activities (American Psychiatric Association, 2022). One of the most researched paraphilias is pedophilia, which is characterized by intense and persistent sexual interest in pre-pubescent children. Pedophilia has received research attention due to the potential threat it poses to the safety of children in the form of sexual exploitation or abuse, since it is a major risk factor for sexual offending against children (see Seto, 2018). At the same time, many individuals with pedophilia do not offend, and seek an understanding of their interests.

Brain Imaging of Pedophilia:

Evidence of biological mechanisms underlying pedophilia has included results from brain imaging studies, including magnetic resonance imaging (MRI). Researchers have identified differences in patterns of white matter volumes and connectivity between the brains of pedophilic and *teleiophilic* individuals (individuals attracted to sexually mature adults). Cantor et al. (2008) reported white matter volume differences in the superior fronto-occipital fasciculus and the right arcuate fasciculus in men with pedophilia compared to men who had committed nonsexual offenses. Later research replicated these results and interpreted them as disrupted communication between these regions in pedophilic individuals (Cantor and Blanchard, 2012), but did not investigate the microstructure of tracts. The hypothesis of white matter-dysconnectivity is supported by cognitive research on pedophilia. Pedophilic individuals and child sexual offenders score significantly lower than healthy controls on measures of processing speed, which is heavily reliant on white matter health and microstructure integrity (Suchy et al., 2009, 2014; Eastvold et al., 2011; Dillien et al., 2020; Turner et al., 2020).

Further imaging research using Diffusion Tensor Imaging (DTI), an imaging modality that investigates white matter structure and tract integrity with indices such as Fractional Anisotropy (FA) and Mean Diffusivity (MD) (descriptions in the Method section), also supports white matter dysconnectivity in pedophilia but with varying results and methodological considerations (i.e., offense history, anti-androgen therapy, sexual orientation, inclusion of participants with mental health or substance use disorders). Cantor et al. (2015), for example, used DTI to compare pedophilic sexual offenders with non-offending controls and reported higher FA in a small left-sided white matter cluster, which was correlated with penile responsivity to erotic depictions of children. They reported that the identified cluster had sources/endpoints in the insula/operculum, superior temporal gyrus, temporal pole, occipital cortex, dorsolateral prefrontal cortex, temporal–occipital junction, superior parietal lobule, frontal pole, and thalamus, and highlighted that these areas resembled those previously identified by meta-analyses as being involved in a sexual response network (including Kühn & Gallinat, 2011; Poeppl, Langguth, Laird, & Eickhoff, 2014; Stoléru, Fonteille, Cornélis, Joyal, & Moulier, 2012). In contrast, Lett et al. (2018) observed that pedophilic individuals with histories of child sexual offending had reductions in FA throughout the brain and concentrated in the corpus callosum compared to both pedophilic men without child sexual offending and non-pedophilic controls (some with histories of violent and general crime). Finally, Gerwinn et al. (2015) found no differences between pedophilic and teleiophilic groups in white matter integrity, as measured by FA and MD.

These results raise the question of the nature of white matter differences among pedophilic samples (higher or lower FA, and the relationship to volume differences). They also highlight the uncertainty about whether previously identified differences reflect a distinction between pedophilia and teleiophilia or between sexually offending and non-offending samples, which would suggest at least some of the difference might be explained by criminality factors.

Historic Limitations:

Indeed, prior research has not controlled for sexual and general offending history in pedophilic samples. Previous neuroimaging research has consistently shown neural differences, especially in impulse control, between criminal and non-criminal samples (Meldrum et al., 2018; Hoskin & Ellis, 2015; Luukkainen et al., 2012). As such, group differences between pedophilic and teleiophilic men in studies that did not control for offense history may reflect the neural correlates of criminality rather than pedophilia. This issue may be remedied by recruiting pedophilic individuals who have never offended. It could be partially remedied by including individuals who have committed online offenses (e.g., child sexual exploitation materials offending, known legally as child pornography offending) but not contact sexual offenses. Indeed, child pornography offenders tend to be less antisocial and have less extensive and diverse offending histories, have fewer psychopathic traits, are more generally prosocial, have lower recidivism rates, and are at lower risk for contact sexual offending than contact sexual offenders. This indicates that this group may be more similar to community controls in terms of criminality-related constructs (Seto, 2008, 2013; Henshaw, Ogloff, & Clough 2017). In this way, pedophilic participants could be compared with sexually typical community members (who may also view pornography reflecting their sexual interests) without fear of systematic neural differences resulting from criminality and related constructs like poor impulse control or antisocial personality features.

Another important limitation is that neuroimaging research has not compared pedophilia with another atypical sexual interest, for example fetishism. By limiting investigations to pedophilia, previous studies have not clarified whether identified neural differences are unique to pedophilia (a “brainprint”) or common to paraphilic sexual interests more generally. Identifying whether neural activity differences vary based on atypical sexual interest would open the door for a new line of research on paraphilias.

Additionally, previous studies of pedophilia have suffered from challenges with recruitment and resulting small sample sizes. Efforts to increase sample size have often led to a failure to control for extraneous variables like sexual orientation, psychiatric comorbidities, brain alterations related to traumatic injury, presence of neurodevelopmental or neurodegenerative disorders, physical health, substance and medication use, and age (Boschetti et al., 2023).

Foot Fetishism:

Fetishism refers to sexual interests and behaviours directed at ‘atypical’ objects or body parts, and has been studied much less than pedophilia. Foot fetishism is one of the most popular forms of fetishism, accounting for the interests of almost half the members of most online fetish communities (Scorolli et al., 2007). Foot fetishism behaviour is not inherently criminal, unlike pedophilic behaviour, and clearly has a significant presence in the North American sexual repertoire and in internet sexual spaces. It is characterized by consensual sexual activity between adult partners and is not associated with negative societal consequences, unlike pedophilia.

Fetishism has not been studied with neuroimaging. Thus, how the sexual processing of a fetish object versus conventional sexual imagery (of adult women for heterosexual men) occurs in the brain is not understood. It is therefore unknown whether fetishism may have its own 'brainprint'.

Current Study:

In the current study, we investigated white matter differences between men with pedophilia and without histories of violent or contact-sexual offenses, men with teleiophilic sexual interests (in sexually mature adult women), and men with foot fetishism. The goal of the study was to determine whether previously identified white matter differences attributed to pedophilia are in fact unique to pedophilia, or whether we might observe them in a group of men with a different paraphilia that can be acted upon legally. We were also interested in determining if there were distinctive white matter differences associated with foot fetishism, a group that has not previously been included in neuroimaging research.

We predicted significant white matter differences between pedophilic men and the other two groups. Specifically, we predicted that we would see white matter microstructure differences between pedophilic men and the other two groups in areas previously identified, including the fronto-occipital fasciculi, arcuate fasciculi, internal and external capsules, corona radiata, and thalamic radiations (Cantor et al., 2008; 2015, Cantor & Blanchard, 2012).

Method

We included 40 participants in this study: 9 pedophilic, 15 fetishistic, and 16 teleiophilic men. Our *a priori* goal was to recruit 30 participants per group for a total of 90 participants, but this was not accomplished due to several challenges (see Limitations section). Participants were included in the study if they met the following criteria:

i. At least 18 years of age;
ii. Exclusively or predominantly heterosexual;
iii. Capable of providing informed consent and participating in all aspects of the study;
iv. MRI compatible (including the absence of metal foreign bodies, history of seizures, recent tattoos, claustrophobia, uncorrectable poor eyesight, chronic pain which would preclude laying supine);
v. No history of moderate to severe head injury or concussions with a loss of consciousness for >1 minute;
vi. Have not been charged or convicted of a violent offense or contact sexual offense, or with multiple (4+) non-violent convictions;
vii. No substance use problems (in accordance with DSM-5 criteria);
viii. No diagnoses of psychotic disorders;

ix. No diagnoses of major mental disorders other than depression, ADHD, and anxiety-related disorders. Psychotropic medications were allowed only if they were ADHD medications, anti-depressants, or anti-anxiety medication;

x. No paraphilias other than those which qualify them for the study group, classified as being as strong as or stronger than the paraphilia being studied.

We only included cisgender men in this study because pedophilia (and paraphilias in general) is much more common in men than in women (Seto, 2008). We excluded individuals who were not heterosexual, had histories of severe head trauma, substance use disorders, or severe psychiatric comorbidities (i.e., bipolar, schizophrenic, and neurodevelopmental disorders) because these conditions are associated with predictable differences in brain structure and function, therefore their presence was minimized in our samples to ensure that groups were as similar as possible. We initially planned to exclude participants with any mental disorders or psychiatric medication use, including depression and anxiety, but early recruitment efforts indicated excluding these disorders severely limited our recruitment capacity (see section on limitations) and was also going to provide a sample that was not representative of the population. Pedophilic participants reported the most mental health comorbidities, and this group would have been almost impossible to recruit had we not modified our inclusion criteria in this way. This experience is consistent with Fox et al's (2022) finding of an association between paraphilias and psychological disorders such as anxiety or depression in men. We also initially attempted to only include right-handed participants because of reliable differences in neural structure and function between right- and left-handed individuals, especially in brain asymmetry. However, a dearth of eligible pedophilic participants led us to include two left-handed pedophilic men who otherwise met all inclusion criteria. There is an association between non-right-handedness and pedophilia, thus it is unsurprising that excluding on this basis would lead to recruitment issues (Cantor et al., 2005; Fazio, Lykins, & Cantor, 2014).

We excluded men with 4+ non-violent offenses or any history of contact criminal offenses to avoid high levels of criminality in our samples. We chose to include pedophilic men with histories of non-contact crimes related to child sexual exploitation material to increase our recruitment capacity and because these offenders tend to be more comparable to non-criminal community controls on several variables (Seto, 2025).

Pedophilic participants were only selected if they acknowledged a recurrent, persistent, and intense interest in prepubescent children. Fetishistic participants acknowledged a recurrent, persistent, and intense sexual interest in women's feet and denied any concomitant interest in prepubescent or pubescent children. Individuals could have multiple paraphilic interests, but we excluded any individuals with stronger paraphilic interests than pedophilia or foot fetishism, respectively. Teleiophilic participants said they were attracted to adults and did not report recurrent, persistent, or intense paraphilic interests of any kind. We recruited pedophilic participants from an outpatient sexual behaviour clinic, and fetishistic and teleiophilic individuals from the community via posters (at the research hospital and university campus) and online advertising. We did not ask for permission to access the clinical files of pedophilic participants referred from the sexual behaviour clinic (e.g., to confirm their diagnoses.)

The procedure consisted of a preliminary phone screening interview to assess eligibility and assign to a study group, followed by an in-person interview and scanning session. During both the phone and the in-person interview, the interviewer informed participants that if they revealed that they had physically or sexually abused a child, and if this information had not already been reported, that the information would be reported to police or the local child protection agency. Consent was provided orally and in writing and all participants expressed their understanding of mandatory reporting requirements. During the in-person session, the interviewer used a structured script to confirm the information provided during the phone screening and asked the participant to complete several questionnaires. Interview questions and questionnaires assessed variables that could impact the interpretation of group differences, such as sociodemographic and behavioural variables (i.e., age, education level, substance use, brain injury, antisocial behaviour). We also assessed level of interest in various paraphilic behaviours and sexual compulsivity to explore how these may differ between the three groups. Measures were all self-report and were completed by the participant, with the interviewer helping as needed. Participants were remunerated for their participation. Questionnaires are listed below, and were included based on good reliability and validity in previous studies:

i. A demographic questionnaire.

ii. A measure of interest in many different paraphilias and the frequency with which participants engage in the corresponding paraphilic behaviours (Paraphilias Scale, Seto et al., 2012).

   a. Validation studies have shown good internal consistency (Seto et al., 2021) and convergent validity with self-reported paraphilic behaviours (Bouchard et al., 2017; Chivers et al., 2014; Dawson et al., 2016; Seto et al., 2012; Seto et al., 2025). Seto et al., 2025 also showed configural invariance across genders (women and men) and sexual orientations for gender (woman or man) and provided additional evidence for a stable four-factor structure.

iii. A measure of hypersexuality and sexual preoccupation (Sexual Compulsivity Scale, Kalichman & Rompa, 1995).

a. Internal consistency ranges from Cronbach's α = .59 - .92, temporal stability coefficient = .95 for 2 weeks and ranges from .64-.80 for three months, the tool demonstrates convergent validity with other related measures and discriminant validity with unrelated variables, and criterion validity was shown with several behavioural outcomes associated with sexual compulsivity (Hook et al., 2010).

iv. Measures of childhood antisocial behaviour and early life criminality (Childhood and Adolescence Taxon Scale – Self Report (CATS-SR), Harris, Rice, & Quinsey, 1994; Self-Report Early Delinquency Scale (SRED), Moffitt & Silva, 1988).

a. The CATS-SR shows good internal consistency (Cronbach's α = 0.73 for male juvenile offenders), discriminant validity between offending and non-offending samples (area under the curve [AUC] = 0.96 for male juvenile offenders compared to non-offending school-aged males), convergent validity with related measures, discriminant validity with unrelated measures, and criterion-related validity with related behavioural variables and psychiatric diagnoses (Pechorro et al., 2020).

b. The SRED has a robust five-factor structure accounting for 45.2% of score variance, and reliability analysis of the factors showed Cronbach's α values of 0.7-0.9 (acceptable to excellent) (Charles & Egan, 2005).

v. A measure of traumatic indices in childhood including abuse and neglect (Adverse Childhood Experiences (ACEs) Questionnaire, Felitti et al., 1998)

a. Internal consistency ranges from Cronbach's $\alpha = 0.64$-0.76, internal item validity ranges from Cronbach's $\alpha = 0.28$-0.70, and strong concurrent criterion validity with outcomes related to early adverse experiences (Kovács-Tóth et al., 2023).

Scores on self-report questionnaires were compared via between-group one way ANOVAs. Mean scores are presented in **Table 2.1**. The self-report questionnaire of general paraphilic interests and behaviours (Paraphilias Scale) included questions about sexual interest and activity with both children and feet. To investigate the degree to which group-specific interests may have been driving average scores and group differences on these questionnaires, analyses were completed for the full questionnaires and again with all questions relating to children or feet removed. Both are reported in **Table 2.1**.

The second part of the procedure consisted of additional MRI compatibility screening, explanation of the imaging procedure, and MRI scanning. Instructions were repeated from a script created by the study coordinator and designer. Participants were informed that they would be in the scanner for approximately 30 minutes and that they would be in verbal contact with the MRI technologist and study coordinator via earphones between each sequence, including a reiteration of instructions and confirmation of understanding. We informed participants that staff could not see what was going on in their brain in real time. Participants were guided through the protocol by staff and instructed to lie as still as possible throughout.

DTI acquisition:

The DTI data was acquired using a Siemens 3.0T Magnetom Biograph PET-MR scanner. Participants laid supine on the bed of the scanner with their head immobilized in a 12-channel head coil. Scanning included a fluid attenuated inversion recovery (FLAIR) double-refocused spin echo sequence. Sixty-four diffusion tensor images were acquired with b-value = 1000s/mm2 and one non-diffusion was acquired (TR=7200ms, TE=828ms, slices number = 63, slice thickness = 2.2mm, field of view (FOV) = 200 mm).

DTI processing:

The preprocessing of the DTI images was conducted using the Functional Magnetic Resonance Imaging of the Brain (FMRIB) software Library tool (FSL, version 6.0.3) (https://fsl.fmrib.ox.ac.uk/fsl/fslwiki). For each participant, a brain mask was generated by applying the Brain Extraction Toolbox (BET) to the b0 image. The raw DTI images were then corrected for motion and residual eddy current distortion, and motion parameters were estimated from the transformation matrices for each participant. Appropriate b-matrix rotations were performed to account for the rotation component of registration. After motion correction, each participant's voxel-wise diffusion tensor was calculated using nonlinear estimation (Pierpaoli et al., 1996).

TBSS processing:

Using the Tract-Based Spatial Statistics procedure pipeline (TBSS, https://fsl.fmrib.ox.ac.uk/fsl/fslwiki/TBSS/UserGuide), all participants' FA and MD images (see below), generated in the previous step, were first aligned to a common registration target using a nonlinear registration approach based on free-form deformations and B-

Splines (Rueckert et al., 1999), then the FA/MD dataset was normalized to the MNI152 standard space (FSL FMRIB58 FA image) (Mazziotta et al., 2001). Next, the mean FA/MD image was derived and thinned to generate a mean skeleton embodying the center of all tracts derived from the whole group. A threshold of 0.2 was applied to the FA/MD map to exclude regions that likely comprise multiple tissue types or fiber orientations. Finally, each participant's aligned FA/MD image was projected onto the template skeleton in order to account for residual misalignments between participants after the initial nonlinear registration.

Statistics:

FSL's randomise of one-way ANOVA model with 500 permutations was conducted to examine the differences in FA/MD among the three groups (Winkler et al., 2014). Threshold-free cluster enhancement (TFCE) was applied, and the threshold of significant results was set at family-wise error (FWE) corrected $p < 0.05$. The result of main group effects was extracted out as the mask image using FSL's cluster function and was applied for the post-hoc simple t tests of the pairwise comparisons between every group. FSL software's automated atlasquery (autoaq) was used to identify the structures in the provided atlas to which the significant cluster peaks belong. The JHU ICBM-DTI-81 white-matter labels atlas (Mori et al., 2005; Wakana et al., 2007; Hua et al., 2008) was used to identify the tracts.

Indicators of White Matter Microstructure (FA and MD):

We examined white matter microstructure via two DTI measures to describe the diffusion of water molecules through brain tissue: *Fractional Anisotropy* (FA) and *Mean*

Diffusivity (MD). FA measures the overall directionally dependent diffusion of water molecules (encompassing both radial and axial diffusion metrics), which is higher (more anisotropic) in organized white matter tract structures and lower (more isotropic) in free-flowing cerebrospinal fluid spaces. Higher FA indicates more directionally-dependent movement of water, reflecting better integrity of axonal cellular microstructure, whereas lower FA indicates less directionally-dependent water diffusion and thus poorer tract integrity. MD measures the mean diffusion of water molecules across all directions and is highest in areas of high water content. The greater the structural organization and integrity of tracts containing water molecules, the lower the MD (the higher the anisotropic movement of water). When axonal tissue is compromised and water flows more freely (more isotropic movement), MD increases. In this way, FA and MD are inversely related to one another.

While both FA and MD offer insights into white matter microstructure and integrity, they differ in the properties they capture. FA is more sensitive at detecting subtle changes in myelin integrity and subsequent extracellular water diffusion within tracts, as reflected by the isotropic VS anisotropic movement of water (Basser & Pierpaoli, 1996; Alexander, Lee & Lazar, 2007; Assaf et al., 2007; Le Bihan & Johansen-Berg, 2013; Wheeler-Kingshott & Alexander, 2019). MD is highly sensitive to changes in white matter pathology including demyelination, axonal injury, age-related degeneration, inflammation and edema, or other intra/extracellular changes, as reflected by the overall diffusion quotient of water. Heuristically, high FA is more indicative of myelin sheath cohesion and integrity, and high MD is more indicative of overall injury, edema, and pathology. FA and MD are therefore expectedly to be inversely related.

Ethical Considerations:

This research was approved by the Research Ethics Board at the local Mental Health Center and the Research Ethics Committee of the University.

Results

Demographic and Questionnaire data:

See **Table 3.1** for a summary of questionnaire results and demographic information. All participants reported being free of contact sexual crimes. Among pedophilic participants, 7 of the 9 reported a history of non-contact sexual offenses, including 7 with convictions related to child sexual exploitation materials and one with an additional conviction related to luring (sexual solicitation of a child via text). No other participants reported criminal charges or convictions. All participants reported sexual attraction to adult women and identified as being either heterosexual, 'heteroflexible', or bisexual, but favoring women over men. Only the pedophilic participants preferred children, only the fetishistic participants preferred women's feet, and teleiophilic participants only preferred women. Pedophilic participants reported sexual thoughts of children multiple times a day (2 participants) or multiple times a week (7 participants). Fetishistic participants reported sexual thoughts of feet multiple times a day (reported by 10 participants) or multiple times a week (5 participants). All paraphilic participants reported that their atypical interest was either as strong or stronger than their interest in conventional sex with an adult woman.

There is an important distinction to be made between paraphilias and paraphilic disorder (American Psychiatric Association, 2022). While the former refers to any 'atypical' sexual interests, a 'paraphilic disorder' involves clinically significant distress or impairment because of these interests (or having committed a sexual offense involving a child). All pedophilic participants had been diagnosed with pedophilic disorder, whereas no fetishistic or teleiophilic participants had been diagnosed with a paraphilic disorder. All fetishistic participants reported that their interests began early in life (before or around puberty), while 6 pedophilic participants reported the same and 3 reported that these interests only began after age 40.

Table 3.1: Interview and Questionnaire Results

Factor	Levels	Pedophilic (PED)	Fetishistic (FET)	Teleiophilic (TEL	
N		9	15	16	
Handedness					
	Right	7	15	16	
	Left	2	0	0	
Mental Health Diagnoses					
	Depression/Anxiety	6	6	2	
	OCD	2	0	0	
	ADHD	2	0	0	
Psychiatric Medications					
	Antidepressant	6	5	1	
	ADHD	3	1	0	
		PED Mean (SE)	**FET Mean (SE)**	**TEL Mean (SE)**	**P Value**
Age		49.44[a] (5.32)	37.4[a,b] (4.02)	29.63[b] (3.20)	**0.009**
Alcohol (drinks per week)		4.44 (2.57)	3.20 (0.98)	1.93 (0.64)	0.421
Head Injuries (number of minor concussions)		3	4	3	0.725
Education (Highest level accomplished)		2.13 (.295)	2.64 (.133)	2.63 (.125)	0.104
Income Bracket (CAD$, Coding below)		1.62 (.744)[b]	3.13 (.350)[a]	2.25 (.370)[a,b]	**0.033**
<$25,000	1				
$25,001-50,000	2				
$50,001-75,000	3				
$75,001-100,000	4				
$100,001+	5				
Lifetime Number of Sexual Partners					
	Female	14.33 (6)	12.53 (2.59)	11.60 (3.70)	0.896
	Male	0.3 (0.38)	0.6 (0.41)	0 (0)	0.279
Stimulus of Interest Ratings (/10)					

Feet	0.56 (0.37)^{b}	8.6 (0.32)^{a}	0.81 (0.27)^{b}	**<.001**
Children (girls)	6.44 (0.58)^{a}	0 (0)^{b}	0 (0)^{b}	**<.001**
Paraphilic Interest General	2.04 (.176)^{a,b}	2.58 (.149)^{a}	1.99 (.193)^{b}	**0.038**
Paraphilic Interest (child & feet items removed)	1.76 (0.19)^{b}	2.58 (0.18)^{a}	2.08 (0.21)$^{a.b}$	**0.029**
Paraphilic Behaviour General	1.23 (.059)^{b}	1.46 (.049)^{a}	1.26 (.068)^{b}	**0.025**
Paraphilic Behaviour (child & feet items removed)	1.21 (0.05)	1.42 (0.06)	1.30 (0.07)	0.128
Childhood Antisociality	9.44 (2.056)	6.33 (.785)	5.75 (.574)	0.061
Childhood Delinquency	19.62 (4.84)	19.80 (2.43)	16.06 (1.25)	0.465
Sexual Compulsivity	2.11 (.249)^{a}	1.67 (.141)^{a,b}	1.31 (.077)^{b}	**0.003**
Adverse Childhood Experiences	2.89 (.611)	1.93 (.452)	1.13 (.424)	0.066

Superscripts indicate statistical significance (e.g., a, b, c) within a row. Means sharing the same superscript do not differ significantly at p < 0.05 with current sample sizes. Significant omnibus p values are bolded.

FA Map:

As shown in **Figure 3.1A**, the main group differences in the FA map (significantly different voxel clusters reflected in blue) were primarily observed in the left posterior thalamic radiation (including optic radiation) (L.PTR), extending to the splenium of the corpus callosum (SCC), left posterior corona radiata (L.PCR), and left superior longitudinal fasciculus (L.SLF). Further post-hoc simple t tests revealed that the main group effects were attributable to the differences between the two paraphilic groups and the teleiophilic group. Specifically, both paraphilic groups showed lower FA than the teleiophilic group in all the regions that were reported in the main group differences (**Figure 3.1B**), while the pedophilic group, but not the fetishists group, showed lower FA than the teleiophilic group in L.PTR (L.SS), (**Figure 3.1C**). No significant difference in FA was found between fetishistic and pedophilic groups at the threshold of family-wise error (FWE) corrected $p < 0.05$.

