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Structural brain characteristics in sexual aggressors diagnosed with paraphilic disorder

Strukturní charakteristiky mozku u sexuálních agresorů s diagnózou parafilní poruchy

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Declaration

I hereby declare that I have prepared the thesis independently, that I have properly cited all sources and literature used, and that the thesis has not been used in the context of another university study or to obtain another or the same degree.

Prague, 10.4.2023 ……

Martina Bartošová

Abstract

Etiology of paraphilic coercive disorder, as well as origin of any paraphilic disorder, remains unresolved. The current approach in research is trying to elucidate the common denominator of paraphilic disorders on the one hand and distinguish their specifics on the other. Findings from neuroscience are increasingly gaining importance in investigating the underlying neurobiological mechanisms linked to the diagnosis of paraphilic disorders. This thesis is addressing clinical specifics and structural characteristics of the brain in sexual aggressors diagnosed with paraphilic coercive disorder. The literature review section provides an overview of theories regarding sexual arousal linked to the etiology of paraphilic coercive disorder. The empirical part of the thesis is devoted to analyzing possible structural specifics of limbic system in individuals diagnosed with paraphilic coercive disorder compared to a normophilic population of men. Volumetric brain tissue parameters in 21 individuals diagnosed with paraphilic coercive disorder and 33 controls were assessed using MRI. Following data analysis was aimed at comparing the differences in individual limbic system structures between the two aforementioned groups. No significant difference between the two groups was found in limbic system structures. This result may indicate larger role of sexual inhibition than sexual excitation; therefore, further research is warranted.

Keywords

Brain Structures; Excitation; Limbic System; Paraphilic Coercive Disorder; Paraphilias; Sexual Arousal

Abstrakt

Etiologie patologické sexuální agrese, stejně jako původ všech parafilních poruch, zůstává nevysvětlena. Současný přístup ve výzkumu se na jedné straně snaží objasnit společný jmenovatel parafilických poruch a na druhé straně rozlišit jejich specifika. Neurovědní poznatky nabývají stále většího významu při zkoumání základních neurobiologických mechanismů pojících se s diagnózou parafilní poruchy. Tato práce se zabývá klinickými specifiky a strukturálními charakteristikami mozku u sexuálních agresorů s diagnózou patologické sexuální agrese. Literárně-přehledová část poskytuje přehled teorií týkajících se sexuálního vzrušení v souvislosti s etiologií patologické sexuální agrese. Empirická část práce je věnována analýze možných strukturálních specifik limbického systému u jedinců s diagnostikovanou patologickou sexuální agresí ve srovnání s normofilní/zdravou populací mužů. Za použití MRI byly zkoumány volumetrické parametry mozkové tkáně u 21 jedinců s diagnózou patologické sexuální agrese a u 33 kontrolních osob. Následná datová analýza byla zaměřená na porovnání rozdílů v jednotlivých strukturách limbického systému mezi výše zmíněnými dvěma skupinami. Nebyl zjištěn žádný statisticky významný rozdíl mezi skupinami ve strukturách limbického systému. Tento výsledek může poukazovat na vyšší vliv sexuální inhibice než sexuální excitace, a tedy je zapotřebí dalšího výzkumného bádání.

Klíčová slova

struktury mozku; excitace; limbický systém; patologická sexuální agrese; parafilie; sexuální vzrušení

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List of abbreviations

APA	American Psychiatric Association
ADHD	Attention deficit hyperactivity disorder
CT	Computed tomography
DSM-3	Diagnostic and statistical manual for mental diseases
DSM-5	Diagnostic and statistical manual for mental diseases
DTI	Diffusion tensor imaging
EEG	Electroencephalography
FA	Fractional anisotrophy
fMRI	Functional magnetic resonance imaging
GABA	Gamma-aminobutyric acid
ICD 10	International statistical classification of diseases and related health problems
ICD 11	International statistical classification of diseases and related health problems
MEG	Magnetoelectroencephalography
MRI	Magnetic resonance imaging
NIMH	National institute of mental health
OCD	Obsessive-compulsive disorder
PET	Positron emission tomography
PPG	Penile plethysmography, phallometry
SPECT	Single-photon emission tomography
VTA	Ventral tegmental area
WHO	World Health Organization

Introduction

This thesis summarizes current knowledge regarding clinical specifics in so-called rapists, i.e. individuals diagnosed with paraphilic coercive disorder "*Other paraphilic disorder involving non-consenting individuals"* (WHO, 2019). The thesis focuses on a diagnosis that has been recognized in the Czechoslovakian context as *pathological sexual aggression*, in the English context known as *paraphilic coercive disorder* or *biastophilia*. Current studies and discussions are not in agreement regarding the classification of paraphilic disorders and their characteristics (e.g., Kafka, 2010; Krueger et al., 2017; Moser, 2018). The thesis aims to analyze possible structural specifics in individuals diagnosed with paraphilic coercive disorder and their connection with sexual arousal, sexual excitation, and sexual inhibition to contribute to the current knowledge of the paraphilic coercive disorder.