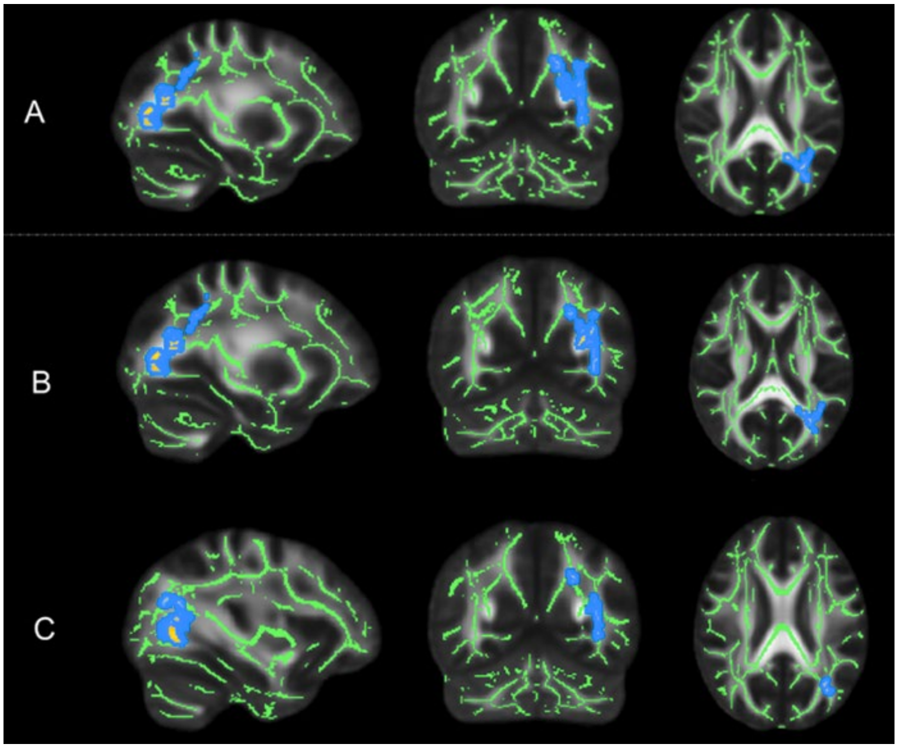

Figure 3.1. One-way ANOVA results of FA map. A) F-test results of FA differences among PED, FET, and TEL groups; **B)** Simple t test result of FET < TEL; **C)** Simple t test of PED < TEL. Threshold of significant results was set at FWE corrected p < 0.05. To aid visualization, regions showing lower FA (blue) are thickened using the TBSS fill script implemented in FSL. Results are shown overlaid on the FMRIB58_FA template and the mean FA skeleton (green). Images are displayed in radiological view (left side of the figure is right side of the brain).

Table 3.2: FA Differences Among Three Groups

Hemisphere	Tract	Cluster Size (voxels)	MNI Coordinates			TFCE p-value
			x	y	z	
post-hoc t test FET < TEL						
L	PTR	1,135	-35	-58	-1	0.003
L	SLF		-34	-56	21	0.003
L	PCR	91	-27	-59	22	0.003
L	SCC		-24	-54	13	0.003
post-hoc t test PED < TEL						
L	PTR	334	-37	-52	-4	0.003

Note: p-values were whole-brain level family-wise error corrected; the threshold was set at $p_{fwe} < 0.05$. MNI = Montreal Neurological Institute Atlas (MNI152). PTR = posterior thalamic radiation; SLF = superior longitudinal fasciculus; PCR = posterior corona radiata; SCC = splenium of the corpus callosum.

MD Map:

As shown in **Figure 3.2A,** there was a significant main effect of group, with a number of tracts showing significant differences in MD among the three groups and the paraphilic groups overall having significantly higher MD than the teleiophilic group (significantly different voxel clusters reflected in red). Post-hoc t tests revealed differences between the two paraphilic groups and the teleiophilic group in the body of corpus callosum (BCC), left splenium of corpus callosum (SCC), bilateral superior corona radiata (SCR) bilateral anterior limb of internal capsule (ALIC), bilateral posterior limb of internal capsule (PLIC), bilateral external capsule (EC), bilateral anterior corona radiata (ACR), bilateral posterior corona radiata (PCR), bilateral superior longitudinal fasciculus (SLF), and the right sagittal stratum (SS) (including inferior longitudinal fasciculus and inferior fronto-occipital fasciculus but only between the fetishistic group and the teleiophilic group). No significant difference in MD was found between fetishistic and pedophilic groups at the threshold of FWE corrected $p < 0.05$.

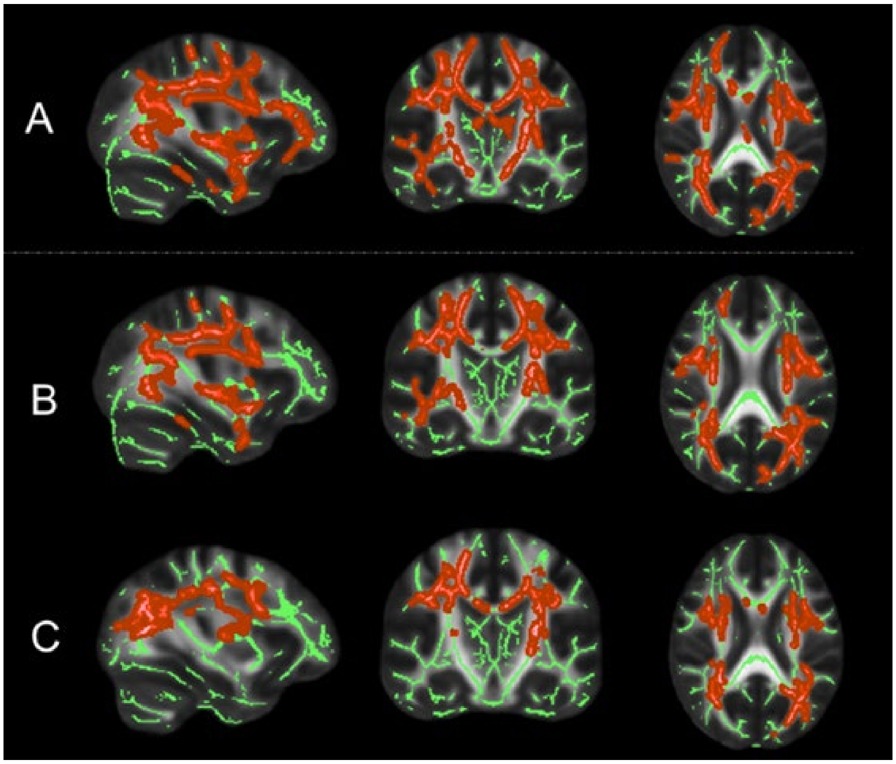

Figure 3.2. One-way ANOVA results of MD map. A) F-test results of MD differences among PED, FET, and TEL groups; **B)** Simple t test result of FET > TEL; **C)** Simple t test of PET > TEL. Threshold of significant results was set to FWE corrected p < 0.05. To aid visualization, regions showing higher MD (red) are thickened using the TBSS fill script implemented in FSL. Results are shown overlaid on the FMRIB58_FA template and the mean FA skeleton (green). Images are displayed in radiological view (left side of the figure is right side of the brain).

Table 3.3: MD Differences Among Three Groups

Hemisphere	Tract	Cluster Size (voxels)	MNI Coordinates			TFCE p-value
			x	y	z	
		post-hoc t test FET > TEL				
R	SS	490	39	-40	-13	0.006
R	BCC	5,076	17	6	33	0.006
R	SCR		18	3	39	0.004
R	EC		31	11	-7	0.004
R	ALIC		18	5	10	0.004
R	PCR		25	-52	27	0.014
R	SLF		34	-25	36	0.004
L	BCC	12,916	-14	6	30	0.008
L	SCC		-25	-66	13	0.002

L	SCR		-17	3	39	0.002
L	EC		-27	11	16	0.002
L	ALIC		-21	5	15	0.002
L	PLIC		-23	-16	5	0.004
L	PCR		-25	-52	25	0.004
L	SLF		-28	-25	39	0.002
post-hoc t test PED > TEL						
L	SCC		-25	-55	18	0.004
L	ALIC		-21	3	16	0.004
L	PLIC	4,939	-26	-16	16	0.002
L	PCR		-26	-52	26	0.004
L	SLF		-27	-25	41	0.01
L	BCC		-13	-6	32	0.014
R	BCC		12	-6	31	0.022
L	SCR		-18	3	40	0.022
R	SCR		19	3	40	0.004
R	EC	6,607	31	3	14	0.002
R	ALIC		22	3	16	0.004
R	PLIC		24	-16	12	0.002
R	PCR		25	-52	26	0.002
R	SLF		28	-25	41	0.002

Note: p-values were whole-brain level family-wise error corrected; the threshold was set at $p_{fwe} < 0.05$. MNI = Montreal Neurological Institute Atlas (MNI152). BCC = body of corpus callosum; SCC = splenium of corpus callosum; ALIC = anterior limb of internal capsule; PLIC = posterior limb of internal capsule; EC = external capsule; ACR = anterior corona radiata; PCR = posterior corona radiata; SCR = superior corona radiata; SLF = superior longitudinal fasciculus; SS = sagittal stratum.

Discussion

The present study is the first of its kind to use neuroimaging techniques to compare pedophilic men with another group of men with a paraphilia, and to compare these two groups with teleiophilic men. It also adapted methodological paradigms from previous research to better isolate the neural correlates of pedophilia from criminality. The current study found that pedophilic and fetishistic individuals both differ from teleiophilic individuals in similar patterns of white matter integrity, with implications for efficiency of communication between higher order cortical regions. In this study, both pedophilic men and fetishistic men had lower white matter integrity than did teleiophilic men in tracts connecting regions involved in the processing of sensory inputs, motor output, impulse regulation, executive functions, attention, emotion, and language. Pedophilic men did not differ from fetishistic men in their patterns of white matter integrity at a threshold of $p<0.05$ family wise corrected. These results, although limited because of the small samples, are sufficient to warrant further investigation into the neurophysiological underpinnings of both pedophilia and foot fetishism.

Regional Differences and Implications:

As noted earlier, the DTI measurements used in this study, FA and MD, are indices of white matter microstructure and are related to the efficiency of communication through axon bundles. They have both been associated with predictable brain development, injury, and disease-states. Our results echo past research showing distinct patterns of white matter connectivity in pedophilic samples, including the internal and external capsules, corona radiata, thalamic radiations (Cantor et al., 2015: higher FA in pedophilic men), and corpus callosum (Lett et al., 2018: lower FA in pedophilic men with offense histories). Our results suggest that differences are characterized by lower FA and higher MD in the paraphilic groups across several large clusters, in contrast to Cantor et al's 2015 finding of higher FA in a small 288 voxel cluster in pedophilic sexual offenders, with no differences found in MD. The large size of several of the white matter clusters identified in our study implies that differences in integrity could have important down-stream effects on speed and efficacy of neural communication between affected areas.

Due to differences in methodology, it is not possible to directly compare these studies. Cantor et al., 2015, recruited participants with contact sexual offense histories and other demographic and clinical differences and employed a highly conservative threshold of p family wise error corrected < 0.025 for group comparisons. It is possible that they would have seen more between-group differences in FA and MD had they used a standard threshold of $p<0.05$, corrected for family-wise error. We also identified lower FA in pedophilic men compared to teleiophilic men in areas that have not previously been observed, and did not observe any between-group FA differences in the area identified by Cantor in 2015. Importantly, these FA results were lateralized to the left side of the brain. This lateralization may reflect the preference for approach motivation (which is more left-lateralized) in left sided neural pathways, which were more fortified in the teleiophilic group and may be more frequently utilized in response to visual sexual stimuli of preference. In contrast, structures preferentially involved in withdrawal motivation (largely right-sided) may be more utilized in non-offending paraphilic samples who seek to avoid arousal resulting from their paraphilic interest (Harmon-Jones & Gable, 2018; Davidson et al., 2003).

The areas identified in the current study differentiating the two paraphilic groups from the teleiophilic group play a vital role in structurally connecting cortical areas involved in executive functioning processes, including delay of gratification (superior longitudinal fasciculus, thalamic radiation, fronto-occipital fasciculus, and splenium of the corpus callosum; Olson, 2009), impulse control and risk-taking behaviour (corpus callosum, corona radiata, and corticothalamic tracts; Berns et al., 2009; Myoung Soo Kwon et al., 2014; Popovic et al., 2023), processing speed, attention, vocabulary, intelligence, and directed behaviour (body and splenium of the corpus callosum; Mathews et al., 2008; Paul, 2011; Fabri & Polonara, 2013; Swanson et al., 2017; Blaauw & Meiners, 2020). The superior longitudinal fasciculus connects the occipital, parietal, and temporal lobes with the frontal cortex (Schmahmann et al., 2008; Kamali et al., 2014) and is associated with language, attention, memory, and emotions (Makris et al., 2005; Kamali et al., 2014; Wang et al., 2016).

With respect to corticothalamic pathways, research has identified functional connections between both the left thalamus and the left posterior corona radiata with left sided frontal areas associated with executive function. Infarcts in posterior regions of the left thalamus and corona radiata result in poorer white matter integrity between key frontal regions, with subsequent decreases in performance on cognitive testing (Li et al., 2014). The corona radiata has also been associated with cognitive and emotional processes through its connections with the anterior cingulate and orbitofrontal gyri (Jiang et al., 2019), while the internal capsule has been implicated with the corona radiata in cognitive, perceptual, and motor function (Gage & Baars, 2018). Overall, the areas identified in this study have been associated with widespread cerebral functions spanning higher and lower order processes vital for interfacing with the world around us.

Sexual Processing:

In terms of sexual processing, the white matter tracts identified in the current study physically connect many of the grey matter regions typically associated with the processing of sexually relevant stimuli, including temporal and ventral prefrontal regions (Georgiadis & Kringelbach, 2012). These regions include ones highlighted by Stoleru et al (2012) as being involved in the cognitive component of sexual arousal to visual stimuli, such as the ventral premotor area, supplementary motor area, and inferior parietal lobule (motor imagery), the orbitofrontal and inferior temporal cortex (appraisal), and the superior and inferior parietal lobule (attention).

Areas identified in the gray matter structural neuroimaging research on pedophilia include the orbitofrontal cortex (bilateral), insula (bilateral), ventral striatum and nucleus accumbens (bilateral), cingulate cortex, parahippocampal gyri, cerebellum (Schiffer et al., 2007), prefrontal cortex, insula, limbic system (Poeppl et al., 2013), and amygdala (Schiltz et al., 2007). Several of these areas are connected to other cortical regions via white matter tracts identified in the current study. These results suggest that a mechanism for, or perhaps result of, gray matter differences in pedophilic individuals may lie in white matter tract integrity throughout the brain.

Impulsivity:

Particular interest may be warranted in tracts identified by the current study which have been implicated in impulse control, such as the corpus callosum, corona radiata, and corticothalamic tracts. To allay concerns from the impact of criminality, no participants in the current study had histories of contact sexual crimes or more than four non-violent criminal offenses. Also, self-report data did not indicate differences in early life antisociality or delinquency between the three groups. However, questionnaire results indicated that there were differences in self-reported sexual compulsivity, with pedophilic participants scoring significantly higher than teleiophilic participants (see **Table 3.1**). Lower white matter integrity in these areas in the paraphilic groups may contribute to differences in response inhibition or sexual impulsivity, as echoed in self-report data and in previous research. Having controlled for contact sexual offending in the current study, these differences could be more confidently attributed to paraphilia/pedophilia alone, rather than their combination with criminality factors.

In addition to sexual compulsivity, our groups differed on a measure of paraphilic interest and behaviour. Specifically, men with fetishism scored higher on items relating to general paraphilic interest both when items specific to feet were included and when they were removed, and they scored higher on items relating to the frequency with which they engaged in paraphilic behaviour, but only when items relating to feet were included (i.e. they only engage more in foot fetish behaviour, not behaviours related to other paraphilic interests). One possible explanation is that fetishistic participants are able to legally explore their fetishistic interests in person and online, and thus may have become exposed to other interests and behaviours and had less incentive to downplay the diversity of their paraphilic interests in questionnaire responses. In contrast, pedophilic participants have had to repress their interest in children, which involves illegal behaviour if expressed, and this may have carried over to repression and under-reporting of other paraphilic interests and behaviours. It is possible that the repression of paraphilic interests – especially relating to their interest in children, which they reported was strongest – may be contributing to greater sexual compulsivity in this group, characterized by chronic difficulty with intrusive, disruptive, and unsatisfied sexual thoughts over which they have little perceived control and no legal outlet to sate their desires. Alternatively, or in addition, pedophilic participants may have been more reluctant to acknowledge other paraphilic interests and behaviours given their legal situations and the warning they received about mandatory reporting. For example, some pedophilic participants may have been unwilling to admit interest in exhibitionism or voyeurism since acting on these interests is also illegal.

Microstructure Perspectives:

FA and MD offer subtly different and inversely related perspectives on white matter microstructure. MD is more sensitive to changes in white matter pathology related to injury, degeneration, inflammation, and edema. FA is more sensitive at detecting the quality of myelin cohesion along tracts and resulting water diffusion within axons.

We found more differences, spanning larger areas in MD than in FA among our three groups. Additionally, MD differences were largely bilateral, while FA differences were unilaterally found on the left. This may hint at the nature of the white matter microstructural group differences being related to overall disruptions in tissue architecture and integrity (i.e. reflecting inflammation or poorer cellular health) or increased blood flow (which can lead to higher diffusivity) rather than of myelin cohesion alone. Increased blood flow, specifically, is a likely contributor as it mirrors the results of functional MRI investigations during a sexual processing task which demonstrated that both paraphilic groups recruited additional areas for sexual processing compared to the teleiophilic group (Leeming et al., in press). While general pathology and inflammation are also possible, these cannot be confirmed in the present analyses.

Limitations:

This study has several limitations. Stigma and fear of persecution related to sexual interests and behaviours involving children likely contributed to a dearth of pedophilic participants. The COVID-19 pandemic also resulted in an 18 month pause in recruitment, with increased challenges for recruiting and scanning participants in the aftermath. Additionally, sample-specific variables unique to our pedophilic group limited our ability to include most candidates following screening. These included a higher rate of neurological, neurodegenerative, and neurodevelopmental disorders, severe mental health diagnoses, anti-androgen medication use, contact sexual offense histories, same sex attractions, and significant history of severe head/brain injury. These issues resulted in a small pedophilic group and lower statistical power, as well as difficulty in matching groups by age and other demographic factors.

In response to these challenges, inclusion criteria had to be modified following the pandemic, allowing for two left-handed pedophilic participants to be included in the study. This constitutes an uncontrolled variable potentially affecting comparability of groups, though some studies comparing left- and right-handed persons (two studies of children and one of adults) have found no group differences in FA or MD (Jang et al., 2017; López-Vicente et al., 2020; Tomasi et al., 2024). Additionally, limited participant availability, especially in the pedophilic group, rendered it impossible to exclude all those with mental health diagnoses. However, efforts were made to exclude those disorders with major affective/behavioural instability or accompanying psychosis, such as bipolar, psychotic disorders, and personality disorders. Nevertheless, our groups differ in terms of presence of depression, anxiety, OCD, and ADHD, as well as medications for these conditions. Efforts were made to minimize these differences by recruiting participants with similar diagnoses in the other two groups. Further research with access to a larger group of pedophilic men would benefit from more stringent controls than were possible in our study.

Related to recruitment obstacles, research has demonstrated that white matter development, maturation, and degeneration follows a predictable timeline through the life course, further stressing the importance of stringent matching between groups, which was not achieved in this study. However, all participants had reached the age-range of approximate white matter maturation in men (from eighteen to the late twenties) at the time of participation (Schmithorst et al., 2002; Barnea-Goraly et al., 2005; Giorgio et al., 2008; Lebel et al., 2008; Asato et al., 2010; Tamnes et al., 2010; Simmonds et al., 2014; Slater et al., 2019).

CONCLUSION

We posit that differences in white matter integrity between pedophilic and teleiophilic men (also seen in previous literature) are indeed reflective of pedophilia more than criminality, but these differences are not necessarily unique to pedophilia. We did not observe differences between our two paraphilic groups in white matter integrity, indicating that white matter dysconnectivity, at least, may be a shared feature across paraphilias. The sample size was likely too small, however, to observe these differences, if real and small in effect size. These findings should not be interpreted as suggesting an equivalence between the two paraphilias. Foot fetishism and pedophilia represent distinct clinical presentations with very different risk of harm to others. This research does not aim to pathologise or stigmatize foot fetishism; rather, it seeks to better understand the neural correlates of pedophilia specifically and paraphilia more generally.

White matter tract bundles play an important role in efficient communication between cortical gray matter regions. Loss of integrity in central white matter "highways" may have subtle but pervasive impacts on the activity of endpoint cortical regions, with implications for alterations in cognitive, emotional, sexual, and behavioural functioning. The current study compared groups that differed not only in their sexual interests, but in their paraphilic behaviours and sexual compulsivity. Despite limitations, we showed that significant differences exist between our two paraphilic groups and the group of teleiophilic men. This preliminary study aimed to open the door to a new line of research on paraphilias. Our data provide a launching point for further comparison of these two groups and justify further investigation of the neurophysiological correlates of paraphilia. Further studies bolstered by better statistical power on non-contact-offending paraphilic individuals is needed to further elucidate the differing neural correlates of pedophilia and other paraphilias.

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CHAPTER 4

Study 3 *(submitted to Archives of Sexual Behavior):* A 'Brainprint' of Paraphilia: An fMRI Study of the Functional Correlates of Sexual Processing in Fetishism and Pedophilia

Abstract

Pedophilia, a persistent sexual interest in prepubescent children, has long been the subject of concern due to its association with child sexual offending. Despite progress in the neuroscientific understanding of pedophilia, the functional mechanisms underlying it remain unclear. Its neural distinctiveness from other paraphilic interests also remains elusive. Additionally, much of the research has not controlled for antisociality variables, raising concerns over whether results were reflective of pedophilia or antisocial factors. This study compared 9 men with pedophilia without any contact sexual offenses, 15 men with foot fetishism, and 16 men who were attracted to adults and had no paraphilic interests (i.e. teleiophilic). Functional magnetic resonance imaging (fMRI) was used during a novel picture task to quantify brain activity during visual sexual processing of both non-paraphilic sexual targets (adult women) and paraphilic sexual targets (children or feet) in the three groups. We also collected self-report data on trauma history, sexual compulsivity, general paraphilic interest, antisociality, criminality, and biographic variables. Both paraphilic groups recruited more brain areas and used more neural resources than the teleiophilic men when engaging in sexual processing of their preferred stimuli. Participants with pedophilia recruited more areas in the frontal and temporal lobes and cerebellum, while participants with foot fetishism recruited more areas in the superior parietal cortex (including the motor and sensory cortices) and the occipital lobe. Amygdalar activity was highest in pedophilic participants, followed by fetishistic and then teleiophilic participants.

The study replicated previous research demonstrating functional differences between pedophilic and teleiophilic individuals and, for the first time, distinguished the neural ‘brainprint’ of pedophilia from that of another paraphilia. These results open the door for a new line of imaging research on the paraphilias.

Introduction

Importance of Pedophilia Research

Paraphilias are sexual interests involving atypical objects, people, or activities. One of the most well-known and thoroughly researched is pedophilia, most likely because it is a risk factor for sexual offending involving children (Hanson & Morton-Bourgon, 2005; Helmus et al., 2015; Seto, 2018). Pedophilia is highly stigmatized and affected individuals often do not disclose their atypical sexual interest. The functional sequelae of untreated pedophilia have far-reaching impacts (Seto, Cantor, & Blanchard, 2006; Seto, 2008). Childhood abuse, particularly sexual abuse, has significant negative effects on victims' mental and physical health, socioeconomic status, and relationships (Dube et al., 2005; Cashmore & Shackel, 2013; Batool & Abtahi, 2017; Fontes et al., 2017). Despite over a century of research on pedophilia, the debate on its origins remains unresolved.

Progress in Neuroimaging Research on Pedophilia

Several fMRI studies have identified differences in brain activity between pedophilic and teleiophilic men (individuals attracted to sexually mature adults). Although there is not yet a consensus on which brain areas consistently differ in these groups, differential activity has been observed in frontal, temporal, and limbic areas repeatedly in pedophilic individuals when engaging in visual sexual processing of child-related stimuli (Mohnke et al., 2014; Tenbergen et al., 2015). A prominent theory underlying these findings is that pedophilic individuals may have neurodevelopmental alterations of key frontal and temporal lobe structures that alter how sexual information is processed. These alterations may then contribute to inappropriate sexual behaviours and interests such as impulsivity, hypersexuality, and fixation on children (Mendez et al., 2000; Schiltz et al., 2007; Ponseti et al., 2012; Seto, 2008, 2009; Poeppl et al., 2013; Tenbergen, 2015).

Indeed, several studies have identified functional differences in these areas in pedophilic participants compared to non-pedophilic participants, as well as within pedophilic groups when viewing child versus adult stimuli. Ponseti et al. (2012) identified altered activations of the caudate nucleus, cingulate cortex, thalamus, amygdala, and cerebellum in pedophilic participants when viewing their preferred sexual stimuli compared with non-pedophilic men. Poeppl et al. (2011) found that when looking at images of children rather than neutral images, pedophilic individuals showed greater activation in the middle temporal lobe, hippocampus, posterior cingulate cortex, thalamus, medial frontal lobe, and culmen of the cerebellum compared with teleiophilic men. In terms of between-group contrasts for their stimuli of interest (children for pedophilic men and adults for teleiophilic men), the pedophilic group showed more activity in the postcentral gyrus, the right middle temporal gyrus, the anterior midcingulate cortex, and the left as well as the right insula, with no regions of higher activity in the teleiophilic group.

Similarly, Cazala et al. (2019) found that when looking at images of children, self-reported ratings of sexual arousal correlated with bilateral activation in the lateral occipital and temporal cortices, especially the right inferior temporal gyrus and the declive of the cerebellar vermis among the pedophilic group. The authors suggested the above regions as being potential mediators for sexual arousal. Mannfolk et al. 2023 compared both offending and non-offending pedophilic men with non-pedophilic men and found widespread increases in activation in the pedophilic groups. They also reported increased reaction times in pedophilic participants when viewing child stimuli, indicating differences in executive function, which was not seen in the control group for their stimuli of preference (Friedman & Robbins, 2022).