Paraphilias and paraphilic disorders are lacking sufficient empirical support. This problem is even greater in the case of paraphilic coercive disorder which is not specific enough (Agalaryan & Rouleau, 2014). One currently applied approach uses brain imaging techniques that have been proven fruitful and helpful in assessing, describing, and understanding paraphilic disorders (Saleh & Berlin, 2004). Some conducted studies have shed light on the non-specifics of brain areas and brain activity that are connected to sexual behavior within paraphilic disorder(s). This thesis addresses this knowledge gap by comparing clinical manifestations and structural brain parameters in individuals diagnosed with paraphilic coercive disorder and control subjects. Furthermore, suggestions have been made repeatedly to incorporate paraphilic coercive disorder diagnosis into the current diagnostics manual, nevertheless, clinical description, empirical support, and sufficient specificity were not strong enough (Moser, 2018). Thus, DSM-5 (APA, 2013) offers a category called *Unspecified Paraphilic Disorder* which might serve as a diagnostic unit in the case of paraphilic coercive disorder. This paper accentuates the importance of the difference between paraphilia (sexual preference) and paraphilic disorder (sexual preference disorder) for the nature of public health.

Given the needs of this thesis, only some existing paraphilic disorders are further described. The first chapter is devoted especially to paraphilic coercive disorder, *6D35 Other Paraphilic Disorder Involving Non-Consenting Individuals* from ICD-11 (WHO, 2019). An overview of the clinical specifics of paraphilic coercive disorder is presented, along with the distinction between paraphilia and paraphilic disorder. Although the number of studies is

scarce, newly conducted studies point to a potential link between paraphilic coercive disorder and frotteuristic disorder, which is thus discussed in this thesis (Siserman et al., 2020). An alternative explanation for sexual aggression is offered via the so-called continuum theory that points out similarities between paraphilic coercive disorder and coercive sexual sadism disorder and suggests a common denominator of the aggressive component (Longpré et al., 2020). Important differences and possible overlaps of paraphilic coercive disorder and coercive sexual sadism disorder are further explained, since those differences can be found in both clinical praxis, and research (e.g., Páv & Brichcín, 2019; Seto et al., 2012; Weiss, 2017). Other challenges regarding the etiology of paraphilic coercive disorder are described in the first chapter. Among the dominant suggestions, postnatal experiences regulating latent innate disposition (Marshall & Kingston, 2018; Weiss, 2017), or framework of courtship theory disorder coined by Kurt Freund (Freund et al., 1983) can be found. In conclusion, the etiology and contributing factors of paraphilic disorders are not explored enough. Relevant research and diagnostics methods together with their contribution are mentioned at the end of the first chapter.

The literature has suggested a possible link of etiology of paraphilic coercive disorder with sexual response function. Certain sub-mechanisms of the overall sexual response seem to be of importance in manifested sexually violent behavior (Basson, 2015). The focus of the second chapter is thus on the role of sexual arousal in human sexual response. More specifically, sexual excitation and sexual inhibition play an important part in human sexual response. Their relationship is further described with the help of the dual control model and the resulting implications (Janssen & Bancroft, 2007). The criteria for hyperexcitable behavior and its occurrence i.e., increased sexual excitation, decreased sexual inhibition, or both are highlighted in the text. Although the emphasis is on sexual excitation, the disinhibitory mechanisms contributing to both increased sexual excitation and enactment of paraphilic rape preference are also described in more detail (Chan, 2022). At the end, the space is devoted to the explanation of possible differences between individuals diagnosed with paraphilic coercive disorder and healthy male population. Here, the role of sexual arousal in paraphilic rape and its linkage with other clinical manifestations, such as paraphilic sexual fantasies (e.g., Maniglio, 2011, 2012), hypersexuality (e.g., Bőthe et al., 2018; Phenix & Hoberman, 2015), or executive dysfunctions (e.g., Chan, 2022; Phenix & Hoberman, 2015) is further explored. A link between paraphilic coercive disorder and behavioral learning approach, and impulsiveness is also sketched.

In attempt to broad the knowledge of paraphilic coercive disorder, human sexual arousal in normophilic sexuality was presented. The third chapter described different models such as the Sexual Tipping Point model (Pfaus, 2009) and the Four Component model (Jordan et al., 2011) that clarify various components of sexual arousal in humans and they link them with their corresponding brain structures and networks. Various areas responsible for sub-mechanisms of sexual arousal are described with the help of current neuroimaging, neuroanatomical, and neurophysiological studies that complement the overall picture (Calabrò et al., 2019; Gazzaniga, 2019). Importantly, connection between sexual excitation and reward system (Calabrò et al., 2019), as well as other relevant structures of limbic system (Berridge & Kringelbach, 2015) is discussed in detail. Lastly, the role of dopaminergic mesolimbic pathway, other neurotransmitters, neurohormones, and hormones is of relevance to human sexual response, sexual arousal, and behavioral manifestations in individuals diagnosed with paraphilic coercive disorder (e.g., Kafka, 1997; Pfaus, 2009).