Limitations in fMRI Pedophilia Research

While these neuroimaging findings present a promising avenue for elucidating the mechanisms of sexual processing of atypical stimuli, there are several limitations in the extant literature. One issue is not having compared those with pedophilia to other paraphilic groups to elucidate if they are independent of each other in their neural activity during sexual arousal. In other words, are the findings specific to pedophilia or are they related to paraphilic interests more generally? Another issue is determining whether previous results are reflective of pedophilia or of criminality/antisociality-related variables present in samples of men who have histories of sexual offenses, namely neural differences reflecting poor impulse control.

Neuroimaging research on pedophilia has seldom controlled for contact-criminality (Mannfolk et al., 2023; Mendez et al., 2000; Walter et al., 2007; Poeppl et al., 2011; Ponseti et al., 2012; Poeppl et al., 2014). Past research has shown neural differences, particularly with respect to impulse control, between criminal and non-criminal participants. Recent research supports that these differences are also present in pedophilic populations. Two fMRI studies showed that pedophilic individuals with a history of child sexual offenses demonstrated greater response interference during a Stroop task, which was correlated with more activity in the left superior parietal cortex and the pre-central gyrus than did pedophilic individuals without child sexual offence history (Weidacker et al., 2022); as well as higher impulsivity and altered activation in the left posterior cingulate and left superior frontal cortex in a Go/No-Go paradigm (Kärgel et al., 2017). The results of both studies indicate that pedophilic men with contact sexual offense histories, compared to those without and men without pedophilia, may demonstrate a greater vulnerability to the effects of cognitive interference and worse response inhibition, highlighting distinct correlates of criminality versus non-criminality in pedophilic samples. Cazala et al. (2019), by contrast, compared the brain activity of pedophilic participants with and without offence histories when viewing child stimuli and found no functional differences, consistent with similar levels of sexual interest across these groups. Together, then, these studies may suggest that pedophilic men with and without histories of contact sexual offenses against children exhibit comparable sexual interest but different inhibitory and executive functions, with clearly different behavioural and risk consequences. Clearly, further investigation is required to tease apart the impacts of paraphilic interest versus offending-related constructs on the way sexual information is processed in the brain.

Sample size is another important and recurrent challenge in the study of pedophilia. Indeed, two reviews of pedophilia research (Mohnke et al., 2014; Tenbergen et al., 2015) reported that mean group size across all samples in fMRI studies until that point was 11.6 individuals (*SD* = 6.5). These sample sizes likely hail from an inherent difficulty in recruiting pedophilic participants due to their unwillingness to self-identify given the societal contempt for pedophilia. Even if individuals with pedophilia do self-disclose, this is often mandated by conditions of parole or probation, and these individuals typically have contact-offense histories. Therefore, recruiting pedophilic individuals who have not already been identified through the criminal justice system and have no histories of contact offenses is doubly difficult due to fears of censure and incarceration, as we experienced in the current study.

Due to small sample sizes, controlling or matching for extraneous variables has also been difficult. This includes sexual orientation, criminality and antisociality, psychiatric comorbidities and medications, brain alterations related to traumatic injury, history of neurodevelopmental or neurodegenerative disorders, and age.

Lastly, while pedophilia has been researched for over a century, there is little known about differences between pedophilia and other paraphilias, like fetishes. In comparing pedophilic groups with only teleiophilic men, as do all existing neuroimaging studies of pedophilia, research does not establish whether results are specific to pedophilic disorder or applicable to a wider set of atypical sexual interests. This important contextualizing information could open the door for a new line of research on paraphilia and lend important insights into what may distinguish pedophilic disorder from other atypical sexual interests and behaviours.

Foot Fetishism

There are limited studies that have explored the neural correlates of paraphilias beyond sexual attractions to children. Among fetishes focused on objects (as opposed to those centered on activities, like voyeurism), foot fetishism is not intrinsically criminal and ranks as one of the most popular globally, with almost half the traffic to most fetish websites from individuals seeking sexual material related to feet (Scorolli et al., 2007). The online advertising campaign for the current study generated over a thousand interactions, with hundreds of interested individuals reaching out from various locations across Canada and the United States.

There is an important distinction to be made between paraphilias and paraphilic disorder. While the former refers to any 'atypical' sexual interests, a 'paraphilic disorder' mandates a clinically relevant level of distress because of these interests, often resulting in dysfunction across several areas of life. Not all individuals with paraphilic interests meet criteria for paraphilic disorder. Foot fetishism, for example, is often characterized by consensual sexual activity between interested adult partners and is not associated with negative societal consequences, unlike pedophilia.

The limited neuroimaging research on fetishism may be due to its non-harmful nature, in contrast to pedophilia, where the sexual targets, by their very nature, cannot provide consent. When practiced among consenting adults, fetishism generally does not pose a threat to society. Therefore, it remains unclear how the brain processes sexual stimuli related to a fetish object compared to traditional sexual imagery (i.e., the typical secondary sexual characteristics of adult women for heterosexual adult men). Consequently, it is not yet known whether paraphilia might possess a unique 'brainprint' or if this could vary depending on the type of target or relevant sociocultural norms (i.e., antisocial implications and levels of acceptance). This raises important considerations regarding the origins and developmental trajectories of atypical sexual interests, as well as the need to differentiate between those that are potentially harmful (e.g. pedophilia) and those that are harmless (e.g. foot fetishism) from a neurological perspective.

The Present Study

Our study aimed to address these limitations by including only pedophilic individuals with no history of contact-sexual offenses (e.g., sexual assault or sexual interference). With this approach, we expected to minimize the influence of potential confounding variables related to criminal behaviour on the neural processing of visual sexual stimuli. Additionally, for the first time, the study included a paraphilic group of individuals with foot fetishism to better determine if the differences obtained regarding pedophilia are specific to it, or common to another paraphilia.

We hypothesized that the activity patterns during visual sexual processing would differ significantly in the pedophilic group compared to the other two groups. Specifically, we expected that men with pedophilia would recruit additional brain areas compared to the other two groups in frontal, temporal, and parietal regions. We also predicted that each group would have longer response times and higher sexual appeal ratings for their self-reported preferred stimuli (i.e. girls, feet, and women, respectively) compared to non-preferred categories (men and elbows). Given that no neuroimaging studies have been conducted with men who have foot fetishes, we did not have any *a priori* hypotheses regarding their patterns of functional activity, or whether they would recruit more or less of the brain than the other two groups.

Method

We included 40 participants in this study: 9 men with pedophilia, 15 men with foot fetishism, and 16 teleiophilic community participants. We initially set out to recruit 30 participants per group for a total of 90 participants, but were unable to accomplish this due to several challenges (see Limitations section). Participants were included in the study if they met the following criteria:

i. At least 18 years of age;
ii. Exclusively or predominantly heterosexual;
iii. Capable of providing informed consent and participating in all aspects of the study;
iv. MRI compatible (including the absence of metal foreign bodies, history of seizures, recent tattoos, claustrophobia, uncorrectable poor eyesight, chronic pain which would preclude laying supine);
v. No history of moderate to severe head injury or concussions with a loss of consciousness for >1 minute;
vi. Have not been charged or convicted of a violent offense or contact sexual offense, or with several (4+) non-violent convictions;
vii. No substance use problems (in accordance with DSM-5 criteria);
viii. No diagnoses of psychotic disorders;
ix. No diagnoses of major psychological / mental illnesses or disorders other than depression, ADHD, and anxiety-related disorders. Psychotropic medications were allowed only if they were ADHD medications, anti-depressants, or anti-anxiety medication;
x. No paraphilias other than those which qualify them for the study group classified as being as strong as or stronger than the paraphilia being studied.

See **Table 4.1** for questionnaire results and demographic information. Participants were paid for their participation. Violent and sexual offenders, men with any history of contact-criminal offending (including violent or contact sexual offenses), and men with histories of >4 non-violent or non-contact criminal offenses were excluded from the study. We also excluded men from study participation if they reported a history of significant traumatic brain injury because research has identified that subsequent neural alterations are associated with increases in criminality (Luukkainen et al., 2012).

We included pedophilic men with histories of offending involving child sexual exploitation material (i.e. non-contact sexual offending like possession/distribution of child pornography) as excluding these would have resulted in extremely low recruitment (see 'Limitation' section for more details). Also, research has demonstrated that men with offenses related to child pornography but without contact-sexual-offenses have fewer indices of psychopathy and antisociality, have lower recidivism rates, are more prosocial, have less diverse criminal histories and are less likely to commit contact-sexual offenses than men with histories of contact-sexual offending (Seto, 2008). In our samples, seven of the pedophilic participants had a history of noncontact sexual offenses, including 7 with convictions related to child pornography and one with an additional conviction related to grooming (via letter writing). No other participants had historical charges or convictions.

Consistent with DSM-5 criteria, pedophilic participants were only selected if they acknowledged a recurrent, persistent, and intense interest in prepubescent children. Fetishistic participants acknowledged a recurrent, persistent, and intense sexual interest in feet and related objects (i.e. shoes, socks, nylons). Non-paraphilic participants expressed sexual attraction to adult women and did not report recurrent, persistent, or intense paraphilic interests of any kind. No participants reported sexual thoughts of their non-preferred stimulus (i.e. pedophilic participants did not report an interest in feet, fetishistic participants did not report an interest in children, and teleiophilic participants did not report interests in feet or children). All paraphilic participants reported that their atypical interest (children or feet) was either as strong or stronger than their interest in conventional sex with an adult woman. We included participants if they had multiple paraphilic interests (e.g. bondage, discipline, submission, and masochism [BDSM] or exhibitionism), but none which were as strong or stronger than the interest dictating their study group (i.e. interest in feet, in pre-pubescent children, or in conventional sex with adult women, respectively). Pedophilic participants reported sexual thoughts of children multiple times a day (2 participants) or multiple times a week (7 participants). Fetishistic participants reported sexual thoughts of feet multiple times a day (reported by 10 participants) or multiple times a week (5 participants). We initially excluded left-handed men from study participation because of several studies which have highlighted functional and structural differences in brain asymmetry between left- and right-handers. However, low recruitment in the pedophilic group led us to include two left-handed men who were otherwise eligible for study participation.

No teleiophilic or fetishistic participants had diagnoses of paraphilias, whereas all pedophilic participants had diagnoses (8 with pedophilia and one with hebephiliac (sexual attraction to pubertal-aged children), but who also met criteria for a diagnosis of pedophilic disorder). All fetishistic participants met criteria for the paraphilia but were not assessed for paraphilic *disorder*. All fetishistic participants reported that their interests began early in life (before or around puberty), while 6 pedophilic participants reported the same and 3 reported that these interests only began after age 40.

We only included cis-gendered men in this study because of the overwhelmingly high proportion of men with pedophilia compared to women (Seto, 2008). We excluded men with severe psychiatric disorders and concomitant medication use, neurodevelopmental or neurodegenerative conditions, and those who were exclusively or predominantly attracted to the same gender to minimize the number of variables which may result in systematic brain differences between individuals, based on previous research (all participants identified as being either heterosexual, 'heteroflexible', or bisexual but favoring women over men). Over the course of this study, we modified our participation criteria to allow for diagnoses of depression- and anxiety-related disorders with concomitant medication use (mood stabilizers only – no antipsychotic medication), as exclusion on this basis severely limited our recruitment capacity (see section on limitations). Pedophilic participants were recruited from a local Sexual Behaviours Clinic (SBC) based on self-reported pedophilic interests (we did not access clinical file information). Fetishistic and teleiophilic individuals were recruited from the community.

The procedure consisted of a preliminary phone screening interview to assess eligibility and assign to a study group, followed by an in-person interview and scanning session. Informed consent was reviewed together and at both points of contact (phone and in-person), participants were informed that if they revealed having sexually or physically abused a child, the interviewer would report this information to the local Children's Aid Society if it had not already been reported. During the phone screening and in-person interviews, the interviewer used a structured script to explore sexual history, paraphilic interests, MRI compatibility, substance use, mental health history, medication use, criminal history, sexual orientation, and level of attraction to each of the stimuli of interest in our study (women, children, and feet) to confirm study group. During the interview, the facilitator provided participants with several self-report questionnaires to explore variables which may affect the validity of our results, including:

i. A demographic questionnaire.

ii. A measure of interest in many different paraphilias and the frequency with which participants engage in the corresponding paraphilic behaviours (Paraphilias Scale, Seto et al., 2012).

   a. Validation studies have shown good internal consistency (Seto et al., 2021) and convergent validity with self-reported paraphilic behaviours (Bouchard et al., 2017; Chivers et al., 2014; Dawson et al., 2016; Seto et al., 2012; Seto et al., 2025). Seto et al., 2025 also showed configural invariance across genders (women and men) and sexual orientations for gender (woman or man) and provided additional evidence for a stable four-factor structure.

iii. A measure of hypersexuality and sexual preoccupation (Sexual Compulsivity Scale, Kalichman & Rompa, 1995).

   a. Internal consistency ranges from Cronbach's α = .59 - .92, temporal stability coefficient = .95 for 2 weeks and ranges from .64-.80 for three months, the tool demonstrates convergent validity with other related measures and discriminant validity with unrelated variables, and criterion validity was shown with several behavioural outcomes associated with sexual compulsivity (Hook et al., 2010).

iv. Measures of childhood antisocial behaviour and early life criminality (Childhood and Adolescence Taxon Scale – Self Report (CATS-SR), Harris, Rice, & Quinsey, 1994; Self-Report Early Delinquency Scale (SRED), Moffitt & Silva, 1988).

   a. The CATS-SR shows good internal consistency (Cronbach's α = 0.73 for male juvenile offenders), discriminant validity between offending and non-offending samples (area under the curve [AUC] = 0.96 for male juvenile offenders compared to non-offending school-aged males), convergent validity with related measures, discriminant validity with unrelated measures, and criterion-related validity with related behavioural variables and psychiatric diagnoses (Pechorro et al., 2020).

   b. The SRED has a robust five-factor structure accounting for 45.2% of score variance, and reliability analysis of the factors showed Cronbach's α values of 0.7-0.9 (acceptable to excellent) (Charles & Egan, 2005).

v. A measure of traumatic indices in childhood including abuse and neglect (Adverse Childhood Experiences (ACEs) Questionnaire, Felitti et al., 1998)

   a. Internal consistency ranges from Cronbach's α = 0.64-0.76, internal item validity ranges from Cronbach's α = 0.28-0.70, and strong concurrent criterion validity with outcomes related to early adverse experiences (Kovács-Tóth et al., 2023).

The remainder of study participation consisted of additional MRI compatibility screening by the MRI technologist, a first explanation of the imaging protocol and task instructions from a structured script, with a chance for participants to ask questions (see below for detailed task instructions and parameters), and a 30-minute MRI scan. Participants were informed that the study coordinator and MRI technologist could not see what participants' brains were doing during the scan and could not see how they were responding to the task. They were instructed to respond as naturally as possible.

Data Acquisition and Task Design

The fMRI data was acquired using a Siemens 3.0T Magnetom Biograph PET-MR scanner. Participants laid supine on the bed of the scanner with their head immobilized in a 12-channel head coil. The fMRI picture task acquisition consisted of an echo planar imaging (EPI) sequence, TR/TE 3000/30 ms, flip angle 90°, FOV 24x24 cm^2, 64x64 matrix, slice thickness 3 mm, 48 axial slices, bandwidth 2894 Hz.

Task instructions were repeated for a second time through the participant's headphones by the study coordinator and they were asked again if they had any questions. The picture task consisted of pre-purchased stock photos of female elbows and feet, and bathing-suit-clad women, men, and pre-pubescent children in non-sexual positions. Swimsuit stimuli were chosen to allay concerns about seeing nude children, as past studies have shown that the swimsuit stimuli can sufficiently elicit sexual processing in the brain. No faces were presented in the photographs to focus on sexual processing of secondary sexual characteristics and avoid the influence of the more nuanced processing of human faces and expressions. This also ensured the anonymity of the models in these stimuli. Feet were also removed from all swimsuit stimuli to avoid "crossover" between conditions. All photos were cropped and pasted on white backgrounds to minimize context-related neural processing. A diverse set of skin colours and body-types was chosen for all image categories to counteract the influence of physical preferences on appeal ratings. Child photos featured female children of varying ages but all pre-pubertal. See **Figure 4.1** for examples of visual stimuli used.

The block design task consisted of five conditions: 1) women; 2) men; 3) girls; 4) feet; and 5) elbows (neutral object). Each condition was repeated four times to ensure sufficient signal to noise ratio, with novel stimuli in each block, for a total of 16 exemplars of each condition (80 stimuli total). The order of block presentation was counterbalanced within the task to account for order effects and was the same for all participants. Images were presented through E-Prime 2 and projected on a screen at the head of the magnet and viewed on an MR compatible mirror affixed to the head coil. Stimuli were presented on screen for six seconds each for a total of twenty-four seconds per block, with nine second rests (black screen with crosshair) between each block for a total task length of eleven minutes and fifteen seconds.

Upon presentation of each stimulus, participants were shown text instructing them to rate the presented image in terms of how sexually appealing they found it on a Likert-type scale ranging from 1-3, with 1 being not at all sexually appealing and 3 being extremely sexually appealing. Participants were instructed to rate by pressing a button on the fiber optic response pad under their right index finger the number of times which corresponded to the rating they wished to give. Instructions were provided to all participants to respond quickly and intuitively, and to pay attention to the sexual appeal of the photographs. A three-point scale was chosen to minimize functional activity related to motor control and movement during the picture viewing task. A rating of 1 was chosen for "not at all sexually appealing" rather than a rating of 0 to ensure that participants were required to pay close attention to each block – the behavioural responses served a dual role of subjective measure of sexual attraction and as a measure of attention.

Prior to imaging, participants were again reminded that their performance and brain activity was hidden from researchers, and that researchers were not aware of their preferences or reactions while they were in the scanner. This was done to minimize fear of judgement / social pressure and ensure that participants responded as naturally as possible. Once a participant had responded to each stimulus, the image remained on screen for the remainder of its allotted 6 seconds. Participants were instructed to continue inspecting the image in terms of its sexual appeal for the remainder of its on-screen time. Attractiveness ratings were the subjective interest measure, whereas relative response time and functional neural activity were the objective measures of interest.

Figure 4.1: fMRI picture task image samples. Images of people (women, men, and children) had faces and feet removed. All pictures had backgrounds removed. Images of elbows did not contain wrists or hands. Images of feet did not contain calves, knees, or thighs.

Data Analysis

General preprocessing. All functional data was motion corrected using SPM12. Realigned images were normalized to the MNI EPI template provided by SPM12 (Mazziotta et al., 2001). Images were smoothed with an 8mm FWHM Gaussian kernel, then analyzed for each individual participant for the contrasts of interest.

Group comparisons and contrasts. Within-group contrasts (i.e. comparisons across stimulus conditions) were analyzed as preference data for each group's preferred condition compared to a non-preferred condition, with brain activity during the non-preferred condition being subtracted from the brain activity during the preferred condition. Based on self-reports during the interview, we expected that men with pedophilia would show more arousal to girls than to women given that they described their sexual interest in children as being stronger or as strong as their interest in adult women (first level contrast: girls-women). We expected that fetishistic men would show more arousal to feet than to women given that they described their sexual interest in feet as being stronger or as strong as their interest in adult women (first level contrast: feet-women). We expected that teleiophilic heterosexual men would show more arousal to women than to men (first level contrast: women-men). For the paraphilic within-group contrasts, we compared preferred conditions to women rather than men in order to visualize the neural sexual processing unique to the paraphilic object (i.e. female children or feet) separate from the potentially combined neural signature of both paraphilic and neuro-typical sexual processing. Between-group contrasts (i.e. comparisons between the three groups for the contrasts defined in the previous step) are indicated in figure captions.

Between-group comparisons for whole brain functional activity during the fMRI picture task consisted of one-way ANOVAs and subsequent multiple comparisons given significant omnibus results between the three experimental groups. We conducted full factorial whole brain analysis with $p < 0.05$, Bonferroni corrected for multiple comparisons at cluster level, with results reported at $p < 0.05$.

Identification of outliers and data exclusion. Individual analyses of all contrasts of interest were conducted to determine outliers (determined by either extreme [≥3SD] of activity globally for the experimental condition VS rest). In this study, there were no scans which required removal.

Performance data. Performance data including reaction times and sexual appeal ratings were collected for all groups using E-Prime 2. The data for one teleiophilic participant was recorded but not stored due to a computer error, though their engagement and completion of the picture task was confirmed by the facilitator. As a result, performance data was calculated for 15 teleiophilic participants. Between group analyses were conducted using ANOVA.

Ethical Considerations

This research was approved by the Research Ethics Board at the local Mental Health Center and the Research Ethics Committee of the University.

Results

Demographics and Questionnaire Data

Demographic and questionnaire results are reported in **Table 4.1**. We noted that the self-report questionnaire of general paraphilic interests and behaviours (Paraphilias

Scale), included questions relating to sexual activity with both children and feet, which we expected would lead to inflated scores for the pedophilic and fetishistic groups, respectively. To investigate the degree to which group-specific interests were driving scores on this measure, analyses were completed for the full questionnaire and again with all questions relating to children or feet removed. Both are reported in **Table 3.1**. Performance data during the fMRI picture task is presented in **Table 3.2**.

Table 4.1: Interview and Questionnaire Results

Factor	Levels	Pedophilic (PED)	Fetishistic (FET)	Teleiophilic (TEL)
N		9	15	16
Handedness				
	Right	7	15	16
	Left	2	0	0
Mental Health Diagnoses				
	Depression/Anxiety	6	6	2
	OCD	2	0	0
	ADHD	2	0	0
Psychiatric Medications				
	Antidepressant	6	5	1
	ADHD	3	1	0

	PED Mean (SE)	FET Mean (SE)	TEL Mean (SE)	P Value
Age	49.44^{a} (5.32)	37.4^{a,b} (4.02)	29.63^{b} (3.20)	**0.009**
Alcohol (drinks per week)	4.44 (2.57)	3.20 (0.98)	1.93 (0.64)	0.421
Head Injuries (number of minor concussions)	3	4	3	0.725
Education (Highest level accomplished)	2.13 (.295)	2.64 (.133)	2.63 (.125)	0.104
Income Bracket (CAD$, Coding below)	1.62 (.744)^{b}	3.13 (.350)^{a}	2.25 (.370)^{a,b}	**0.033**

<$25,000	1
$25,001-50,000	2
$50,001-75,000	3
$75,001-100,000	4
$100,001+	5

Lifetime Number of Sexual Partners

	Female	14.33 (6)	12.53 (2.59)	11.60 (3.70)	0.896
	Male	0.3 (0.38)	0.6 (0.41)	0 (0)	0.279
Stimulus of Interest Ratings (/10)					
	Feet	0.56 (0.37)[b]	8.6 (0.32)[a]	0.81 (0.27)[b]	**<.001**
	Children (girls)	6.44 (0.58)[a]	0 (0)[b]	0 (0)[b]	**<.001**
Paraphilic Interest General		2.04 (.176)[a,b]	2.58 (.149)[a]	1.99 (.193)[b]	**0.038**
Paraphilic Interest (*child & feet items removed*)		1.76 (0.19)[b]	2.58 (0.18)[a]	2.08 (0.21)[a.b]	**0.029**
Paraphilic Behaviour General		1.23 (.059)[b]	1.46 (.049)[a]	1.26 (.068)[b]	**0.025**
Paraphilic Behaviour (*child & feet items removed*)		1.21 (0.05)	1.42 (0.06)	1.30 (0.07)	0.128
Childhood Antisociality		9.44 (2.056)	6.33 (.785)	5.75 (.574)	0.061
Childhood Delinquency		19.62 (4.84)	19.80 (2.43)	16.06 (1.25)	0.465
Sexual Compulsivity		2.11 (.249)[a]	1.67 (.141)[a,b]	1.31 (.077)[b]	**0.003**
Adverse Childhood Experiences		2.89 (.611)	1.93 (.452)	1.13 (.424)	0.066

Superscripts indicate statistical significance (e.g., a, b, c) within a row. Means sharing the same superscript did not differ significantly at p < 0.05 with current sample sizes. Significant omnibus p values are bolded.

Table 4.2: Picture Task Sexual Appeal Ratings and Reaction Times

Factor	Condition	Pedophilic (PED)	Fetishistic (FET)	Teleiophilic (TEL)		
N		9	15	15		
		PED Mean (SD)	**FET Mean (SD)**	**TEL Mean (SD)**	**F Statistic**	**P Value**
Ratings (1-3)						
	Women	2.08 (0.49)[b]	2.43 (0.41)[a,b]	2.64 (0.34)[a]	**5.35**	**0.009**
	Men	1.26 (0.59)	1.19 (0.29)	1.07 (0.11)	0.94	0.401
	Girls	1.81 (0.43)[a]	1.04 (0.05)[b]	1.02 (0.38)[b]	**48.5**	**0.00001**
	Feet	1.08 (0.18)[b]	2.27 (0.32)[a]	1.05 (0.09)[b]	**131.75**	**0.00001**
	Elbows	1.11 (0.27)	1.06 (0.17)	1.02 (0.07)	0.797	0.458
	Preferred Stimuli	1.81 (0.43)[c]	2.27 (0.32)[b]	2.64 (0.34)[a]	**15.66**	**<0.001**
		PED Mean (SD)	**FET Mean (SD)**	**TEL Mean (SD)**	**F Statistic**	**P Value**
Response Time (ms)						
	Women	2569.25 (453.85)	2339.14 (455.40)	2567.81 (575.18)	1.05	0.362
	Men	1574.36 (894.06)	1583.56 (549.72)	1623.31 (654.09)	0.019	0.981

Girls	2557.74 (730.81)[a]	1443.85 (473.21)[b]	1596.43 (664.42)[b]	**10.39**	**0.00028**
Feet	1453.27 (518.38)[b]	2221.05 (413.03)[a]	1539.66 (560.47)[b]	**9.56**	**0.00047**
Elbows	1479.88 (572.10)	1413.58 (507.01)	1554.81 (595.23)	0.241	0.787
Preferred Stimuli	2557.74 (730.81)	2221.05 (413.03)	2567.81 (575.18)	1.47	0.24

Superscripts indicate statistical significance (e.g., a, b, c) within a row. Means sharing the same superscript do not differ significantly at p < 0.05 with current sample sizes. Significant omnibus p values are bolded. 'Preferred Stimuli' refers to the within-group contrasts defined in the Data Analysis section for each group.

As shown in **Table 4.2**, teleiophilic participants rated women as significantly more appealing than did pedophilic participants ($p<0.004$), but not than fetishistic participants. Both pedophilic and fetishistic participants rated their stimuli of interest higher than the other two groups, respectively (both $p<0.00001$). There were no differences in average ratings for elbows or men between the three groups. When comparing each group's ratings for their stimuli of interest, we saw that they were all significantly different, as follows: teleiophilic men's ratings of women > fetishistic men's ratings of feet > pedophilic men's ratings of girls.

Similarly, both paraphilic groups exhibited longer response times for their preferred stimuli (both $p<0.001$) compared to teleiophilic men. There were no significant differences in response times for women, men, or elbows between the three groups. There were no differences in response time between groups for their preferred stimulus of interest (e.g. girls for the pedophilic group; feet for the fetishistic group; women for the teleiophilic group) using the within-group contrasts.

Functional Imaging Results

Whole-brain omnibus between-group results showed significant differences in neural activation across all groups during the sexual processing task when each group was viewing their stimuli of interest. Results indicated that there were no areas where the two paraphilic groups showed significantly less activity than the teleiophilic group. **Figure 4.2** shows areas of increased activity in pedophilic participants compared to teleiophilic participants. **Figure 4.3** shows areas of greater functional activation in pedophilic participants compared to fetishistic participants. **Figure 4.4** shows areas of increased activity in fetishistic participants compared to teleiophilic participants while **Figure 4.5** shows areas of increased activity in fetishistic participants compared to pedophilic participants.

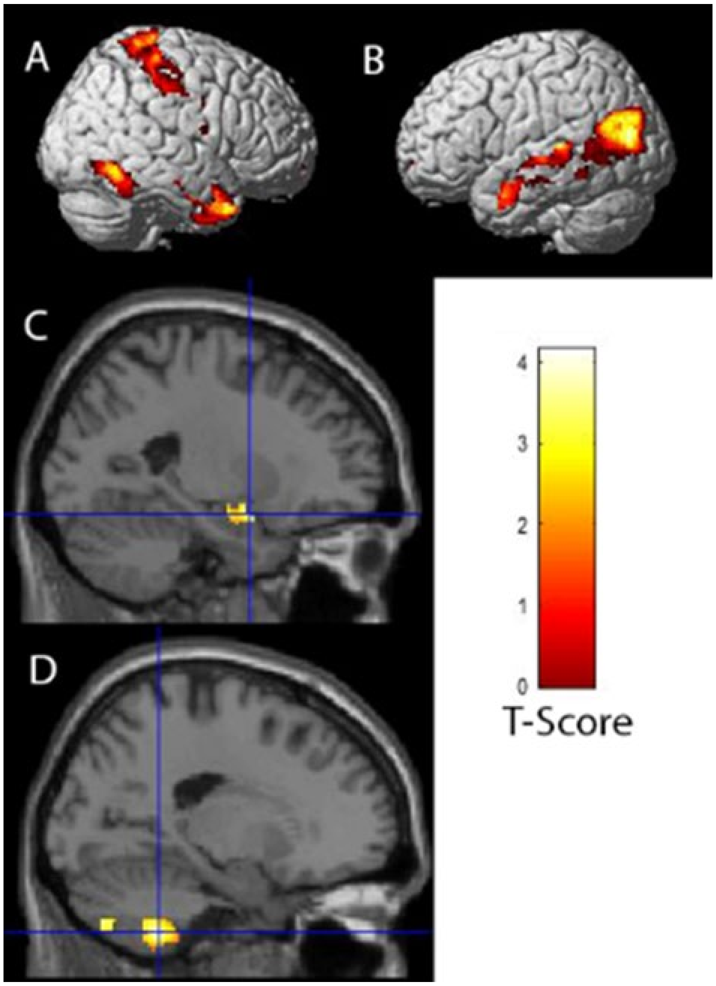

Figure 4.2. T-test results of Pedophilic – Teleiophilic between-group analysis when viewing their stimuli of preference. Coloured areas show significantly more activity in pedophilic than teleiophilic participants. **A.** R inferior temporal gyrus, R temporal pole (corrected for family-wise error (FWE), p <0.001), R. Fusiform Gyrus, R Precentral Gyrus, R Postcentral Gyrus (both corrected for false discovery rate (FDR) p= 0.024). **B.** L Middle Occipital Gyrus, L Angular Gyrus, L Middle Temporal Gyrus (all FWE <0.001). **C.** L Amygdala (FWE <0.001). **D.** Bilateral Cerebellum (FWE <0.001).

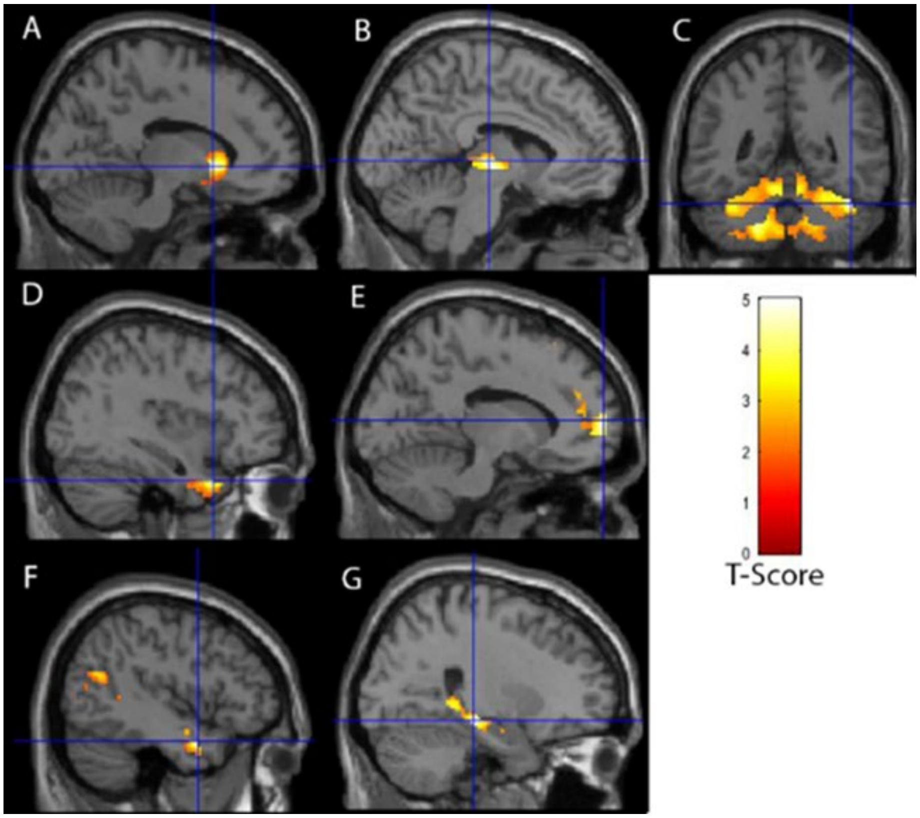

Figure 4.3. T-test results of Pedophilic – Fetishistic between-group analysis when viewing their stimuli of preference. Coloured areas show significantly more activity in pedophilic than fetishistic participants, all significant at FWE <0.001. **A.** Caudate, **B.** Thalamus, **C.** Bilateral Cerebellum, **D.** Right Temporal Pole, **E.** Superior Medial Frontal Gyrus, **F.** Left Middle Temporal Gyrus, **G.** Right Hippocampus.

Table 4.3: Functional activity differences in pedophilic participants compared to the other two groups.

Comparison	**Region**	**Cluster size (voxels)**	**MNI Coordinates**			***T***	***p*-value**
			X	**Y**	**Z**		
PED > TEL	L. Middle Occipital Gyrus	27,246	-40	-80	14	4.70	FWE <0.001
	L. Cerebellum		-18 -12	-48 -76	-48- 44	4.16 3.98	
	R. Fusiform Gyrus		40	-44	-18	4.16	
	R. Inferior Temporal Gyrus		44	-48	-26	4.14	
	L. Amygdala		-22	4	-14	4.12	
	R. Cerebellum		22	-70	-40	4.10	
	L. Middle Temporal Gyrus		-50	-72	12	4.09	
	L. Angular Gyrus		-46	-70	26	3.97	
	R. Temporal Pole		46	18	-32	3.90	
	R. Medial Orbital Frontal Gyrus		0	62	-6	3.61	

	R. Precentral Gyrus	3,213	36	-12	60	3.97	FDR 0.024
	R. Postcentral Gyrus		14	-52	72	3.79	
PED > FET	L. Caudate	32,836	-12	14	-2	5.01	FWE <0.001
	L. Middle Temporal Gyrus		-42	4	-24	4.62	
	L. Thalamus		-6	-18	2	4.43	
	R. Cerebellum		44 26	-48 -58	-28 -46	4.24 3.85	
	R. Temporal Pole		32	10	-28	4.19	
	L. Cerebellum		-20	-50	-44	4.04	
	L. Medial Superior Frontal Gyrus		-12	60	8	4.04	
	R. Hippocampus		26	-26	-12	3.84	

PED = pedophilic group; FET = fetishistic group; TEL = teleiophilic control group. FWE = family-wise error; FDR = false discovery rate. MNI = Montreal Neurological Institute Atlas (MNI152). L = left; R = right.

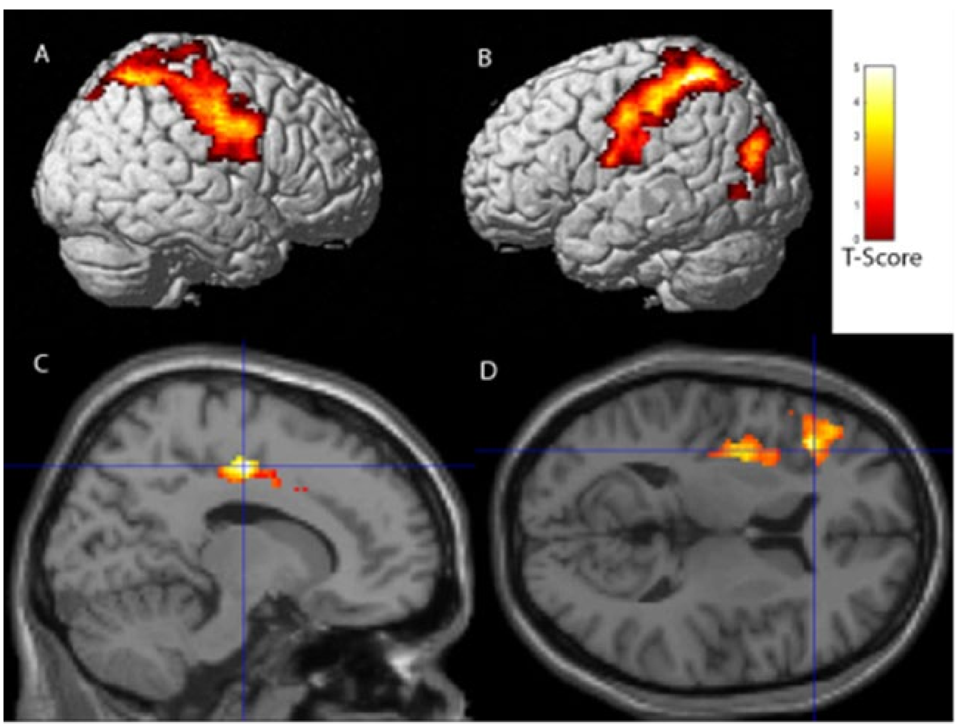

Figure 4.4. T-test results of Fetishistic – Teleiophilic between-group analysis when viewing their stimuli of preference. Coloured areas show significantly more activity in fetishistic than teleiophilic participants, all significant at FWE <0.001. **A.** R. Superior Parietal, R. Postcentral Gyrus, R. Precentral Gyrus **B.** L. Superior Parietal, L. Inferior Parietal, L. Postcentral Gyrus, L. Middle Occipital Gyrus **C.** R. Middle Cingulate Gyrus **D.** L Frontal Inferior Triangularis, L. Insula.

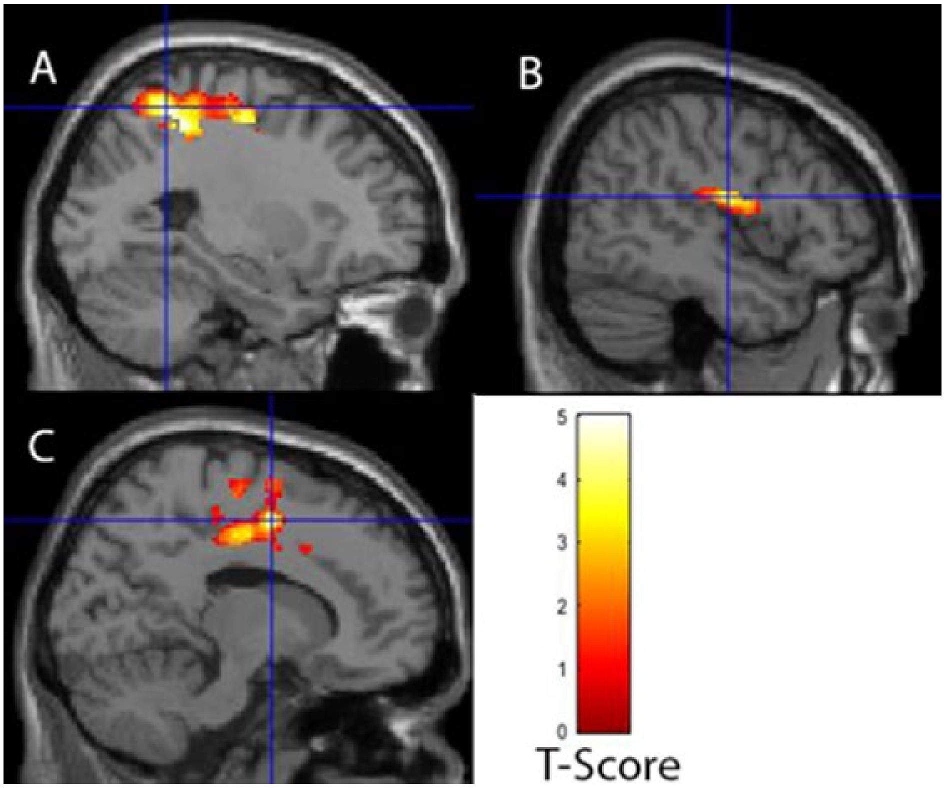

Figure 4.5. T-test results of Fetishistic – Pedophilic between-group analysis when viewing their stimuli of preference. Coloured areas show significantly more activity in fetishistic participants, all significant at FWE <0.001. **A.** L. Superior Parietal Lobule, L. Precentral Gyrus, L. Postcentral Gyrus **B.** R. Insula, R. Rolandic Operculum, **C**. R. Supplementary Motor Area, Middle Cingulate Gyrus.

Table 4.4: Functional activity differences in fetishistic participants compared to the other groups.

Comparison	Region	Cluster size (voxels)	MNI Coordinates			*T*	*p*-value
			X	Y	Z		
	L. Superior Parietal Lobule		-32	-48	60	5.27	
FET > TEL	R. Superior Parietal Lobule	24,440	34	-50	60	5.26	FWE <0.001
	R. Postcentral Gyrus		60	-10	36	5.09	
	L. Inferior Parietal		-30	-42	52	4.70	
	R. Middle Cingulate Gyrus		14	-14	46	4.63	
	L. Postcentral Gyrus		-54	-10	40	4.35	
	L. Middle Occipital Gyrus		-28	-82	28	4.35	
	R. Precentral Gyrus		58	2	26	4.28	
	L. Frontal Inferior Triangularis		-40	28	6	3.93	
	L. Insula		-38	-12	18	3.30	

FET > PED	R. Supplementary Motor Area	15,422	16	-2	52	5.24	FWE <0.001
	L. Superior Parietal Lobule		-26	-50	58	4.89	
	L. Precentral Gyrus		-24	-14	54	4.44	
	L. Postcentral Gyrus		-26	-42	50	4.77	
	R. Rolandic Operculum		48	-10	18	4.12	
	R. Insula		34	-24	22	3.86	
	R. Middle Cingulate Gyrus		16	-16	46	3.61	
	L. Middle Cingulate Gyrus		-12	-2	42	3.51	

PED = pedophilic group; FET = fetishistic group; TEL = teleiophilic control group. FWE = family-wise error. MNI = Montreal Neurological Institute Atlas (MNI152). L = left; R = right.

Given the significant differences in amygdala activation between pedophilic men and teleiophilic men and significant differences in self-reported sexual compulsivity, general paraphilic interest, and general paraphilic behaviour, we explored the relationships between these indices. Specifically, we investigated the correlation between left amygdala activity in a region of interest (ROI) identified in our PED>TEL between-group analysis at MNI= -22, 4, -14 and each group's scores on the three significantly different self-report measures. We explored correlations with the self-report measures both with child- and feet-related items included and with these removed in order to investigate the degree to which paraphilia-specific interests may be driving differences. Results are presented in **Table 4.5**.

Table 4.5: Pearson correlations between activity in the left amygdala and revised self-report measures.

Self-Report Measure	Group	Pearson's R	P	Standard Error	95% Confidence Interval	
Sexual Compulsivity	PED	–0.22	0.561	0.37	-0.773	0.518
	FET	0.32	0.244	0.26	-0.229	0.715
	TEL	**–0.54**	**0.032**	0.23	-0.816	-0.058
General Paraphilic Interest	PED	–0.12	0.766	0.27	-0.725	0.592
	FET	0.26	0.341	0.27	-0.287	0.684
	TEL	–0.07	0.806	0.27	-0.545	0.443
General Paraphilic Interest (feet- and child-related items removed)	PED	-0.29	0.45	0.26	-0.8	0.463
	FET	0.246	0.376	0.27	-0.304	0.674
	TEL	-0.058	0.829	0.27	-0.538	0.451
Paraphilic Behaviour Frequency	PED	–0.08	0.840	0.38	-0.705	0.619
	FET	**0.67**	**0.006**	0.21	0.24	0.88
	TEL	0.11	0.688	0.27	-0.409	0.574
Paraphilic Behaviour Frequency (feet- and child-related items removed)	PED	-0.174	0.653	0.37	-0.751	0.554
	FET	**0.542**	**0.037**	0.23	0.042	0.825
	TEL	0.061	0.822	0.27	-0.448	0.54

Pearson correlation coefficients between activity in the left amygdala and the self-report measures with feet- and child-related items removed, presented by group. PED = pedophilic group (n=9); FET = fetishistic group (n=15); TEL = teleiophilic control group (n=16). Significant results at p<0.05 are bolded. MNI = Montreal Neurological Institute Atlas (MNI152).

Discussion

We sought to add to the current understanding of the functional correlates of sexual processing in men with pedophilia, and to better distinguish these from the correlates of criminality. We also sought, for the first time, to expand this exploration to another paraphilic group in order to determine whether previously suggested differences are unique to pedophilia or common across paraphilic interests. Using a novel imaging task, we found functional differences across large clusters between the brains of pedophilic men, teleiophilic men, and for the first time, also suggested a distinct 'brainprint' of foot fetishism. Regions identified in the present investigation have been seen in several previous neuroimaging studies of pedophilia and also include regions previously implicated in neurotypical sexual processing.

The 'Brainprints' of Pedophilia and Fetishism

While the pedophilic and fetishistic groups each demonstrated unique patterns of functional activation compared to the teleiophilic group, there were also similarities in activation between the two paraphilic groups, mainly in the parietal and occipital areas. The regions dominating the visual sexual processing in the pedophilic group appeared to be frontal and limbic/temporal, while the superior parietal and occipital regions appeared dominant in fetishistic participants (all compared to the teleiophilic group). Active regions in both paraphilic groups formed large clusters, indicating clinically important differences in the use of neural resources between the paraphilic groups and the teleiophilic group, who did not recruit any brain areas over and above the other two groups. Amygdalar activity was highest in the pedophilic group, followed by the fetishistic group, then the control group (PED > TEL at FWE $p<0.001$, other comparisons were not significant).

Functional Implications of Identified Regions

Across neuroimaging studies of pedophilia, a common hypothesis posits that differences in the activation of key frontal and temporal structures during sexual arousal may contribute to impulsive sexual behaviour, hypersexuality, increased variety of atypical sexual interests, and inappropriate sexual fixation on children. In line with this hypothesis, most studies have identified higher neural activity across several regions in pedophilic individuals when processing child stimuli, though these regions have not been consistent across studies. Many of the repeatedly identified regions were also seen in the current study, including the superior parietal lobule, hippocampus, amygdala, thalamus, and middle frontal gyri (Mohnke et al., 2014; Mendez et al., 2000; Schiltz et al., 2007; Ponseti et al., 2012; Poeppl et al., 2013, 2014; Tenbergen, 2015).

Similarly, several regions identified in the current study have been implicated in previous research as having lower grey matter volume in pedophilic individuals compared to teleiophilic individuals, including the cerebellum, cingulate cortex, amygdala, insula, and superior and middle temporal regions (Poeppl et al., 2013; Schiffer et al., 2007; Schiltz et al., 2007). While the relationship between structural and functional brain differences associated with sexual interest in children is not a linear, nor fully elucidated one, complementary results across imaging modalities suggest that good progress is being made in our understanding of the neural correlates of pedophilia. It should be noted, however, that most historical studies included mainly contact-offending pedophilic individuals who were both homo- and heterosexual, therefore it cannot be guaranteed that results were purely reflective of pedophilia and not combined correlates of other confounding factors.

Frontal Regions

In our study, we saw the most frontal activity in men with pedophilia, followed by men with foot fetishism, with no areas of higher activity in the group of teleiophilic men. Previous studies have reported functional and structural differences in the frontal cortex between men with pedophilia and men without (Schiffer et al., 2007, 2008a,b; Poeppl et al., 2011; Tenbergen et al., 2015). Greater activation has been repeatedly seen in the medial frontal lobe (Schiffer et al., 2008a,b; Poeppl et al., 2011) and middle frontal gyrus (Habermeyer et al., 2013) in pedophilic versus teleiophilic participants in response to child versus adult or neutral stimuli. Structurally, several studies have found smaller volumes in frontal areas among pedophilic participants compared to controls (Poeppl et al., 2013; Schiffer et al., 2007, 2017; Klöckner et al., 2021)

The orbitofrontal cortex and other medial frontal regions have been associated with behavioural control, sexual disinhibition, emotional attention, reward, and hypersexuality in this population (Bechara et al., 2000; O'Doherty et al., 2003 (a,b); Mendez & Shapira, 2011; Hartikainen et al., 2012), introducing the idea that smaller volumes, pathology, and altered activity patterns in these regions may be related to sexual offending in pedophilia. These areas were preferentially activated in pedophilic individuals in the current study. Given our efforts to mitigate the effects of criminality in the present samples, differences in these key frontal regions may be reflective of the degree of disinhibition of pedophilic sexual fantasy, desire, or compulsivity, even if sexual offending behaviours are not completed. Despite not being able to act on their desires (or perhaps because of this), individuals with pedophilia may experience a perceived lack of control over their own sexual desires and suffer the challenges of managing increased sexual compulsivity in a society where they cannot (or should not) fulfill their fantasies. Anecdotally, interviews in the current study revealed that several pedophilic participants reported struggling with repression of their desires and sought to decrease the frequency of their child-related fantasies. Note that we also identified that pedophilic individuals self-reported higher levels of sexual compulsivity than the other two groups, which is congruent with their increased activity in these frontal areas. Likely, regional activity differences are working in a compensatory manner with larger-scale deficits in neural macro- and micro-structure, communication, and efficiency to produce the lived experience of pedophilic sexual desire and processing.

Limbic Regions

Higher activity in the right insula and bilateral cingulate gyrus was present in the fetishistic group compared to the pedophilic group, as well as higher activity of the left insula in the fetishistic group compared to the teleiophilic group. These areas have been implicated in research on the teleiophilic sex response network. They have also been identified as playing an important role in cross-modal transfer of visual information to imagined tactile stimulation, motivation, emotional context, visceral sensory processing of penile inputs, internal proprioception, and salience (Damasio et al., 2000; Arnow et al., 2002; Georgiadis & Holstege, 2005; Moulier et al., 2006; Stoleru et al., 2012). These regions were activated in fetishistic men over and above what was seen in the teleiophilic and pedophilic groups, indicating that fetishists rely on these areas more heavily than most during visual sexual processing of their preferred stimuli. Similar to preferential activation of sensory and motor areas in this group, we propose that this may be related to their degree of access to their fetishistic interest and related materials. It is possible that, given the frequency with which the fetishistic group were able to enact their sexual fantasies compared with pedophilic individuals (online and in person), that their sexual processing may be more rooted in the tactile world and geared towards "acting, doing, touching" rather than "wanting, imagining".

Limbic activations in the fetishistic group may also be related to the enactment of fetish behaviours in person with sexual partners, rather than exclusively in online spaces. Indeed, in self-report questionnaires (**Table 4.1**) men with fetishism reported engaging in in-person behaviours related to their fetish interest significantly more than the other two groups. The pedophilic participants in this study denied acting out their paraphilic desires with children, with most participants reporting use of online child-sexual exploitation material. Therefore, the relative dominance of limbic activity in men with fetishism compared to pedophilic men may be reflective of a greater emotional valence to their memories of engaging in paraphilic behaviour with physical partners rather than online, which may have coloured their processing of sexually salient fetish stimuli compared to the pedophilic group.

Amygdala

Although several regions of the limbic system were more activated in fetishistic participants, the most representative limbic structure, the amygdala, was most active in men with pedophilia. Previous research has demonstrated higher activity in the amygdala in men with pedophilia than when viewing child stimuli compared to women and men, (Sartorius et al., 2008; Schiffer et al., 2008a; Poeppl et al., 2011; Ponseti et al., 2012; Polisois-Keating & Joyal, 2013). Reliably lower amygdalar volume has also been noted in pedophilic men compared to teleiophilic men (Mendez et al., 2000; Schiffer et al., 2007; Schiltz et al., 2007; Poeppl et al., 2013; Mohnke et al., 2014).

Practically, the amygdala has been identified as playing an important role with other temporal structures in sex drive, reward, physical pleasure, emotional processing of sexual arousal, and behavioural inhibition (Gloor, 1986, Zald, 2003; Baird et al., 2007; Ferretti et al., 2005; Stoleru et al., 2012; Calabro et al., 2019). However, researchers of antisocial behaviour have posited that lower amygdalar volume and altered activation patterns may also be associated with aggression, violence, psychopathic traits, impulsivity, depressed mood, or anxiety (Kiehl, 2006; Anderson and Kiehl, 2012). This puts into question what role the amygdala really plays in pedophilic interest versus offending behaviour. This reinforces the importance of distinguishing criminality and antisociality factors from pedophilia to ensure that results reflect the construct being investigated (i.e. pedophilia) and not a confound (i.e. criminality). Observed differences in amygdala activity in the current sample of participants without histories of contact sexual offenses suggest that differences identified in the pedophilic group may be attributable to paraphilic interest separate from criminality-related variables.

Of important note, pedophilic men exhibited more amygdalar activity than teleiophilic men but not fetishistic men. This may indicate some increased amygdalar activity in the fetishistic group, but not enough to reach statistical significance compared to the teleiophilic group given sample sizes. Given our efforts to mitigate the effects of criminality on our results, paired with the tiered activity seen in our current samples, this is strong evidence to support the idea that amygdala activity is related to paraphilic interest.

To investigate this further, we examined correlations between activity in the amygdala and measures of sexual compulsivity, general paraphilic interest, and frequency of paraphilic behaviour. We found a significant moderate negative correlation between left amygdala activity and sexual compulsivity scores in our group of teleiophilic men. We also found a significant moderate positive correlation between activity in this region and scores of engagement in paraphilic behaviours, both when removing the effects of behaviours involving group specific paraphilic interests (e.g. children and feet), and when including all paraphilic behaviours. Given the novelty of these analyses in our experimental groups, replication of these results would be necessary to formulate any conclusive interpretations.

Parietal Lobes and Motor and Sensory Regions

In the fetishistic group, the 'brainprint' of visual sexual processing was dominated by activity in parietal and occipital regions, including the motor and somatosensory cortices. This pattern reinforces the common and colloquial hypothesis that fetishism hails from "wires overlapping" between adjacent motor/sensory regions leading to neural cross-contamination in which stimuli which are typically sexually inert become invoked in individuals' lexicons of sexually evocative objects. This hypothesis (popularized by Ramachandran, 1994) is based on the topographical organization of the sensory homunculus in which the toes and genitals are anatomically adjacent. While evidence for this theory is minimal, it is logically cogent and has thus prevailed for decades in popular culture. More recent discussions have noted that this hypothesis may not fully explain why individuals with foot fetishism are often aroused by observing or touching others' feet rather than their own. Ramachandran and Hirstein (2011) suggested that mirror neuron activity (i.e., neurons that respond both when performing an action and when observing another perform that same action) may allow for vicarious sexual arousal through sensorimotor embodiment of analogous, adjacent regions of the somatosensory homunculus (Giummarra & Gibson, 2008; Hilti et al., 2013).

Indeed, high activation of motor and sensory regions among fetishistic men in the current study confirms that these regions are preferentially activated during sexual processing, though whether neural cross-contamination is the cause remains unclear. The absence of spurious paired stimulation in other parts of the sensory homunculus suggests that this prevailing theory may be an oversimplification. Additionally, this theory would fail to explain the development of other behaviourally similar object fetishes, like those involving clothing, human waste, or hands (which are not represented near the genitals in the somatosensory cortex).

It is possible that fetishistic individuals harkening back to memories of engaging in their fetish behaviours during the picture task (which would be less likely for pedophilic participants given their lack of contact-offense histories), may explain activity in these areas. Alternatively, tiered activity of these regions across groups (fetishistic>pedophilic>teleiophilic) may be (like amygdalar activity in the pedophilic group) a hallmark of general paraphilia, with temporal and frontal regions dominating in pedophilia and motor/sensory regions in fetishism.

There was significant overlap in active areas between the pedophilic and fetishistic groups, mainly in the parietal and occipital lobes, including the somatosensory and motor cortices. Specifically, the pedophilic group also had high activity in the parietal lobes compared to the teleiophilic group, including motor and sensory cortices, and in the angular gyrus, the latter of which was not seen in the fetishistic group. The combination of high activity in the angular gyrus, frontal lobes, and amygdala in the pedophilic group is interesting because these structures have been implicated in social cognitive and moral judgment processes (Raine & Yang, 2006, Forbes & Grafman, 2010; Poeppl et al., 2013). The angular gyrus, in particular, is involved in morality and empathy, and was noted to have lower gray matter volume in a group of men with pedophilia compared to teleiophilic men (Bzdock et al., 2012; Poeppl et al., 2013), which was also negatively correlated with victim age. High activity in these regions in the pedophilic group raises the question of whether underlying structural deficits are resulting in compensatory over-activation during sexual processing.

Cerebellum & Occipital Lobes

In our study, we also saw increased cerebellar activity in pedophilic men but not fetishistic men. This is in line with the results of several previous studies which have implicated the cerebellum in pedophilic sexual processing. For example, Poeppl et al (2011), Ponseti et al (2012), and Cazala et al (2019) found greater cerebellar activity during sexual processing in pedophilic participants, and Schiffer et al (2007) found structural differences in this area in pedophilic groups. The cerebellum has also been implicated in research on the teleiophilic sex response network (Stoleru et al., 2012), where its activity has been attributed to emotional, motivational, and motor imagery processes induced by sexual stimuli (Hu et al., 2008; Stoodley & Schmahmann, 2009). The cerebellum may also be associated with the “feeling” experience of sexual arousal (Beauregard et al., 2001; Stoleru et al., 2012), and activity in this structure has been associated with level of erection during sexual arousal (Tsujimura et al., 2006).

Given the cerebellum’s important role in normative sexual processing and its involvement in pedophilic sexual processing in several prior studies, our results suggest that cerebellar activity is more crucial for sexual processing in men with pedophilia than in men with fetishistic or teleiophilic sexual interests. It is possible that deficits in emotional or imagery processing elsewhere in the brain are resulting in overutilization of the cerebellum (among other structures) to achieve a sufficient phenomenological experience of sexual arousal in this group. The idea of overactive regions compensating for deficits elsewhere is an aged idea in pedophilia research and is consistent with the results of the current study.

In both the pedophilic and fetishistic groups, we observed increased occipital cortex activity when participants viewed their preferred sexual stimuli (children and feet, respectively), compared to the teleiophilic group. The occipital cortex plays an important role in visual perception and attention allocation and is also a component of the sex response network. This higher activity is also not surprising given the results of more time visually attending to images of children and feet, respectively, compared to the teleiophilic group.

Compensation and Efficiency

Considering a whole-brain perspective, the dominating doctrine in neuroimaging states that healthy neural processing should be resource efficient. Thus, individuals suffering from the effects of aging, deficits in cognitive processing, or pathology tend to expend more resources to complete the same tasks as their younger or healthier counterparts (Cabeza et al., 2018). Across the extant neuroimaging literature on pedophilia, studies have demonstrated that pedophilic individuals tend to recruit more of the brain to complete sexual processing tasks than do teleiophilic individuals. For example, Schuler et al (2022) found increased temporal lobe activity in pedophilic participants with lower intelligence, suggesting a compensation mechanism for deficits in other areas. The current study similarly demonstrated that both paraphilic groups recruited more brain areas than the teleiophilic group during the visual sexual processing task. This may point to different white matter connectivity or to gray matter volume variability in key areas of the sex response network. These differences may then prompt an overutilization of neural resources in some areas of this network.

Performance data from our visual sexual processing task revealed that both paraphilic groups exhibited longer response times for their stimuli of interest than for non-preferred stimuli. Research has demonstrated that individuals tend to spend more time visually attending to visual sexual stimuli that aligns with their sexual preferences (Lalumiere et al., 2018), reinforcing that our two paraphilic groups were indeed sexually attracted to the stimuli we presented. Viewing sexually salient stimuli also utilizes more attentional resources than sexually neutral stimuli, resulting in slower reaction times when participants are asked to complete a simultaneous cognitive task. In cognitive research, this stimulus-induced delay has been dubbed ‘response interference’, in which the sexually or emotionally salient stimuli (and increased demands on attention) interfere with executive function during goal-directed behaviour (i.e. bottom-up processing). This results in an expected delay in behavioural response times and depends on higher order cognitive functions localized in the frontal lobe (Friedman & Robbins, 2022). Greater response interference was noted by Weidacker et al (2022) in pedophilic individuals with a history of child sexual offending compared to both non-offending men with pedophilia and men without pedophilia.

Despite there being no differences in the relative reaction times to each group’s preferred stimuli , we saw that our two paraphilic groups recruited significantly more neural resources to engage in the sexual processing of visual stimuli which were not any more sexually salient than the stimuli for the teleiophilic group (as evidenced by similar reaction times across all groups). In fact, subjective sexual appeal ratings indicated that teleiophilic men reported significantly higher ratings for women than did fetishistic men for feet or pedophilic men for girls, suggesting that the two paraphilic groups recruited significantly more neural resources for stimuli (children and feet) that were perhaps *less* sexually salient than the preferred stimuli for the teleiophilic group (women). This reinforces our hypothesis that over-activation of regions comprising the sex response network in the paraphilic groups is representative of a compensation for processing deficits elsewhere. This is an especially cogent hypothesis given that the regions most active in the pedophilic group are those most involved in executive function and bottom-up visual and emotion processing (frontal and temporal lobes).

LIMITATIONS

This study has several limitations. The sample size of the pedophilic group was small, likely due to fear and stigma around discussing sexual interests and behaviours involving children. Self-report metrics, such as the ones used in this study, also fall victim to bias and subjective interpretations between participants, especially due to the clandestine nature of pedophilic interests. However, using imaging as an objective outcome measure provides less biased empirical evidence.

Sample-specific variables unique to our pedophilic group limited our ability to include most applicants following screening. These included a higher rate of neurological, neurodegenerative, and neurodevelopmental disorders, severe mental health diagnoses, anti-androgen medication use, contact-criminal offense histories, same-gender attraction, and history of severe brain injury. Additionally, limited participant availability, especially in the pedophilic group, rendered it impossible to exclude all those with mental health diagnoses and led to the recruitment of two left-handed participants and to match groups exactly (e.g. on age). However, efforts were made to exclude those disorders with major affective/behavioural instability components or accompanying psychosis, such as Bipolar 1, Schizophrenia-related disorders, and personality disorders. To combat systemic differences resulting from mental health comorbidities and medication use in the pedophilic group, we recruited participants with similar diagnoses in the other two study groups. Future studies would benefit from a larger sample of pedophilic non-contact offenders and more stringent controls.

Methodological heterogeneity of the extant neuroimaging research on pedophilia also impacts comparison between studies. This highlights the need for future large-scale studies which also control for contact-criminality and include other paraphilic groups as comparisons.

CONCLUSIONS

The present study is, to our knowledge, the first of its kind to use neuroimaging techniques to compare pedophilic individuals with individuals who have a different target paraphilia. We adapted methodological paradigms from previous research to better quantify the neural correlates of paraphilia independently from criminality. We found that pedophilic and fetishistic individuals both differ from teleiophilic individuals in their distinct patterns of functional brain activation in response to visual sexual stimuli of their preferred stimuli/paraphilic target.

With this study, we hope to further advance the research on neuroimaging of paraphilias. We have done this by 1) providing the first 'brainprint' of fetishism, characterized by activity in somatosensory and motor regions, 2) framing pedophilia as its own distinct paraphilic interest with an accompanying and unique neural signature characterized by activity in frontal and temporal regions and cerebellum, and 3) demonstrating a shared hallmark of 'general paraphilia' in parietal and occipital regions. Despite limitations, the results of the present study open a new line of research into the investigation and classification of neural differences among paraphilic interests, helping to further elucidate their etiologies, as well as possible mechanisms underlying their behavioural sequelae.

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CHAPTER 5

General Discussion

Study Goals

We sought to add to the research body on neuroimaging of pedophilia, and to replicate previous results suggesting that pedophilic men may differ from teleiophilic men in terms of their white matter structural connectivity, functional processing of visual sexual stimuli, and regional gray matter volumes. We also used MRI to study another paraphilic group for the first time – men with foot fetishism – and compared them to a group of men with pedophilia to determine whether previously identified neural differences across three modalities are unique to *pedophilia* or common to *paraphilias* as a larger group. Through careful methodological design, we attempted to address gaps in the existing literature on pedophilia to better quantify its neural correlates, independent of potential confounding variables. Despite several challenges, we met our original study goals and contributed to the growing body of research examining the neurophysiological and neuroanatomical correlates of atypical sexual interests. We opened the line for further neuroimaging studies of fetishism and proposed unique and novel 'brainprints' for two atypical sexual interests.

Addressing Gaps in the Existing Literature

Many of the gaps in the existing literature on pedophilia lie in their construct validity. This refers to whether a measurement tool or paradigm is measuring what it is trying to measure. For example, many previous studies have compared pedophilic men with contact sexual offenses to non-offending community controls. These two groups differ across constructs of sexual interest and criminal histories (and likely related variables like poor impulse control and antisocial traits). In cases such as these, the construct validity must be considered tenuous at best, as it is difficult to assert whether identified brain differences are related to pedophilia, to criminality-related constructs, or to both. A solution to this issue is to recruit men with no criminal histories, though these are rare among identified men with pedophilia and would call into question the external validity of the resulting sample (i.e. the extent to which results from the sample are generalizable to the wider population of interest). A partial solution to the construct validity problem – and what we employed in our studies – is to recruit men with no histories of nonsexual violent or contact sexual offenses. This method would target populations with comparable pro-sociality and level of risk to non-offending community controls (e.g. child pornography offenders) (Seto, 2008).

Additionally, the historic approach of comparing contact sexual offenders to non-offending, non-pedophilic men fails to differentiate between the pedophilic *interest* and the pedophilic *behaviours*. A growing body of literature suggests that there are brain differences between men with pedophilia who offend and those who do not, especially in impulse control, which may be more related to antisociality than to purely pedophilic sexual interest (Kärgel et al., 2017; Gibbels et al., 2019; Wittström et al., 2020; Weidacker et al., 2022). It is a worthwhile pursuit to explore the neural correlates of pedophilic sexual offending behaviours; however, it is important to be clear about the construct being investigated. We addressed this gap in our studies by recruiting men with pedophilic interests but without contact sexual offense histories.

Perhaps in response to recruitment challenges, previous studies have made various other concessions to their methodologies – such as including participants with non-right-handedness, same-gender attraction, serious mental illness, and anti-androgen medication use. These variables introduce possible confounds which may reduce the signal to noise ratio of data, increasing the likelihood of Type II error and again threatening validity (Jahnke, 2015; Tenbergen et al., 2015; Kruger & Kneer, 2021). We addressed this issue in our studies by limiting our recruitment to participants who were right handed, self-identified as being heterosexual or 'heteroflexible', but more attracted to women than to men, did not have diagnoses of serious mental illness (e.g. related to psychosis, serious mood disorders, personality, substance use, neurodevelopmental disabilities), and were not taking anti-androgen medications.

Another gap lies in the exclusion of additional paraphilic comparison groups in the pedophilia research to date. Past results have understandably been disseminated under the assumption that they represent the neural signature of pedophilia, but authors have not considered whether the most important difference between their groups was atypical sexual interest *in children* or *atypical sexual interest*, full stop. This again raises the concern of construct validity. Past research, while likely identifying important neural correlates of pedophilia, has failed to specify whether these correlates are entirely unique to pedophilia or common to a wider population of men with atypical sexual interests. Is it the interest in children that is the driver of neural differences, or is it the spurning of sexual and/or societal norms? If it is both, then it is the job of researchers to define and differentiate both the 'brainprint' of *paraphilia* and the unique sub-signatures of specific paraphilic interests.

Even outside of concerns related to validity, the existing research provides no understanding of how other atypical sexual interests may be represented in brain structure and function. A new line of research on other paraphilias may improve our overall understanding of diverse sexual interests. To address this historic limitation and to open the door for a new line of neuroimaging research on paraphilias, we included a third study group of men with foot fetishism.

Study Challenges

We encountered several challenges over the course of our project, many of which highlight the distinctive characteristics of this population (men with pedophilia). Recruitment of men with pedophilia, in particular, has been a recurring challenge in the field (Roche et al., 2025). In our case, most pedophilic men were excluded following screening because of left-handedness, serious mental illness & psychiatric medication use, anti-androgen medication use, history of contact sexual offenses, neurodevelopmental or neurodegenerative disorders, same-sex attraction, or history of significant brain injury (often a combination of these factors). As detailed in the method sections of Study 1, 2, & 3, we had to make several concessions to our eligibility criteria in response to recruitment challenges. These included allowing for some mental illnesses (mainly mood-related disorders), psychiatric medications (mood stabilizers), and non-right-handedness.

I screened several men who were in treatment for pedophilia (medications reducing sex drive and/or group therapy) and who reported sexual attraction to children, but at an intensity which was insufficient for eligibility in the pedophilic group, leading to a relaxing of the threshold for group inclusion (we initially used a cutoff of 7/10 for pedophilic participants' sexual attraction ratings towards prepubescent girls, which was relaxed to 5/10 following recruitment issues). Whether these low self-report ratings were because interventions for their interests were effective, participants were in denial or had poor insight into their interests, or because they were minimizing the intensity of their interest in children is unclear.

Fewer men with pedophilia responded to the study advertisements (online and physical posters) than did men with foot fetishism or teleiophilic men. Of course, men with pedophilia are a relative rarity compared to the other two groups based on available epidemiological data, but I suspect that stigma and fear of self-incrimination prevented some minor-attracted men from volunteering. Even if they did not have histories of offending against children, fear of censure for their interests alone or fears of being 'outed' to their communities may have kept them from responding. A short anecdote from the course of our study recruitment reinforces this belief: in the comment section of an online advertisement for the study, more than one individual suggested that the study coordinators were undercover police officers setting up an operation to catch men with sexual interests in children. These comments urged readers not to volunteer for fear of arrest and each garnered *hundreds* of "likes" and affirmative replies. Clearly, internet browsers had suspicions about the intentions and honesty of the study team, despite public information about the limits of confidentiality, anonymity, and ethics approval. The general public may be largely uninformed about scientific research standards and practices, especially relating to confidentiality, and the stigma against men who are sexually attracted to children is strong. Ultimately, I propose that these played important roles in our recruitment difficulties.

Task Design

Our team contended with additional challenges during the design of the fMRI picture task, the process of which highlights the complexity of brain imaging research and importance of strict methodology. We initially based our task design on previous research of cognitive response interference in pedophilia (Mokros et al., 2010; Poeppl et al., 2011) suggesting that viewing emotionally or sexually salient images (compared to neutral images) elicits a bottom-up response delay to a choice-task due to increased demands on selective attention and emotional processing. We created a choice-reaction time task which asked participants to rapidly indicate the physical location of a stimulus (a dot) presented on screen, overlaid on a sexually salient or neutral image (e.g. woman, prepubescent girl, man, foot, or elbow). The goal of the task was to elicit visual sexual processing in the brain (from viewing the image) and to produce an objective behavioural output (reaction time to the choice-task) which would indicate which image category caused the most cognitive interference in a given group, providing another (implicit) indicator of sexual interest (we expected longer reaction times for each group's image category of interest). In pilot data, we saw no neural (i.e. higher activation of the sex-response network for preferred stimuli) or reaction time differences between sexually salient and non-salient conditions. We attributed this to an excessively high cognitive demand from the choice-task and insufficient neural effort demanded by the sexually salient imagery, because past studies (Mokros et al., 2010; Poeppl et al., 2011) used photos nude children, whereas we did not.

As a solution, we introduced the idea of a subjective appeal rating for each image, with the decision-making process relating to the appeal ratings being the only cognitive "task", and the indirect measure of cognitive interference being reaction times for ratings. We were unsure whether sexual appeal ratings would be enough of a cognitive demand to induce a response delay based on sexual preference, but happily, pilot data indicated that it was. In developing this new task design, we had to address additional challenges, including designing a Likert-type rating scale which would provide participants with an appropriate range of responses while avoiding systematic over-involvement of motor and sensory regions for conditions of interest (e.g. participants pressing buttons on the response pad several times for salient categories and never for neutral categories, creating a predictable pattern of motor activity differences across categories and introducing statistical noise). We also wanted to ensure a measure of attention was built into the task to ensure participants were actively engaging in the task, and to tell when they were not. We solved this, ultimately, by using a 1-3 Likert-type scale that required participants to press a button on the response pad even if they were not sexually interested in a stimulus (thus, if participants did not respond for some stimuli, it could be deduced that they were not paying attention, and their data would be discarded). We chose a maximum rating of 3 so as to minimize the maximum difference in motor output between any two categories (max rating difference of two button-presses). On pilot investigation, this task design produced significant differences in brain activity between sexually salient and neutral stimuli and was thus retained.

We also encountered the puzzle of selecting visual stimuli which would be sufficiently salient so as to produce a reaction (i.e. involve the sex response network), but would not be so graphic so as to shock participants when viewing stimuli they were not attracted to (e.g. adult men viewing child photos) or to induce physiological arousal, which would overwhelm the neural activity and also cause cross-condition overlap in brain function (because physiological arousal has a longer refractory period than does the hemodynamic response), reducing the signal-to-noise ratio. We chose images of swimsuit-clad people, which pilots reported finding sexually attractive (preferred stimuli) but not shocking or aversive (non-preferred stimuli). Upon first piloting this task design, we unfortunately saw no significant differences in within-group brain activity between sexually salient and non-salient conditions (i.e. women and men). Upon discussion, the team realized that by including faces in the stimuli, the task was involving too many types of processing and not isolating sexual processing sufficiently. That version of the task elicited the neural processing of faces, of facial expressions, of hair colour, style, and texture, of makeup, of race, and of memory-induced emotional context for the above characteristics, which is more complex and specialized than the processing of body characteristics alone (breasts, torsos, limbs, body shape, etc.) (Kanwisher & Yovel, 2006; Pinsk et al., 2009; Kitada et al., 2009; Schrouff et al., 2020; Barton, 2022). Research tells us that while pedophilic and teleiophilic men are attracted to children's and women's faces, respectively, they are also highly attracted to body-attributes (Dixson et al., 2011; Martijn et al., 2022). We thus sought to remove the more complex processing of human faces and force participants to base their sexual appraisals of the images on the remainder of the body, which was successful in producing within-group differences based on sexual salience.

Task length and paradigm were also carefully considered. The task had to be long enough to produce a strong signal to noise ratio for neural activity differences, but not so long that participants' attention waned, also reducing signal strength. The presentation length of each stimulus needed to be long enough to elicit a hemodynamic response (i.e. blood flow to active regions of the brain), but not so long that participants became bored or began to engage in visual processing of the images that went beyond sexual appraisal of human bodies (e.g. considering clothing, memories related to swimsuits or people with similar visual characteristics, thoughts of visiting the beach).

To avoid order effects (the neural activity during one condition temporally bleeding into the time allocated to the next condition), I manually counterbalanced the condition presentation order (e.g. if the presentation of 'women' preceded that of 'men' at the beginning of the task, 'men' must precede 'women' later on). We also thoughtfully considered an event-related task paradigm versus block-design, ultimately choosing the latter. While event-related designs can allow for greater flexibility, randomization, and counterbalancing of stimuli and can yield better signal, 'bleeding' of the BOLD signal (blood-oxygen-level dependent signal) between conditions can be a major concern if stimuli are presented too quickly or too temporally close together, resulting in poor signal if sample sizes do not provide sufficient statistical power. Block design, while allowing for less presentation flexibility and a lower ceiling for statistical power (given a sufficiently large sample), reduces the likelihood of BOLD response overlap between conditions (order effects) and can provide a better signal to noise ratio when sample size is a concern.

Finally, after several iterations of the fMRI picture task and data from a dozen teleiophilic pilot participants, we were able to see significant within-group differences between men's brain activity when viewing their preferred stimuli (adult women) compared to stimuli for which they reported no sexual interest (men, girls, feet, or elbows). Specifically, our pilot participants exhibited widespread activity during visual processing of their sexually preferred stimuli compared to neutral stimuli across the sex-response network (Georgiadis & Kringelbach, 2012; Stoleru et al., 2012).

Overview of Findings: Study 1

The findings of our gray matter VBM analyses were in line with both the previous research on gray matter volume differences between pedophilic men and teleiophilic men, and with our *a priori* hypotheses. Overall, we saw that both paraphilic groups had lower gray matter volume in several brain regions compared to teleiophilic group. On average, pedophilic men demonstrated the smallest and most widespread gray matter differences, followed by fetishistic men. Regionally, the orbitofrontal cortex was most reduced in pedophilic men, followed by fetishistic men. Both paraphilic groups showed similarly low volumes in the bilateral fusiform gyri. Within limbic regions, pedophilic men exhibited the smallest volumes in bilateral hippocampal and parahippocampal regions, as well as in the cingulate cortex and right putamen, with fetishistic men showing smaller reductions. The bilateral amygdalae followed a similar pattern and were smallest in pedophilic men, followed by fetishistic men. Notably, fetishistic men showed the smallest volumes in the left precentral, paracentral, and postcentral gyri, with pedophilic men showing modest reductions. Occipital regions were reduced in both paraphilic groups, particularly in the precuneus and cuneus. Lastly, cerebellar volumes were also most reduced in pedophilic men, although some overlap with the fetishistic group was observed. Overall, our results reinforce the accuracy of previous studies showing gray matter volume differences between men with pedophilia and men without pedophilia. They also suggest that there may be distinct 'brainprints' of pedophilia and fetishism, with considerable overlap between the two, potentially representing differences shared by paraphilias more generally.

Overview of Findings: Study 2

Our findings were partially in line with our original hypothesis. We did indeed identify significant differences in FA and MD between our pedophilic group and the teleiophilic group, but not between our pedophilic and fetishistic groups, the latter of which differed from the teleiophilic group, which we did not predict. Differences in MD were more widespread and in larger clusters than differences in FA. These differences suggested that the paraphilic groups had lower white matter integrity than the teleiophilic group. Based on the dominance of MD differences, we surmised that the lower integrity may have been hailing from general pathology, inflammation, higher blood flow (in line with the higher functional activity we saw in Study 3), or a combination of these. I interpreted these findings as preliminary evidence that previously identified white matter differences between men with pedophilia and men without pedophilia may in fact be attributable to paraphilia more generally.

Overview of Findings: Study 3

Our findings were largely in line with our hypotheses. We saw unique patterns of functional activation in both paraphilic groups and high recruitment of frontal, temporal, and parietal areas in the pedophilic group. However, we saw higher, rather than lower recruitment of the amygdala in the pedophilic group compared to the other two groups. We also saw significant differences in subjective measures of sexual appeal to preferred stimuli (across all three groups for their preferred stimuli) and response times (significantly longer in the paraphilic groups for their stimuli of interest). Both paraphilic groups recruited more brain areas than did the control group. There were no areas of higher activity in the control group than the paraphilic groups. We saw unique patterns of brain activation in response to visual sexual stimuli in each paraphilic group, with some areas of overlap (mainly in the parietal and occipital lobes). Participants with pedophilia recruited areas in the frontal and temporal lobes and cerebellum more, while participants with foot fetishism recruited areas in the parietal cortex more (including the pre- and post-central gyri). Activity in the motor and sensory cortices was strongest in the fetishistic group, followed by pedophilic group, then the teleiophilic group. Amygdalar activity was highest in the pedophilic group, followed by the fetishistic group, then the teleiophilic group. In limbic areas, pedophilic men preferentially recruited the amygdala, temporal lobes, caudate nucleus, thalamus, and hippocampus, while fetishistic men preferentially recruited the cingulate gyrus and insula. Overall, our results suggest that there are indeed distinct functional 'brainprints' of pedophilia and fetishism when men are viewing their sexually preferred stimuli, with important overlapping activity patterns which may be representative of paraphilia more generally.

Implications of Results across our Three Studies

Our results from **Study 1** indicate that out of our three groups, men with pedophilia had the lowest gray matter volumes, followed by men with fetishism. This pattern was especially present in frontal and limbic areas. Gray matter volume is significantly positively correlated with cognitive and executive functioning and overall intelligence (Frangou, Chitins, & Williams, 2004; Narr et al., 2007; Hilger et al., 2020). Pertinently, one study investigated both gray matter volume and white matter integrity (measured via FA) in the orbitofrontal and cingulate cortices and found that they were both positively correlated with overall intelligence in adult men (Ohtani et al., 2014).

Our results from **Study 2** indicate that the two paraphilic groups had more indicators of low white matter integrity and fewer indicators of high white matter integrity than the teleiophilic group. The white matter tracts we identified structurally connect many of the smaller gray matter regions identified in **Study 1.** As white matter integrity is positively correlated with the speed and efficiency of communication between gray matter regions, it stands to reason that this may be subtly impeded in the two paraphilic groups, with yet unknown downstream effects on behaviour and functioning (Deary et al., 2006; Penke et al., 2010; Kerchner et al., 2012; Borghesani et al., 2013; Hong et al., 2015).

Results from both our structural studies fit well within the context of previous research suggesting that men with pedophilia, on average, have lower IQs, lower levels of education, and slower processing speed than teleiophilic men (Cantor et al., 2004; Blanchard et al., 2007; Suchy et al., 2014). A recent review also summarized repeated findings of poorer executive function in pedophilic men with histories of sexually offending against children, compared to both non-offending men with pedophilia and non-pedophilic controls. They also reported gray matter reductions in sexually offending men with pedophilia in the frontal, parietal, and temporal lobes as well as white matter reductions in the pre-frontal cortex (Ara-García et al., 2025).

To our knowledge, there have been no such neuroimaging investigations of men with fetishism, and few studies have investigated the functional, cognitive, or behavioural correlates of fetishism independent of sexual offending behaviours. Also, these studies tend to group fetishes in with other paraphilias – many of which have implications for impulse control and sexual offending (e.g. hypersexuality). Therefore, it is unclear whether the differences we observed in white matter integrity and gray matter structure are accompanied by neuropsychological alterations in this population.

Our results in **Study 3** also complement the existing research on pedophilia, indicating that both paraphilic groups used significantly more neural resources when engaging in visual sexual processing of their desired stimuli – notably in the frontal lobes among other areas, and most pronounced in the pedophilic group. Of note, the over-activity patterns observed in the pedophilic group in **Study 3** are in line with the regions in which we observed smaller gray matter volumes and lower white matter integrity in **Study 1** and **Study 2**, respectively.

These results in **Study 3** are interesting given that there were no significant differences between the reaction times for each group's preferred stimuli (e.g. pedophilic men looking at girls; fetishistic men looking at feet; teleiophilic men looking at women) (**Table 4.2**). In fact, this over-activity in the paraphilic groups is especially interesting given that they both rated their preferred stimuli significantly *lower* than did the teleiophilic group – that despite the preferred stimuli of the paraphilic groups being no more salient than the teleiophilic group's stimuli (and in fact, perhaps *less* salient considering subjective rating data), these groups are expending significantly more neural resources to complete the same visual sexual processing task. Paired with the structural differences identified in **Study 1** and **Study 2**, the results of **Study 3** reinforce the cogent and well-backed hypothesis that deficits in executive functioning (frontal lobes) and emotional processing (limbic & temporal areas) are important hallmarks of pedophilia – and that these may also be common to paraphilias more generally.

Our similar results in men with fetishism, albeit in distinct patterns of structural and functional differences, are completely novel. Given that we also observed general over-recruitment of neural resources in the fetishistic group, but focused in the motor and sensory cortices rather than frontal and temporal regions, I raise the question as to the nature of the group differences that are contributing to this functional activation pattern. It is also unclear how the altered white matter integrity, gray matter volumes, and functional recruitment differences may be related to executive function or emotion processing in this group, since no studies have investigated these among men with foot fetishism. This is an important line of investigation for future studies of paraphilia.

Though our three-fold results do not permit inferences about the *etiology* of pedophilia and fetishism, it is relevant to highlight that they are in line with a dominant mechanistic hypothesis positing that perturbations (potentially neurodevelopmental) across frontal and temporal regions contribute to pedophilic sexual desires and sexual behaviours involving children. This hypothesis is sometimes called the “dual dysfunction theory” or “fronto-temporal theory”, and regardless of the etiology, our results support that the structural and functional mechanisms associated with pedophilia do indeed appear to be rooted in these regions.

In line with this interpretation, multiple brain imaging studies of pedophilia have identified low gray matter volumes, especially in the frontal and temporal lobes, in pedophilic men compared to teleiophilic men, as we observed in **Study 1** (though readers should note the methodological issues and validity concerns plaguing many previous studies of pedophilia). Areas historically identified as having lower gray matter volume have been implicated in selective attention, reward, sexual drive and disinhibition, and behavioural control, and were identified in our gray matter investigation (**Study 1**). These were also *functionally* different in our pedophilic group in **Study 3**, and the white matter tracts connecting them had lower integrity, as shown in **Study 2**. These areas include the cerebellum (identified by one previous study), regions in the frontal cortex (6 studies), amygdala (4 studies), temporal lobes (6 studies), and limbic structures (4 studies) (Mendez et al., 2000; Schiffer et al., 2007; Schiltz et al., 2007; Cantor et al., 2008; Poeppl et al., 2013; Gerwinn et al., 2015; Poeppl et al., 2015; Schiffer et al., 2017; Klöckner et al., 2021;

Scarpazza et al., 2021). These structural and functional alterations did not result in performance differences in our task paradigm, which had a very low cognitive demand, but may be working together to produce more subtle differences in cognitive, executive, and emotional processing, as shown in previous studies of pedophilia and not yet investigated in fetishism. In the following section, I examine how the results of our three studies complement each other and present an overall interpretation of our omnibus results.

Integrating the Three Perspectives: Proposing 'Brainprints'

Across three modoalities, our converging results suggest that structural differences in gray and white matter may underlie the distinct patterns of brain activation observed during sexual processing in pedophilic and fetishistic men. Specifically, I propose that the between-group differences seen in our functional data from **Study 3** may be hailing from lower gray matter volumes (as we showed in **Study 1**) and lower white matter integrity (shown in **Study 2**), resulting in over-recruitment of these same areas during visual sexual processing as a means of compensating for the deficits.

In **Study 1**, lower gray matter volumes in pedophilic men were most pronounced in frontal and limbic regions, including the orbitofrontal cortex, hippocampus, parahippocampus, amygdala, and cingulate cortex – regions critical for emotional regulation, reward, and executive control. Fetishistic men also showed lower volumes in these areas, though to a lesser extent, and uniquely exhibited the greatest reductions in the primary motor and somatosensory cortices. These gray matter differences are parallel to our results from **Study 2**, in which both paraphilic groups showed compromised white matter integrity in tracts involved in executive and emotion processes, such as the superior longitudinal fasciculus, corpus callosum, fronto-occipital fasciculus, and corticothalamic pathways. The combination of lower white matter integrity and lower gray matter volumes in endpoint regions may interfere with the efficient integration of cognitive and emotional information, particularly in pedophilic men, where frontal-limbic structures appear most affected.

In **Study 3**, these two-fold structural findings were mirrored in each group's functional 'brainprints': pedophilic men showed heightened activation in frontal and limbic regions (e.g., orbitofrontal cortex, medial superior frontal gyrus, amygdala, hippocampus, caudate nucleus, and temporal pole), while fetishistic men exhibited greater activity in sensorimotor and parietal areas, including the precentral and postcentral gyri and superior parietal lobule, with some limbic overlap in the insula. In short, our results across all three studies are complementary and demonstrate a consistent pattern.

The overlap in structural and functional differences between the pedophilic and fetishistic groups across our three studies is considerable and may constitute an early common 'brainprint' of paraphilia. Taken together, these multimodal findings suggest that the structural deficits identified in pedophilic and fetishistic men – particularly in frontal-limbic versus sensorimotor circuits – may contribute directly to the unique ways in which each group processes visual sexual information related to their paraphilic interests, with implications for their resulting behaviours and phenomenological experiences.

Given my interpretation of our results across three studies and the considerable overlap between the two paraphilic groups in all modalities, I consider the following questions: How are each of these profiles unique? What do they have in common, and how do we interpret the overlap? How might each group's structural and functional neural signatures contribute to their distinct paraphilic targets and behaviour? To begin answering these questions, I offer a detailed exploration of the known functions of regions we identified across our three studies as they may relate to functioning in our paraphilic groups. The regions most active in the pedophilic group are associated with executive control, behavioural inhibition, and decision-making (frontal cortex; Poeppl et al., 2015; Tenbergen et al., 2015), emotional salience, arousal, threat appraisal (amygdala; Schiltz et al., 2007; Poeppl et al., 2015), reward processing and goal-directed behaviour (caudate nucleus; Poeppl et al., 2015), emotion, memory, and context/salience attribution to stimuli (hippocampus and limbic system/temporal lobes; Tenbergen et al., 2015; Poeppl et al., 2015), and reward and sexual arousal (cerebellum; Schiffer et al., 2007).

Regions identified in the fetishistic group are associated with visuospatial attention and sensorimotor integration of visual stimuli (superior parietal lobule; Stoleru et al., 2012; Cheng et al., 2015), emotion regulation, inhibitory control, and decision-making (anterior cingulate cortex; Sumich, Kumari, & Sharma., 2003; Stoleru et al., 2012; Cheng et al., 2015), visual processing (occipital cortex; Poeppl et al., 2015), interoception, sexual arousal, and emotional awareness (insula; Cheng et al., 2015; Poeppl et al., 2015), genital stimulation and anticipatory sexual motor activity (primary motor cortex; Cheng et al., 2015; Cera et al., 2020; Bittoni & Kiesner, 2023), and physical and imagined genital stimulation, body-mapping, and erotic sensory anticipation (primary somatosensory cortex; Redouté et al., 2000; Stoléru et al., 2012; Allen et al., 2020).

The most overlap between these two groups was seen in parietal and occipital regions, accounting for shared activity increases associated with visual attention and processing for their respective stimuli of interest.

With respect to the distinction between these two 'brainprints', I propose that the unique neural activity in the pedophilic group may hail from deficits (of structural origins as seen in studies 1&2) in emotional and executive functioning. For the fetishistic group, hyper-activity in motor, sensory, and limbic regions may similarly hail from structural differences, but may *also* be related to their more extensive memories and experiences interacting with their fetish interest. They may associate the viewed stimuli during the task with "moving, touching, doing, feeling" (motor, sensory, limbic), while the pedophilic participants (without histories of contact sexual offending) may have been more involved in processes such as "withholding, avoiding, fear and censure, wanting, fantasizing, imagining, inhibiting desires" (potentially occurring while completing the picture task *and/or* during minimization or underreporting of symptoms and desires) (frontal, limbic, temporal, cerebellar). These results are cogent given the self-reported behavioural differences between the two paraphilic groups: fetishistic men scoring significantly higher on a tool measuring the frequency of paraphilic behaviour and pedophilic men scoring significantly higher on a measure of sexual compulsivity (including efforts to control intrusive and disruptive sexual thoughts). Simply put, fetishistic men reported more frequent interaction with their fetish objects and activities, while pedophilic men had histories of chronically inhibiting their sexual desires and behaviours, with accompanying fears of censure and loss of control. In the absence of identified differences in other possible confounds we assessed (including history of adverse childhood experiences, head injury, antisociality, and early-life delinquency), this hypothesis is especially compelling.

Given the shared structural deficits across these two groups, we may be seeing common anatomical perturbations resulting in vastly different functional and practical outcomes depending on a multitude of contributing factors (such as neurodevelopmental, genetic, and environmental variables). These deficits – observed in both white matter microstructure and gray matter volume – call for further investigation of possible etiological mechanisms driving the two paraphilias, as well as how additional variables may shape their distinct targets and phenomenologies.

Recall, the existing pedophilia research indicates that men with a sexual interest in children exhibit many signs of early neurodevelopmental perturbations (Dyshniku et al., 2017; Abé et al., 2021). This population also tends to have more childhood trauma and more head injuries early in life – both of which can negatively impact brain development, including long-term structure and function (Blanchard et al., 2002, 2003; Cantor et al., 2008; Tenbergen et al., 2015; Schiffer et al., 2017). For example, prenatal risks (exposure to teratogenic substances and chronic psychological distress) and early life adverse experiences (abuse, neglect, and deprivation) can both impair white matter development and result in lower FA and higher MD (Lebel & Deoni, 2018). I emphasize, however, that our samples did not differ significantly on a measure of adverse childhood experiences or in their relative histories of head/brain injury, suggesting that observed differences may be more related to pedophilia than to early-life adverse events or injuries.

Determining nature versus nurture in the etiology of pedophilia also becomes challenging when considering acquired (interests in children which develop as a mature adult) versus idiopathic (developing around puberty) pedophilia – which was not specifically investigated in our studies. Overall, the sum of the literature appears to suggest that nature and nurture work in concert, and that the paraphilia (including pedophilia and other atypical interests) may be related to a varying and complex combination of variables such as trauma, brain injury, neurodevelopmental alterations, and genetic influences. The neural differences we observed in men with pedophilia in our current studies may have hailed from any and all of these sources, and it is very likely that the research community will never be able to say with certainty what "causes" pedophilia - only what contributors may increase the likelihood of the disorder and what neural mechanisms are reliably associated with it.

Conclusion

Overall, our studies suggest that pedophilia and foot fetishism each have distinct structural and functional 'brainprints', and that these overlap considerably, suggesting a shared 'brainprint' of paraphilia, with additional unique neural hallmarks for each atypical sexual interest. Our convergent, multimodal evidence suggests that underlying structural differences in the gray and white matter of men with pedophilia and foot fetishism may be driving their distinct functional profiles during sexual processing of their paraphilic targets. I believe that previous studies have indeed shed light on the neural correlates of pedophilia, but that these results have comprised the combinatory signatures of pedophilia and *paraphilia*, and that they have also frequently been conflated with the correlates of sexual offending behaviours – both issues that we addressed in our studies.

We have contributed to the growing body of literature that supports a combined fronto-temporal mechanism of pedophilia by highlighting significant differences in gray matter volumes, in white matter microstructure, and functional activity during visual sexual processing, which are most prominent in frontal and temporal/limbic structures. Given our sample of men without histories of contact-sexual offending, we also provided evidence to support that previously identified differences are associated with pedophilia, respective of criminal offending. Our research, for the first time, situated the neural profile of pedophilia in the context of a second paraphilia: foot fetishism, which has never been investigated using neuroimaging. We proposed the first multimodal 'brainprints' of foot fetishism and highlighted considerable structural and functional overlap between these two paraphilic groups, which may be preliminary evidence of a common 'paraphilic brainprint'.

Limitations

Sample Size: These studies have several limitations that should be considered when interpreting the findings. Most notably, the small sample size, particularly in the pedophilic group, limited statistical power and constrained our ability to conduct more nuanced correlational analyses between brain structure, self-report measures, and other variables. As in much neuroimaging research, participant numbers were restricted by logistical and financial constraints, given the time-intensive nature of MRI scanning. Recruitment was further hindered by the extensive exclusion criteria necessitated by MRI compatibility and safety protocols, including left-handedness, metal exposure, surgical implants, seizure history, and neurodevelopmental or neurological disorders. We chose to submit our results for publication with the current samples because our findings were both significant and compelling. In sharing our data promptly rather than delaying dissemination in the pursuit of larger sample sizes, we hoped to spark further research in this important and understudied area.

Recruitment Challenges and Confounding Variables: Unique challenges were encountered in recruiting pedophilic participants, likely due in part to stigma, fears, uncertainty around limits of confidentiality and informed consent, and perceived legal risks associated with disclosure of sexual interests involving children. Sample-specific issues in the pedophilic group including as higher rates of neurological and psychiatric conditions, anti-androgen medication use, contact sexual offense histories, same-sex attraction, and severe head injury limited eligibility. As a result, group matching by age and other demographic variables was not achieved – an important consideration given age-related changes in both gray and white matter.

To improve feasibility and recruitment, some inclusion criteria were revised mid-study. For instance, two left-handed individuals who were otherwise eligible for the study were included in the pedophilic group, introducing a potential confound. However, some existing literature has indicated that left- versus right-handedness may not significantly affect white matter microstructure as measured by diffusion metrics (Jang et al., 2017; López-Vicente et al., 2020; Tomasi et al., 2024). Similarly, although efforts were made to exclude severe psychiatric conditions involving psychosis or major affective instability, our groups still differed with respect to common disorders such as depression, anxiety, OCD, and ADHD, as well as medication status. We attempted to mitigate this by recruiting comparably diagnosed individuals in the teleiophilic and fetishistic groups.

The Fallibility of Self-Report: Another limitation concerns the self-reported nature of offense history information we collected. While we sought to only include individuals without histories of contact offenses, the sensitive nature of the topic – and associated perceived risk of censure and legal ramifications – means we cannot rule out underreporting. Ideally, future studies would include file-verified offense histories to improve accuracy. However, this comes with its own limitations, including access barriers and ethical considerations. Likewise, while the inclusion of entirely non-offending pedophilic men would enhance the validity of conclusions drawn from our data, such participants are likely rare and would be difficult to identify (given fears of coming forward and admitting to sexual interests in children), raising questions about the external validity and generalizability of results from such samples.

Contributions and Relevance

This dissertation presents the first known neuroimaging studies to investigate men with foot fetishism, and to directly compare this group to men with pedophilic interests. Ours are also among the few studies to include men with pedophilia but without histories of contact sexual offending – partially controlling for offending behaviour to distinguish the neural correlates of sexual interest from those associated with criminal conduct. This distinction strengthens construct validity in a field that has often conflated pedophilia with offending, and it contributes to a more precise understanding of the mechanisms that may underlie atypical sexual interests.

By including a non-criminal, non-harmful paraphilic comparison group (i.e., men with foot fetishism), our research addresses a significant gap in the literature. It challenges the assumption that previous neuroimaging findings reflect a neural signature unique to pedophilia, rather than characteristics shared across paraphilias more broadly. This work therefore advances efforts to delineate the neural correlates that may be specific to pedophilic and fetishistic interests, how these overlap (perhaps reflecting paraphilia more generally), and how they may relate to behavioural outcomes.

A deeper understanding of the neural mechanisms underlying pedophilia – particularly among men without histories of sexual offending – can offer important insights into how this sexual interest specifically relates to cognitive, executive, and emotional processes. These findings can inform theoretical models and non-stigmatizing support strategies for individuals with pedophilic interests. For example, we found that men with pedophilia show heightened brain activation in response to visual stimuli involving children. This suggests that exposure to such stimuli may reinforce a positive feedback loop, increasing arousal and making urges harder to manage. Educating individuals committed to non-offending about this selective neural responsivity may support self-regulation strategies and encourage the avoidance of triggering material.

Moreover, both our results and the existing literature suggest that men with pedophilia may experience differences in cognitive and emotional processes, including sexual compulsivity, reward evaluation, higher order executive function, and affective regulation. These areas may be important targets for interventions. Future work could explore psychoeducational and cognitive-behavioural approaches that address these neurobiological differences, support safe and offense-free living, and prevent harm to children. Ongoing research into the neural correlates of pedophilia is essential – not to pathologise, but to clarify the mechanisms that influence behaviour and to inform ethical, effective prevention efforts.

This work contributes to the refinement of existing clinical and forensic models, many of which are based on limited empirical foundations. It also underscores the importance of advancing this field with ethical sensitivity. Pedophilia remains a heavily stigmatized topic, and research in this area may be avoided as a result. However, such avoidance does not improve public safety – rather, it leaves a critical gap in knowledge where evidence-based policy and practice are most needed.

Ultimately, this research supports a more nuanced, evidence-driven understanding of paraphilic interests – one that can reduce unwarranted stigma, inform ethically responsible interventions, and ensure that public health and forensic responses are proportionate and precise. Future research would benefit from similar approaches, with additional methodological stringencies to ensure results are robust, representative, and appropriate in their scope and theoretical design.

Future Directions

Construct and External Validity: Given the methodological challenges that have characterized neuroimaging research on pedophilia thus far, future studies should aim to enhance both construct and external validity. A primary concern in the literature to date has been the confounding of pedophilic interest with criminal behaviour, as many studies have relied on comparisons between contact sexual offenders and non-offending controls – two groups that differ not only in sexual interest but also in traits related to antisociality and impulse control. This conflation obscures the neural correlates specific to pedophilia, undermining the ability to draw meaningful conclusions. Future research should include three groups: pedophilic men with offense histories, pedophilic men without offense histories, and teleiophilic men, to address the generalizability constraints that accompany our approach.

Widening the Scope to Multiple Paraphilias: Repeated inclusion of additional paraphilic comparison groups is also a critical next step. The current study is the first to compare men with pedophilia to those with fetishism – an atypical interest that is not associated with criminal offending behaviours. This line of research should be expanded to include a broader range of paraphilias to help clarify which neural features are unique to pedophilia and which may reflect more general aspects of paraphilia or norm-deviating sexual preferences. Doing so would promote the development of a "brainprint" of paraphilia, as well as the identification of subtypes that may be associated with differential risks or treatment needs.

Methodological Stringency and Sample Characteristics: Methodologically, future studies should strive for larger samples, ideally through multi-site collaborations or data-sharing, to address the issue of low statistical power that plagues much of the existing work, including our own. Consistent and rigorous sample characterization and exclusion criteria must be balanced against the need for external validity, and future studies (if sample sizes allow) should endeavor to include men with diverse sexual orientations for gender, handedness, and psychiatric comorbidities if these can be considered in statistical analyses.

Task Designs: Additionally, incorporating more complex task-based and resting-state functional paradigms, particularly those that probe domains such as behavioural inhibition, emotional regulation, reward processing, cognitive functioning, and sexual arousal, may yield more granular insights into the mechanisms underlying pedophilic and paraphilic interests.

Ultimately, the goal of research in this field is to identify the precise neural mechanisms underlying pedophilia and to understand its unique etiological trajectory. The development of sexual interests in children does not appear to be explained solely by neurodevelopmental perturbations, cognitive functioning, or adverse events occurring over the life course. Therefore, it is crucial for researchers to continue elucidating the specific neural mechanisms underlying or driving sexual interests in children *and* to situate their results within the context of what we know so far about the etiology of pedophilia.

The combined results of the present studies are particularly interesting given that we currently have no empirical data to suggest that men with fetishism would be similar to men with pedophilia in terms of neurodevelopmental or cognitive differences, yet we observed considerable overlap between the two groups across all three brain imaging modalities. Additional studies are needed to better understand what may account for this overlap and to better characterize the neural, behavioural, cognitive, and developmental correlates of pedophilia and *paraphilia*. Ultimately, the goal of any research on paraphilias should not be diagnostic determinism, but to promote a non-stigmatizing and scientifically grounded understanding of atypical sexual interests that can inform care and prevention strategies.

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APPENDICES

Appendix A: Phone screening questionnaire

Information Script:

Do you have a few minutes so that I can explain the study to you?

The purpose of the study is to determine if there are structural and functional differences in the brains of men with different sexual interests. To do this we will be using magnetic resonance imaging (MRI) and functional magnetic resonance imaging (fMRI).

MRI is a way to produce 3-dimensional images of the entire brain. It uses radio waves and strong magnetic fields to produce the images. fMRI is used to determine what areas of the brain are being used at a given time. Changes in the blood flow through the brain can be detected by comparing images taken at different times. Changes in blood flow increases when an area of the brain is being used. MRI and fMRI are safe and painless tests.

The study includes a screening session that involves completing a few questionnaires. These will ask about your sexual history and interests. You will also be interviewed about your sexual behaviours and interests. To participate in this study we would need to meet with you for a total of 2 visits that will last approximately one hour each. You will be compensated for your time. All of the testing will be at the Royal Ottawa Mental Health Centre's Institute of Mental Health Research, which is located on Carling Avenue.

Are you still interested in participating in this study?

If No - thank you for your interest

If Yes – Do you have time right now to answer some screening questions to determine if you are eligible for this study? It will take about 15-20 minutes.

Yes – Continue with screening

No – When would be a good time to call you to do the screening?

Record first name, phone # and day/time to call back

There is a possibility that some of these questions may make you feel uncomfortable or distressed. If any questions make you feel this way, please let me know, and we can stop this screening at any time, or take a break. You also have the right to refuse to answer any questions that you find distressing or that make you uncomfortable. I also want to assure you that the information collected during this phone screen is confidential. **However, if you tell us that you have sexually or physically abused a child, by law we must report it to the Children's Aid Society if it has not been previously reported.** The information that I collect from you today will be destroyed if you are not eligible for the study or choose not to participate. If you are eligible, this information will be kept in a safe place.

Keeping in mind that some of the questions I will ask are quite personal, is it alright if I proceed?

Yes – Continue with screening

If No - - Is there a better time to call you?

If no longer interested - thank you for your interest

Record first name, phone # and day/time to call back

Script and Questions for General Screening:

Which study ad did you see?

- The one for "sexual interest in women's feet'?
- The one for "no sexual interests in unusual activities or persons'?
- The one for "sexual interest in prepubescent girls'?

1. How old are you? (**if less than 18 years old - exclude**)
2. Are you able to speak and understand English enough to talk to me and to read and fill out a questionnaire? YES* NO
3. Do you have any metal implants (e.g., artificial joint, pacemakers, etc.) YES NO*
4. Have you ever worked grinding metal, e.g., as a metal worker or machinist YES NO*
5. Do you have a history of seizures or epilepsy? YES NO*
6. Have you ever had a head injury? YES NO*

   If Yes – How many?

   How severe was the head injury? (**if moderate to severe – exclude**)

   Did you have a concussion? YES NO*

   If yes - How many times?

   If Yes - Did you lose consciousness for more than 1 minute? YES NO*

   Exclude if ever lost consciousness for more than 1 minute or if 3 or more times
7. Do you have any tattoos? YES NO*
   - **i.** If Yes – How old are the tattoos? **(If yes – wait at least 2-3 weeks prior to scanning)**
8. Do you experience claustrophobia or discomfort being a confined space that would be at a level that is distracting or would make it difficult for you to relax and to participate in the study? YES NO*

9. Approximately how many alcoholic drinks do you have per week?

   (Exclude only if DSM-5 criteria for substance use disorder* are met; collect self-report data then assess if potentially applicable.)

* A problematic pattern of *substance* use leading to clinically significant impairment or distress, as manifested by at least two of the following, occurring within a 12-month period:

1. *substance* is often taken in larger amounts or over a longer period than was intended.
2. There is a persistent desire or unsuccessful efforts to cut down or control *substance* use.
3. A great deal of time is spent in activities necessary to obtain *substance*, use *substance*, or recover from its effects.
4. Craving, or a strong desire or urge to use *substance*.
5. Recurrent *substance* use resulting in a failure to fulfill major role obligations at work, school, or home.
6. Continued *substance* use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of *substance*.
7. Important social, occupational, or recreational activities are given up or reduced because of *substance* use.
8. Recurrent *substance* use in situations in which it is physically hazardous.
9. *substance* use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by *substance*.
10. Tolerance, as defined by either of the following:
    A need for markedly increased amounts of *substance* to achieve intoxication or desired effect.
    A markedly diminished effect with continued use of the same amount of *substance*.
11. Withdrawal, as manifested by either of the following:
    The characteristic withdrawal syndrome for *substance* (refer to Criteria A and B of the criteria set for *substance* withdrawal, pp. 499–500).
    substance (or a closely related substance, such as a benzodiazepine) is taken to relieve or avoid withdrawal symptoms.

10. Do you currently use drugs that were not prescribed for you? YES NO*

    i. ____________________________If Yes – What drugs do you use?

    ii. How often do you use these drugs?

(Exclude only if DSM-5 criteria* for substance use disorder are met; collect self-report data then assess if potentially applicable.)

11. Have drugs been a problem for you in the past at all? YES NO*

    a. If Yes –When were they a problem? **Exclude if in the last 6 months**

    b. Did you seek treatment for drug dependence?YES NO*

12. Are you currently taking any prescription medication? YES NO

a. If yes – What medications are you taking and for what? ___________________________

Exclude if taking any prescription psychotropic medications

13. Have you ever been diagnosed with any mental / psychological illnesses or disorders?

YES NO

a. If yes – What are these diagnoses and when were they made?

____

b. Which, if any, of these diagnoses are still affecting you today, or within the last 6 months? ____

Exclude if current major psychological diagnoses (relevant within last 6 months)

14. Do you wear glasses or contact lenses? YES NO*

a. If Yes – Do you wear glasses for reading? YES NO*

15. Do you have lower back pain? YES NO*

a. If yes – are you able to lie on your back for extended periods of time?

YES* NO

16. Do you have an adult criminal record? YES NO*

If yes – ask what & # charges/convictions:

Exclude if any violent or contact sexual (non-contact sexual offenses including child porn are accepted if pedophilic group). Ok if up to 4 nonviolent in total & up to 2 per type (i.e. 2 DUI or 2 Theft etc.).

<u>Questions for Nonparaphilic, Pedophilic and Fetishistic group participants:</u>

1. Are you exclusively or predominantly sexually attracted to females over males?

YES* NO

2. How would you describe your sexual orientation for gender? __________
3. How many female sexual partners have you had since puberty? _________
4. How many male sexual partners have you had since puberty? _______
5. On a scale from 1 to 10, where 1 is "none at all", 5 is "significant" and 10 is "very strong", how would you rate your sexual interest in women's feet? (needs to be at least 7)
    a. How often do you have sexual thoughts, fantasies, or urges regarding women's feet?

        never/rarely/ occasionally[1+/month]/regularly[1+/week] (needs to be occasionally or regularly for recurrence criterion)
    b. Would you consider your sexual interest in women's feet or shoes to be as strong or stronger than your interest in conventional sex with a woman?

        YES NO
        i. (if Yes, continue screening for Fetish group)
6. How long have you had a significant or strong sexual interest in women's feet? _______ (needs to be for at least 6 months)
7. How old were you when you first experience your sexual interest in feet? ____

    (needs to be for at least 6 months)

Eligible for foot fetishism group if 7/10, (pedophilia = 1; other paraphilia=1), occasionally [1+/month]/regularly [1+/week], as strong or stronger, at least 6 months]

8. On a scale from 1 to 10, where 1 is “none at all”, 5 is “significant” and 10 is “very strong”, how would you rate your sexual interest in prepubescent girls? ____ (needs to be at least 7)
   a. How often do you have sexual thoughts, fantasies, or urges regarding prepubescent girls?
      never/rarely/ occasionally [1+/month]/regularly [1+/week] (needs to be occasionally or regularly for recurrence criterion)
   b. Would you consider your sexual interest in prepubescent girls to be as strong or stronger than your interest in women? YES* NO
9. How long have you had a significant or strong sexual interest in prepubescent girls? ________ (needs to be for at least 6 months)
10. How old were you when you first experience your sexual interest in prepubescent girls? (not part of DSM-5 criteria but of interest)

[Eligible for pedophilia group if 7/10, (foot fetishism = 1; other paraphilia = 1), occasionally [1+/month]/regularly [1+/week], as strong or stronger, at least 6 months]

11. Do you have strong sexual interests that would be considered unusual by most people, such as a fetish for leather or rubber, an interest in masochism or sadism, exposing yourself, secretly watching people, an interest in the elderly, or other interests that haven’t been mentioned? YES NO*
    a. Specify:

b. [for potential control group] Are any of these unusual sexual interests interests as strong or stronger than your interest in adult women? YES NO*

c. [for potential foot fetishism group] Are any of these unusual sexual interests interests as strong or stronger than your interest in women's feet? YES NO*

d. [for potential pedophilic group] Are any of these unusual sexual interests interests as strong or stronger than your interest in girls? YES NO*

12. Have you ever been diagnosed as having any kind of paraphilia? YES NO

a. If yes – Specify:

13. Do you have any concerns about your sexual interests? YES NO

If yes – ask what it is - (use to rule out other paraphilias)

If meets criteria: Based on this preliminary screen, you seem like a good candidate for the study. Do you have any questions and are you still interested in participating?

IF YES: I would like to tentatively schedule you to come in for your first session, although I must first review your file with my supervisor.

Is there a date/time that would work for you (preferably morning/early afternoon):_____________________________________, I will email or call you to confirm an appointment date as soon as possible.

If questionable that person meets criteria: Based on this preliminary screen, you seem like you may qualify for study participation. However, I will need to review this interview with one of the researchers and we will contact you shortly about your participation. Is that alright?

Do you have any further questions?

If does not meet criteria for any group: I am sorry, you do not qualify for this study. Would you like us to keep your name and contact information on a list of potential research participants in case you meet the criteria for other studies?

Consent for future contact for research:

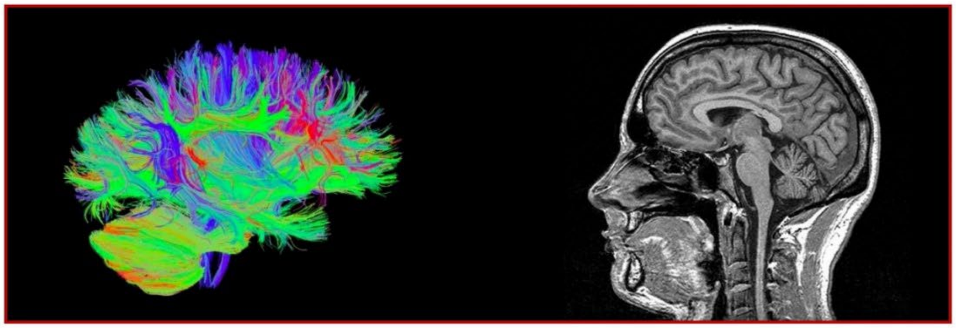
Yes No

First name: Phone#

Email Appointment:

Appendix B: Advertisement Posters

MRI Study of Erotic Interests



We are conducting a brain imaging study on erotic responses. We are looking for men who have no strong unusual erotic interests. This study involves answering questions in an interview, completing questionnaires, and participating in a brain scanning session. The study is completely confidential and voluntary.

There are two sessions on separate days. Each session is about 1-1 ½ hours in duration. You will be compensated $20 for the first session (interview and questionnaires) and $70 for the second session (MRI scanning). If you complete the 2nd session you will receive a CD containing MRI images of your brain.

Who can participate:

- Heterosexual males
- 18 years of age or older
- Able to understand and read English
- No strong erotic interests in unusual activities or persons

This study has been funded by the University of Ottawa's Medical Research Fund and the School of Psychology at the University of Ottawa. This study has been reviewed by the Royal Ottawa Health Care Groups Research Ethics Board.

For further information or to participate contact Allison Leeming by phone at [redacted] or by email at [redacted]

Version-August 6, 2019

Get a free disk with images of your brain!

MRI Study Allison Leeming [redacted]

MRI Study Allison Leeming [redacted]

MRI Study Allison Leeming [redacted]

MRI Study Allison Leeming [redacted]

MRI Study Allison Leeming [redacted]

MRI Study Allison Leeming [redacted]

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MRI Study Allison Leeming [redacted]

MRI Study Allison Leeming [redacted]

MRI Study of Erotic Interests

We are conducting a brain imaging study on erotic responses. We are looking for men who have strong erotic interests in women's feet. This study involves answering questions in an interview, completing questionnaires, and participating in a brain scanning session. The study is completely confidential and voluntary.

There are two sessions on separate days. Each session is about 1-1 ½ hours in duration. You will be compensated $20 for the first session (interview and questionnaires) and $70 for the second session (MRI scanning). If you complete the 2nd session you will receive a CD containing MRI images of your brain.

Who can participate:

- Heterosexual males
- 18 years of age or older
- Able to understand and read English
- Strong erotic interest in women's feet

This study has been funded by the University of Ottawa's Medical Research Fund and the School of Psychology at the University of Ottawa. This study has been reviewed by the Royal Ottawa Health Care Groups Research Ethics Board.

For further information or to participate contact Allison Leeming by phone at [redacted], or by email at [redacted]

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MRI Study of Erotic Interests

We are conducting a brain imaging study on erotic responses. We are looking for men who have strong erotic interests in girls. This study involves answering questions in an interview, completing questionnaires, and participating in a brain scanning session. The study is completely confidential and voluntary.

There are two sessions on separate days. Each session is about 1-1 ½ hours in duration. You will be compensated $20 for the first session (interview and questionnaires) and $70 for the second session (MRI scanning). If you complete the 2nd session you will receive a CD containing MRI images of your brain.

Who can participate:

- Heterosexual males
- 18 years of age or older
- Able to understand and read English
- Strong erotic interest in prepubescent girls

This study has been funded by the University of Ottawa's Medical Research Fund and the School of Psychology at the University of Ottawa. This study has been reviewed by the Royal Ottawa Health Care Groups Research Ethics Board.

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MRI Study Allison Leeming [redacted]

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MRI Study Allison Leeming [redacted]

MRI Study Allison Leeming [redacted]

Appendix C: MRI-Pre Screening Questionnaire

The | Le Royal
Mental Health - Care & Research
Santé mentale - Soins et recherche

Brain Imaging Centre
at The Royal

MRI PRE-SCREENING

The Principal Investigator or Designate must complete and submit this form a minimum of 3 business days before the scheduled MRI appointment. For bookings made less than 3 business days before the scheduled appointment, the form must be submitted at the time of booking. In this case, the requested scan slot will be tentative until the MRI technologist has reviewed the screening form. A detailed pre-screening is necessary to ensure the safety of the participant/patient, and to avoid last minute cancellations due to MRI incompatibilities.

Participant: ______________________ ______________________
First Name Last Name

DOB: __________ Height (cm): ______ Weight (kg): ______ Sex: -SELECT-

The MR system has a very strong magnetic field that is ALWAYS ON. It may be hazardous to anyone entering the MR environment if they have certain metallic, electronic, magnetic, or mechanical implants, devices or objects. Please consult an MRI Technologist if you have any questions.

Please complete the following questionnaire. Please record all relevant details in the comments section. Please indicate if the participant has the potential for aggressive behaviour or has a history of known aggressive behaviour.

YES	NO	
		Prior MRI examination? If yes, record anatomical region, month, year and hospital/site.
		Any difficulties during previous MRI examination?
		Claustrophobic?
		Pacemaker?
		Implanted Cardioverter Defibrilator (ICD)?
		Implanted hearing device (e.g., cochlear, middle-ear or auditory brainstem implants)?
		Aneurysm clip(s)?
		Worked with metal either as a hobby or profession (e.g., filing, grinding and/or welding)?
		Eye injury or metal fragments in eye?
		Injury from shrapnel, BB pellets, bullets or other metal fragments?
		Prior surgery or invasive procedures of any kind?
		Any of the following: braces, retainer, screws, pins, plates, joint replacements, pumps, prostheses, electronic or magnetically-activated implants or devices, surgical clips, coils, stents, wires, tattoos, permanent cosmetics, IUD, any other implant or device?

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The | Le Royal
Mental Health - Care & Research
Santé mentale - Soins et recherche

Brain Imaging Centre
at The Royal

Participant: ____________________ ____________________
First Name | Last Name

		Colonoscopy or endoscopy within six weeks prior to MRI scan?
		Are you currently positive for any antibiotic resistant organisms: MRSA, VRE, C.diff, E.coli? (Methicillin-resistant Staphylococcus aureus, Vancomycin-Resistant Enterococci, Clostridium difficile, Escherichia Coli)
		Have you ever tested positive for any antibiotic resistant organisms?
		Have you ever been treated or tested positive for tuberculosis?
		Have you been in close contact with anyone who has active tuberculosis?
		Do you have or have you ever been treated for any of the following: pneumonia, meningitis, encephalitis or Respiratory Syncytial Virus (RSV)?
-SELECT-		Pregnant or a chance of pregnancy
-SELECT-		Intra-uterine device? If yes, please record make and model into Comments section.
-SELECT-		Prescription Eyewear? If yes, please provide prescription Sphere below.
Right Eye	n/a	MRI-Safe eyewear is available only in the prescription strengths listed in the pulldown menus. Contact lenses are safe to wear in the MRI scanner. Coloured contact lenses are MRI unsafe and are not permitted.
Left Eye	n/a	

Comments:

Name of Study Coordinator:

Date: 13-Nov-2021

Reviewed and Signed by MRI Technologist

Technologist Notes:

Approved Denied

Technologist Signature

Revised 04 JAN 2021

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Appendix D: Pre-Appointment Information Email

Hi XXXXX, here is a confirmation email regarding your participation for a two-part MRI project taking place at the Royal Ottawa Mental Health Centre. This email contains important information for both parts, so you will receive it prior to each session.

Date and time: **XXXX at XXXX (interview) and XXXX (scanning)**

Location: **The Royal Ottawa Mental Health Center, 1145 Carling Avenue, Ottawa, ON** - when you get to the front entrance of the Royal, you can call me at **XXXX** and I'll come get you.

If you are driving in you can turn onto **Harmer Road** beside the Royal and park there free (governed by City of Ottawa guidelines), or park anywhere along the **ring road that curves around the back of the Royal (Anna Ave.).** Please phone me once you have arrived so that I can give you the code to provide you with complimentary parking. I have attached a map to this email to direct you. If you have arrived by bus, I would be happy to provide you with bus tickets.

Once you have parked or arrived by bus/bike/walking, make your way to the main entrance and I will come down and get you. I will not say your name or the purpose of the study aloud to maintain confidentiality, so just look out for someone searching for "anyone here for MRI".

What you will be doing: you are coming in on Thursday, February 27th at 1:30pm (interview) and 3:00 (scanning) to participate in an MRI study of erotic interests. More details regarding the purpose of the study will be provided to you upon arrival. Though I know you may be quite curious about the study design or hypotheses, it is preferable for participants to know as little as possible in this area to prevent bias. Expectancy about your own performance outcomes (especially in the fMRI) can have an effect on performance bias.

The first part of this study will take approximately 1 hour, though we ask that you arrive a **minimum of 15 minutes early** to account for traffic and parking. The first session will consist of an interview and filling out some questionnaires. At this point, if there are any concerns about claustrophobia in the MRI scanner, we will also be visiting the mock-scanner to test out your comfort level.

The second part of this study will also last approximately 1 hour (though again we ask that you arrive minimum 15 minutes early) and will consist of one fMRI scan. The scanner performs structural and functional Magnetic Resonance Imaging (MRI), which uses radio frequency and a strong magnetic field to look at structure and blood flow in the brain at rest and during activity. It doesn't require the injection of any radioactive materials, is completely non-invasive, and is painless and non-harmful. You will also be able to get a disk with all the structural images of your brain after!

Because of the strong magnetic field, it is very important that you be free of metal before going in. This means that you will change into scrubs provided by the hospital and will remove any piercings or jewellery. If you wear glasses normally, we have non-metal glasses with several prescription lenses available but if you have contact lenses, I recommend you wear them as it is more comfortable. Prior to scanning, you will fill out an MRI compatibility questionnaire to assess suitability for scanning. If you have any metal implants (i.e. screws, pins, plates, or other surgical implants), **please send me proof of MRI compatibility from your doctor as soon as possible.** It is also important that you not be claustrophobic, as the scanner seems like an enclosed space when you're in there.

If you have ANY questions or concerns please feel free to ask me at any time.

See you on **XXXX at XXXX (interview) and XXXX (scanning).** Thanks again, we appreciate your time and effort.

Best,

XXXXX

Appendix E: Study Information and Informed Consent

Information Sheet for Study Participants

Title of Protocol: Are Connectivity Differences Unique to Pedophilia?
Principal Investigator: Michael Seto
Co-Investigators: Martin Lalumière
James Cantor
Paul Fedoroff
Andra Smith

INTRODUCTION

You are being asked to take part in a research study. Before you decide to be part of this research, you need to understand the risks and benefits so that you can make an informed decision. This is known as informed consent. This Information Sheet will give you information about the study and what your participation will involve. If you would like more details about something mentioned here, or if you have any other questions, please feel free to ask.

Once you understand what the study involves, you will be asked to sign this consent form if you want to take part in the study. You are free to choose whether or not to take part in the study. You may withdraw from the study at any time. You do not have to tell us your reason for stopping the study. Your decision to participate and/or withdraw from the study will not influence any future treatment at the Royal.

Please ask the study staff to explain any information that is not clear to you. If you participate, you will receive a signed copy of this consent.

PURPOSE OF THE STUDY

Research has identified a specific network in the brain which is involved in the processing of sexual stimuli. The purpose of this study is to investigate the functioning of this neural sex-network for different sexual preferences and stimuli to determine how sexual preference is represented in the brain. To do this we will be using magnetic resonance imaging (MRI).

MRI is a way to produce 3-dimensional images of the entire brain. It uses radio waves and strong magnetic fields to produce the images. Functional magnetic resonance imaging (fMRI) is used to determine what areas of the brain are being used at a given time. Changes in the blood flow through the brain can be detected by comparing images from different time points. Changes in blood flow increases when an area of the brain is being used. MRI is a safe and painless test.

PROCEDURE

Participation requires testing on two different days. The first session takes about 1 hour, and the second session will take approximately 1 ½ hours.

In the first session you will be asked to complete some questionnaires. These will ask about your sexual history. You will also be interviewed about your sexual behaviours and interests.

In the second session, for the fMRI testing, you will be asked questions about your medical history. This is to ensure that you do not have health problems that may be affected by the MRI. There will be no needles, injections, drugs, or x-rays. Because the MRI uses magnets, nothing metal is allowed in the room. You will be given a hospital gown to wear while in the MRI machine.

The MRI is a large donut shaped machine with a sliding table in the middle. You will lie on the table and the table will be moved so that your head is in the center of the machine. You need to stay very still. Your head may feel slightly warm during the scan. You will hear a loud thumping sound when the machine is working. While in the machine you will be asked to look at some pictures of males and females in swimwear. These images will be of adults and children. There will also be images of feet and shoes and elbows. You will be asked to rate how sexually attractive you find the image.

Your responses in the interview and to the questionnaires in the first day of testing will be used to determine if you meet the criteria for the MRI testing in session 2.

RISKS AND BENEFITS

There are no direct health benefits to you from participating in this study.

Even though fMRI is a type of brain scan, it is not the kind of brain scan that a medical doctor would use to find out if there is a medical problem in your brain. If you are concerned that there might be a problem in your brain, you should make an appointment with your regular doctor immediately. Do not rely on this study to tell you if your brain is healthy or might have a problem. The results are for research purposes only.

The MRI has few risks as long as you have answered the screening questions correctly and you do not take any metal into the MRI room.

Serious harm to you could occur if you:

- have any metal implants or devices,
- have been employed in grinding metals, as a metal worker or machinist
- do not remove all metal jewelry
- have a history of seizures or epilepsy
- have new tattoos

The MRI machine may make you feel closed-in (a little claustrophobic). You may find it uncomfortable to remain lying still. The machine makes a loud thumping noise that may be annoying. Filling in the questionnaires and being interviewed may cause some distress. Looking at the images may be tiring.

It is completely up to you whether to participate. If you change your mind, you may stop at any time. The researchers running this study may also stop the study or stop your participation in the study at any time, for any reason. After completing session 1, you will be given $20. If you are invited to participate in session 2, you will be given $70 after completing the testing. If you decide not to finish all of the testing, you will still be paid for the proportion you did finish. So, if you finish half of the FMRI, you will be paid half of the $70, which would be $35.

The brain imaging scan is being done for research purposes only and will not be reviewed for clinical purposes. The technical staff involved in the study are not trained or qualified to diagnose medical problems. During brain imaging procedures however, there is a small chance of discovering a potential abnormality during the scan. In the rare case of an unexpected finding, your images will be reviewed by a radiologist. If follow-up is deemed necessary, you will be contacted directly by the principal investigator and asked to provide permission for the findings to be shared with your primary physician. Your physician can then provide you with a referral for further testing and clinical follow-up. If you do not have a primary physician, a study physician will provide you with a referral and follow-up.

CONFIDENTIALITY

The results from the testing and the questionnaires are confidential. However, if you tell us that you have sexually or physically abused a child, by law we must report it to the Children's Aid Society if it has not been previously reported. The data will be available only to staff involved in this study at the Royal Ottawa Mental Health Centre. No identifying information will be released without your permission. Your name and identifying information will not be shared with researchers outside of the Royal. Your research information may be reviewed by the Royal's Research Ethics Board. Your research information may also be reviewed by the Royal's Research Quality Associate.

The consent forms will be stored in a locked cabinet at the Royal's Institute of Mental Health Research. Only researchers at the Royal will have access to it.

You will be assigned a study ID number which will be used to identify your questionnaires and other testing data. Your name will not be on the questionnaires or other testing data.

The results of this research may be presented in meetings or in publications. No identifying information will be presented.

QUESTIONS

If you have any questions about this study, please contact Michael Seto at XXXX or by email at XXXX

This protocol has been reviewed by the Royal Ottawa Hospital Research Ethics Board. If you have any questions about your rights as a research participant, you may contact:

Royal Ottawa Mental Health Centre's Research Ethics Board
Ottawa, Ontario
Telephone: XXXX
Email: XXXX

Informed Consent Form for Study Participants

Title of Protocol:	Are Connectivity Differences Unique to Pedophilia?
Principal Investigator:	Michael Seto
Co-Investigators:	Martin Lalumière James Cantor Paul Fedoroff Andra Smith

I, ____, have read the preceding information. I have had a chance to ask questions to help me understand what my participation will involve. My signature below indicates that the study and related procedures have been explained to me. I freely give my consent to participate in the study.

I can withdraw from the study at any time.

I may not be invited to participate in session 2 (MRI testing).

I will receive a copy of this consent form.

______________________	______________________	______________________
Participant (Print Name)	Signature	Date
______________________	______________________	______________________
Person obtaining Consent (Print Name)	Signature	Date

Appendix F: Consent to be Contacted for Research

The University of Ottawa Institute of Mental Health Research (IMHR) is committed to building a future where we can identify and successfully treat mental illness.

We are asking you for your consent to allow an IMHR research staff to contact you to see if you are interested in participating in a research study being conducted at the IMHR. Even if you consent to be contacted now, you may *withdraw your consent at any time.* If you prefer not to be contacted for research, *your care and treatment will not be affected in any way*.

Any personal health information you may give us is protected under the Personal Health Information Protection Act, 2004 (Ontario).

I, ___________________________, consent to be contacted by staff from the Institute of Mental Health Research.

Date: ___________________________________

Phone number where you can be reached: area code (   ) ______________________

When is the best time to reach you? MORNING AFTERNOON EVENING (Please circle)

Is it okay to leave a message? YES NO (Please circle)

How would you prefer to be contacted? PHONE EMAIL (Please circle)

If you selected email, please provide email address: ______________________________

Signed: _____________________________ _________

(Patient or substitute decision maker) (Relationship to patient, if applicable

Please complete this section for screening purposes.

Gender: Male Female

Willing to participate in research involving phallometric testing?

Yes No Need more details

Have you experienced any of the following?

- ❑ Hypersexuality (sexual thoughts, urges, or behaviours you feel are excessive or out of control).
- ❑ Adverse childhood experiences (childhood events you feel were significantly harmful or distressing for you).

Appendix G: Session 1 Interview Questions

Date: Study#
Group: Ped Fet Con Interviewed by:

Remind participant of limits of confidentiality - **The results from the testing and the questionnaires are confidential. However, if you tell us that you have sexually or physically abused a child, by law we must report it to the Children's Aid Society if it has not been previously reported.**

1. Do you have any metal implants (e.g., artificial joint, pacemakers, etc.)? YES NO*
2. Have you ever worked grinding metal, e.g., as a metal worker or machinist? YES NO*
3. Do you have a history of seizures or epilepsy? YES NO*
4. Have you ever had a head injury? YES NO*

   If Yes – How many?

   How severe was the head injury? (**if moderate to severe – exclude**)

   Did you have a concussion? YES NO*

   If yes - How many times?

   If Yes - Did you lose consciousness for more than 1 minute? YES NO*

   Exclude if ever lost consciousness for more than 1 minute or more than 3 times.

5. Do you have any tattoos? YES NO*
   i. How old are your tattoos? (If new, must wait at least 2-3 weeks to scan)
6. Do you experience claustrophobia or discomfort being a confined space that would be at a level that is distracting or would make it difficult for you to relax and to participate in the study? YES NO*

7. Approximately how many alcoholic drinks do you have per week? (exclude if meets DSM-V criteria for substance use disorder)
8. Do you currently use non-prescription drugs? YES NO* (exclude if meets DSM-V criteria for substance use disorder)
    i. If Yes – What drugs do you use?
    ii. How often do you use these drugs?
9. Have drugs been a problem for you in the past at all? YES NO*
    iii. If Yes –When were they a problem?
    iv. If yes –Have you needed to seek treatment for drug dependence?

        YES NO*

    If Yes –When was this?
10. Do you wear glasses or contact lenses? YES NO*
    i. If Yes – Do you wear glasses for reading? YES NO*
11. Do you have lower back pain? YES NO*
    a. If yes – are you able to lie on your back for approximately an hour without pain?

        YES* NO
12. Do you have an adult criminal record? YES NO*

    If yes – ask what & # charges/convictions:

    Exclude if any violent or hands-on sexual (ok child porn if Ped group).

    Ok if up to 4 nonviolent in total & up to 2 per type (i.e. 2 DUI or 2 Theft etc.).
13. Are you exclusively or predominantly sexually attracted to females over males?

    YES* NO
14. How would you describe your sexual orientation for gender?

15. How many female sexual partners have you had since puberty?

16. How many male sexual partners have you had since puberty?

14. On a scale from 1 to 10, where 1 is "none at all", 5 is "significant" and 10 is "very strong", how would you rate your sexual interest in women's feet? ____ (needs to be at least 7)

    a. How often do you have sexual thoughts, fantasies, or urges regarding women's feet?

       never/rarely/occasionally[1+/month]/regularly[1+/week]

       (needs to be occasionally or regularly for recurrence criterion)

    b. Would you consider your sexual interest in women's feet or shoes to be as strong or stronger than your interest in conventional sex with a woman?

       YES NO

    c. How long have you had a significant or strong sexual interest in women's feet?

       (needs to be for at least 6 months)

    d. How old were you when you first experience your sexual interest in feet?

       (needs to be for at least 6 months)

[Eligible for foot fetishism group if 7/10, pedophilia = 1, occasionally [1+/month]/regularly[1+/week], as strong or stronger, at least 6 months]

17. Do you have a sexual interest in women's elbows that you would describe as strong?

    YES NO*

18. Would you consider your sexual interest in women's elbows to be as strong or stronger than your interest in conventional sex with a woman?

    YES NO (**if Yes, Exclude**)

19. Are you sexually interested in prepubescent girls in a way that you would describe as intense and persistent?   YES   NO
    e. If YES – How old were you when you first experienced your sexual interest in prepubescent girls?   **(needs to be for at least 6 months)**
20. Do you have strong sexual interests that would be considered unusual by many people, such as a fetish for leather or rubber, a fetish for feet or shoes, an interest in masochism or sadism, exposing yourself, secretly watching other people, an interest in the elderly, or other interests that haven't been mentioned?   YES   NO*
    a. Specify:
    b. Are these interests stronger than your interest in adult women? YES NO*
21. Have you ever been diagnosed as having any kind of paraphilia (a condition characterized by atypical sexual desires)?   YES   NO

    What was the diagnosis?

Appendix H: Demographic Questionnaire

Study Number:
Current age: ___________ Date of Birth _____ ______ _______
day month year

Ethnicity:
- White
- Chinese
- Black
- Filipino
- Latin American
- Arab
- Korean
- Japanese
- South Asian (e.g., East Indian, Pakistani, Sri Lankan)
- Southeast Asian (e.g., Vietnamese, Cambodian, Malaysian, Laotian)
- West Asian (e.g., Iranian, Afghan)
- Other:_________________

Current marital status:
- Single
- Dating
- Common-law
- Engaged
- Married
- Separated
- Divorced
- Widowed
- Other _______________________________

Number of sons: ____Number of daughters: ____

Highest level of education achieved:
- No school
- Some high school
- High school/GED
- Some trade courses
- Some College
- Some University
- Trade certificate
- College diploma
- Undergraduate degree
- Graduate degree
- Other:_____________________________________

Employment status:

- Student/not employed
- Student/part-time employed
- Student/full-time employed
- Not employed
- Employed full-time
- Employed part-time
- Contract employment
- Seasonal employment
- Retired
- Other (includes vocational/sheltered positions)

Living situation:

- Living alone
- With parents
- With other family
- With partner/spouse
- With friends/roommates
- Supported housing
- Retirement home
- Other: ____________________

Please indicate your approximate yearly income (CAD):

- < $25,000
- $25,001-50,000
- $50,001 to 75,000
- $75,001 to 100,000
- $100,001 plus

Appendix I: Sexual History Questionnaire

In the following questions, which are designed to assess your sexual history in its entirety (i.e., throughout your whole life), male/man and female/woman refers to the gender of the people you have been sexually active with and attracted to.

Please fill in or check the appropriate answer.

1. How old were you when you first engaged in sexual intercourse (oral, vaginal, or anal intercourse)? _____ ○ Not Applicable
2. How many female sexual partners have you had that have involved genital contact since puberty? _____ ○ Not Applicable
3. How many of your sexual relationships with females were casual (one month or less)? ______
4. In the past month, how many times have you had sexual intercourse (oral, vaginal, or anal intercourse) with a female partner? _____
5. How many different female partners did you have sex (oral, vaginal, or anal intercourse) with in the past year? ______
6. How many different female partners have you had sex (oral, vaginal, or anal intercourse) with on only one occasion? ______
7. How many male sexual partners have you had that have involved genital contact since puberty? _____ ○ Not Applicable
8. How many of your sexual relationships with males were casual (one month or less)? ______
9. In the past month, how many times have you had sexual intercourse (oral, vaginal, or anal intercourse) with a male partner? _____
10. How many different male partners did you have sex (oral, vaginal, or anal intercourse) with in the past year? ______
11. How many different male partners have you had sex (oral, vaginal, or anal intercourse) with on only one occasion? ______
12. I am presently involved in a long-term, committed, relationship: YES NO
13. I am presently sexually involved with one or more persons: YES NO
14. My longest relationship (including current relationship) lasted (e.g., if you have been in a relationship for 6 months, this would be 0.5 years): ______ years

Appendix J: Paraphilia Scales
(Part One)

Please rate how sexually arousing or sexually repulsive you currently find each of the following activities, whether you have tried it or not, using the scale shown below.

-3……………….-2……………..-1………………0……………….+1………………+2……………….+3
very repulsive | somewhat repulsive | mildly repulsive | indifferent | mildly arousing | somewhat arousing | very arousing

		Very Repulsive	**Somewhat Repulsive**	**Mildly Repulsive**	**Indifferent**	**Mildly Arousing**	**Somewhat Arousing**	**Very Arousing**
1.	You are having sex with an adult woman	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
2.	You are touching a material like rubber, PVC, or leather	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
3.	You are having sex with a boy (age 12 to 14)	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
4.	You are kissing, fondling, and touching someone's feet	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
5.	You are having sex with an animal	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
6.	You are being spanked, beaten, or whipped by someone	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
7.	You are being urinated on by someone ("golden showers")	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
8.	You are having your feet kissed, fondled and touched	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
9.	You are treating someone as an animal	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
10.	You are touching an object like shoes, gloves, or plush toys	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
11.	You are having sex with an adult man	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
12.	You are imagining yourself as someone of the opposite sex	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**

13.	You are tying or handcuffing someone	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
14.	You are being tied or handcuffed	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
15.	You are controlling or dominating someone	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
16.	You are dressing up as someone of the opposite sex	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
17.	You are having sex with a boy below the age of 12	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
18.	You are spanking, beating, or whipping someone	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
19.	You are verbally humiliating someone	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
20.	You are being forced by someone into sexual activity	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
21.	You are having your breathing restricted during sexual activity	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
22.	You are seeing someone unconscious or unable to move	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
23.	You are having sex with a girl (age 12 to 14)	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
24.	You are urinating on someone ("golden showers")	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
25.	You are being defecated on by someone ("scat")	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
26.	You are cutting someone's skin	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
27.	You are touching or rubbing a stranger who is not expecting it	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
28.	You are having sex with a girl below the age of 12	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
29.	You are restricting someone's breathing during sexual activity	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
30.	You are pretending to rape someone	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
31.	You are having someone verbally humiliate you	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
32.	You are being treated as an animal	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**

33.	You are watching an unsuspecting stranger while they undress	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
34.	You are exposing your genitals to a stranger who is not expecting it	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
35.	You are having your skin cut	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
36.	You are forcing someone into sexual activity	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
37.	You are being controlled or dominated by someone	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
38.	You are defecating on someone ("scat")	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
39.	You are making obscene phone calls to someone who is not expecting it	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
40.	You are having someone pretend to rape you	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**

Paraphilia Scale (Part Two)

Please rate how rate how frequently you have engaged in each of the following activities in a sexual context in your lifetime, using the scale shown below.

1……………………2……………………3……………………4……………………5

never — once or twice ever — once a year or more on average — once a month or more on average — once a week or more on average

		Never	**Once or twice ever**	**Once a year or more on average**	**Once a month or more on average**	**Once a week or more on average**
41.	You are having sex with an adult woman	**1**	**2**	**3**	**4**	**5**
42.	You are touching a material like rubber, PVC, or leather	**1**	**2**	**3**	**4**	**5**

43.	You are having sex with a boy (age 12 to 14)	**1**	**2**	**3**	**4**	**5**
44.	You are kissing, fondling, and touching someone's feet	**1**	**2**	**3**	**4**	**5**
45.	You are having sex with an animal	**1**	**2**	**3**	**4**	**5**
46.	You are being spanked, beaten, or whipped by someone	**1**	**2**	**3**	**4**	**5**
47.	You are being urinated on by someone ("golden showers")	**1**	**2**	**3**	**4**	**5**
48.	You are having your feet kissed, fondled and touched	**1**	**2**	**3**	**4**	**5**
49.	You are treating someone as an animal	**1**	**2**	**3**	**4**	**5**
50.	You are touching an object like shoes, gloves, or plush toys	**1**	**2**	**3**	**4**	**5**
51.	You are having sex with an adult man	**1**	**2**	**3**	**4**	**5**
52.	You are imagining yourself as someone of the opposite sex	**1**	**2**	**3**	**4**	**5**
53.	You are tying or handcuffing someone	**1**	**2**	**3**	**4**	**5**
54.	You are being tied or handcuffed	**1**	**2**	**3**	**4**	**5**
55.	You are controlling or dominating someone	**1**	**2**	**3**	**4**	**5**
56.	You are dressing up as someone of the opposite sex	**1**	**2**	**3**	**4**	**5**

57.	You are having sex with a boy below the age of 12	**1**	**2**	**3**	**4**	**5**
58.	You are spanking, beating, or whipping someone	**1**	**2**	**3**	**4**	**5**
59.	You are verbally humiliating someone	**1**	**2**	**3**	**4**	**5**
60.	You are being forced by someone into sexual activity	**1**	**2**	**3**	**4**	**5**
61.	You are having your breathing restricted during sexual activity	**1**	**2**	**3**	**4**	**5**
62.	You are seeing someone unconscious or unable to move	**1**	**2**	**3**	**4**	**5**
63.	You are having sex with a girl (age 12 to 14)	**1**	**2**	**3**	**4**	**5**
64.	You are urinating on someone ("golden showers")	**1**	**2**	**3**	**4**	**5**
65.	You are being defecated on by someone ("scat")	**1**	**2**	**3**	**4**	**5**
66.	You are cutting someone's skin	**1**	**2**	**3**	**4**	**5**
67.	You are touching or rubbing a stranger who is not expecting it	**1**	**2**	**3**	**4**	**5**
68.	You are having sex with a girl below the age of 12	**1**	**2**	**3**	**4**	**5**
69.	You are restricting someone's breathing during sexual activity	**1**	**2**	**3**	**4**	**5**
70.	You are pretending to rape someone	**1**	**2**	**3**	**4**	**5**

71.	You are having someone verbally humiliate you	**1**	**2**	**3**	**4**	**5**
72.	You are being treated as an animal	**1**	**2**	**3**	**4**	**5**
73.	You are watching an unsuspecting stranger while they undress	**1**	**2**	**3**	**4**	**5**
74.	You are exposing your genitals to a stranger who is not expecting it	**1**	**2**	**3**	**4**	**5**
75.	You are having your skin cut	**1**	**2**	**3**	**4**	**5**
76.	You are forcing someone into sexual activity	**1**	**2**	**3**	**4**	**5**
77.	You are being controlled or dominated by someone	**1**	**2**	**3**	**4**	**5**
78.	You are defecating on someone ("scat")	**1**	**2**	**3**	**4**	**5**
79.	You are making obscene phone calls to someone who is not expecting it	**1**	**2**	**3**	**4**	**5**
80.	You are having someone pretend to rape you	**1**	**2**	**3**	**4**	**5**

Appendix K: Sexual Compulsivity Scale

Please answer as honestly and seriously as possible.

A number of statements that some people have used to describe themselves are given below. Read each statement and then select the option that shows how well you believe the statement describes you.

Select the option that best describes you:

	Not at all like me	**Slightly like me**	**Mainly like me**	**Very much like me**
My sexual appetite has gotten in the way of my relationships.	**1**	**2**	**3**	**4**
My sexual thoughts and behaviours are causing problems in my life.	**1**	**2**	**3**	**4**
My desires to have sex have disrupted my daily life.	**1**	**2**	**3**	**4**
I sometimes fail to meet my commitments and responsibilities because of my sexual behaviours.	**1**	**2**	**3**	**4**
I sometimes get so horny I could lose control.	**1**	**2**	**3**	**4**
I find myself thinking about sex while at work.	**1**	**2**	**3**	**4**
I feel that sexual thoughts and feelings are stronger than I am.	**1**	**2**	**3**	**4**
I have to struggle to control my sexual thoughts and behaviour.	**1**	**2**	**3**	**4**
I think about sex more than I would like to.	**1**	**2**	**3**	**4**
It has been difficult for me to find sex partners who desire having sex as much as I want to.	**1**	**2**	**3**	**4**

Appendix L: Childhood and Adolescence Taxon Scale – Self Report (CATS-SR)

Please answer the following questions by checking the appropriate box, circling the appropriate number or by filling in the blank.

		Yes	No
1.	Were you ever arrested prior to the age of **16 years**?	☐	☐
2.	Did you live with both of your biological parents up until the age of **16 years**?	☐	☐

If you answered **NO** to the previous question, please answer questions 3 and 4.
If you answered **YES** to the previous question please skip to question 5.

3.	Were you separated from your biological parents for more than 1 month?	☐	☐

4. What was (were) the reason(s) for the separation? (for example, death of a parent, one parent left, divorce, abandonment, removed from home, institutionalization):

Specify reason: ____

5. Did you get in a lot of physical fights (excluding siblings) prior to **16 years** of age?

1	2	3	4	5	6	7
No fights			Some fights			A lot of fights

Please indicate whether or not you engaged in any of the following behaviors prior to **15 years** of age:

		Yes	No
6.	Initiating physical fights often	☐	☐
7.	Lying often	☐	☐
8.	Running away from home overnight (at least twice, or once without returning)	☐	☐
9.	Stealing (including forgery)	☐	☐
10.	Fire-setting (deliberately)	☐	☐
11.	Skipping school often	☐	☐

		Yes	No
12.	Breaking into a car, house, or building	☐	☐
13.	Vandalism (other than fire-setting)	☐	☐
14.	Cruelty to animals	☐	☐

15. Forcing sexual activity on another person(s) ☐ ☐

16. Using a weapon in more than one fight ☐ ☐

17. Physically cruel to people ☐ ☐

18. Did you ever have discipline problems or attendance problems (skipping class) in elementary school?

1	2	3	4	5	6	7
No problems			Some problems			Serious problems

	Yes	No
19. Were you ever suspended or expelled from school?	☐	☐

20. Have you even felt that, as a teenager, you had problems with alcohol (i.e., that your drinking interfered in some way with your life?

1	2	3	4	5	6	7
No problems			Some problems			Serious problems

	Yes	No
21. Do you feel that one or both of your parents had a drinking problem while you were growing up?	☐	☐

Appendix M: Self-Report Early Delinquency Scale (SRED)

For each of the following activities please answer all of the questions by placing a checkmark in the appropriate space, even if you are unsure of the answer.

Write "NA" for all those questions that are not applicable to you.

1. **Carrying an illegal weapon**
   a) How often have you done this? Never Once Two or more times
   b) How old were you when you first did this? ________
   c) Have you done this in the last 12 months? Yes No
2. **Getting drunk**
   a) How often have you done this? Never Once Two or more times
   b) How old were you when you first did this? ________
   c) Have you done this in the last 12 months? Yes No
3. **Trespassing**
   a) How often have you done this? Never Once Two or more times
   b) How old were you when you first did this? ________
   c) Have you done this in the last 12 months? Yes No
4. **Stealing less than $10**
   a) How often have you done this? Never Once Two or more times
   b) How old were you when you first did this? ________
   c) Have you done this in the last 12 months? Yes No
5. **Taking a car without permission for a joy ride**
   a) How often have you done this? Never Once Two or more times
   b) How old were you when you first did this? ________
   c) Have you done this in the last 12 months? Yes No
6. **Fighting in the street**
   a) How often have you done this? Never Once Two or more times
   b) How old were you when you first did this? ________
   c) Have you done this in the last 12 months? Yes No
7. **Going to see X-rated movies**
   a) How often have you done this? Never Once Two or more times
   b) How old were you when you first did this? ________
   c) Have you done this in the last 12 months? Yes No
8. **Breaking into a house**
   a) How often have you done this? Never Once Two or more times
   b) How old were you when you first did this? ________
   c) Have you done this in the last 12 months? Yes No
9. **Breaking the windows of an empty building**
   a) How often have you done this? Never Once Two or more times
   b) How old were you when you first did this? ________
   c) Have you done this in the last 12 months? Yes No
10. **Getting into trouble because of alcohol**
    a) How often have you done this? Never Once Two or more times
    b) How old were you when you first did this? ________
    c) Have you done this in the last 12 months? Yes No
11. **Prank telephone calls**
    a) How often have you done this? Never Once Two or more times

b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

12. Shoplifting
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

13. Stealing out of a parked car
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

14. Using a weapon in a fight
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

15. Writing graffiti in a public place
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

16. Swearing loudly in public
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

17. Stealing over $10
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

18. Hitting a person to hurt them
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

19. Letting the air out of other people's car tires
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

20. Truancy (skipping school)
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

21. Getting suspended or expelled from school
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

22. Stealing alcohol
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

23. Starting a fire when you're not supposed to
a) How often have you done this? Never Once Two or more times

b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

24. Driving without a license
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

25. Throwing objects at people/cars
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

26. Smoking cannabis (marijuana)
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

27. Being part of a delinquent gang
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

28. Fare dodging (e.g. getting on a bus without paying)
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

29. Struggling with a police officer
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

30. Drinking alcohol at school
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

31. Gambling
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

32. Stealing a bicycle
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

33. Raising a false alarm
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

34. Damaging a parked car
a) How often have you done this? Never Once Two or more times
b) How old were you when you first did this? ________
c) Have you done this in the last 12 months? Yes No

Appendix N: Adverse Childhood Experiences (ACEs) Questionnaire

Please answer each question by checking Yes or No.

Prior to your 18th birthday:	Yes	No
1. Did a parent or other adult in the household often or very often… Swear at you, insult you, put you down, or humiliate you? or Act in a way that made you afraid that you might be physically hurt?		
2. Did a parent or other adult in the household often or very often… Push, grab, slap, or throw something at you? or ever hit you so hard that you had marks or were injured?		
3. Did an adult or person at least 5 years older than you ever… Touch or fondle you or have you touch their body in a sexual way? or Attempt or actually have oral, anal, or vaginal intercourse with you?		
4. Did you often or very often feel that … No one in your family loved you or thought you were important or special? or Your family didn't look out for each other, feel close to each other, or support each other?		
5. Did you often or very often feel that … You didn't have enough to eat, had to wear dirty clothes, and had no one to protect you? or Your parents were too drunk or high to take care of you or take you to the doctor if you needed it?		
6. Were your parents ever separated or divorced?		
7. Was your mother or stepmother: Often or very often pushed, grabbed, slapped, or had something thrown at her? or Sometimes, often, or very often kicked, bitten, hit with a fist, or hit with something hard? or Ever repeatedly hit over at least a few minutes or threatened with a gun or knife?		
8. Did you live with anyone who was a problem drinker or alcoholic, or who used street drugs?		
9. Was a household member depressed or mentally ill, or did a household member attempt suicide?		
10. Did a household member go to prison?		