The following chapter summarizes documented cognitive impairments and aberrations in individuals diagnosed with paraphilic disorder or undiagnosed sex offenders (e.g., Fabian, 2012). This summary is complemented by comparison between different sex offenders and their neuroanatomical differences (Joyal et al., 2014; Saleh & Berlin, 2004) in which the majority of brain impairments among sex offenders has been observed in frontal and temporal areas of the brain (Appelbaum, 2009; Fabian, 2012). For example, lesions and other aberrations in frontal and temporal lobes are linked to sexual disinhibition, hypersexuality, decreased mate selectivity, and sexually violent behavior (Fabian, 2012). Importantly, hyperfunction of sexual excitation can be, according to available literature, connected with aberrations of the limbic system (Schmidt et al., 2017). Thus, specific limbic system structures relevant for regulation of sexual arousal are described more in detail e.g., amygdala, caudate nucleus, putamen, or pallidus. A connection between limbic system structures and orbitofrontal cortex is sketched because of their similar relevance in moral decision-making, impulse control, sexually violent behavior or hypersexuality (e.g., Basson, 2015; Rodriguez et al., 2017). Fabian (2012) notes that impairment to the frontal and temporal lobes, as well as subcortical brain structures can be linked to both hypersexuality and paraphilic coercive behavior. Other confounding factors in hypersexuality and paraphilic coercive disorder, namely abuse in childhood as a co-acting factor in development of overinvolvement in sexual life or disinhibition are suggested in the text (Longpré et al., 2022). Other influential factors considered are discussed in detail (e.g., Craig & Bartels,

2021; Langevin & Curnoe, 2008; Phenix & Hoberman, 2015). Lastly, the role of neurotransmitters in individuals diagnosed with paraphilic coercive disorder or non-diagnosed sex offenders is mentioned (e.g., Appelbaum, 2009; Calabrò et al., 2019).

Following the explanation and description of the rationale for the selection of anatomical brain structures, the empirical part describes the research design exploring the aforementioned connections between possible structural differences in patients who preferentially perform their sexuality in a coercive manner compared to a healthy male population. This closer examination will be done through the description and analysis of data from a quantitative comparison of volumetric brain tissue parameters in 21 patients with a paraphilic diagnose (dg. F65.5/6/8/9 in ICD-10) and 33 control healthy men followed by a chapter about research ethics, detailed results description, and discussion respectively. The discussion highlights the important findings and offers alternative explanations together with suggestions for future research on paraphilic coercive disorder. The focus of the research part is in correspondence with the literature-review part where theories of sexual arousal with emphasis on sexual excitation and sexual inhibition and its relation to limbic system structures play an important role in explaining enacted sexually violent behavior such as paraphilic coercive disorder. This thesis summarizes the available literature on the topic and includes both original texts, theories, and research, as well as current knowledge and findings on paraphilic coercive disorder.

Literature review section

1. Paraphilias and Paraphilic Disorders

Paraphilia is the current designation of atypical sexual arousal and interest formerly known as sexual deviation. *International classification of diseases and related health problems, 11th edition* (hereafter referred to as ICD-11) (WHO, 2019) defines paraphilic disorders as "characterized by persistent and intense patterns of atypical sexual arousal, manifested by sexual thoughts, fantasies, urges, or behaviors, the focus of which involves others whose age or status renders them unwilling or unable to consent and on which the person has acted or by which he or she is markedly distressed.". Weiss (2017) uses the term *sexual preference disorder* and defines it as "a disorder that currently causes difficulty or deterioration in the individual's condition, and/or a disorder whose satisfaction entails personal harm or risk of injury to others.". Similarly, ICD-11 (WHO, 2019) states the importance of some other atypical sexual arousal patterns being involved within paraphilic disorder if they "cause marked distress to the individual or involve significant risk of injury or death". By this definition, ICD-11 includes the following diagnoses:

- 6D30 Exhibitionistic Disorder
- 6D31 Voyeuristic Disorder
- 6D32 Pedophilic Disorder
- 6D33 Coercive Sexual Sadism Disorder
- 6D34 Frotteuristic Disorder
- 6D35 Other Paraphilic Disorder Involving Non-Consenting Individuals.

In the applicable diagnoses above, it is worth mentioning a recent revision that has been introduced with the current edition of ICD-11 (WHO, 2019). In this current edition more focus was placed on clearly distinguishing arousal patterns that involve non-consenting individuals from arousal patterns that involves consenting individuals or is typical solicitary behavior (First et al., 2021). Reed et al. (2019, p. 16) describe this newly introduced categories of diagnosis involving solitary behavior or consenting individuals as applicable when "sexual thoughts, fantasies, urges or behaviours are associated with substantial distress (but not as a consequence of rejection or feared rejection of the arousal pattern by others) or confer direct risk of injury or death (e.g., asphyxophilia).".

According to Krueger (2017), it is important to capture the behavior that is relevant to public health and/or could have impact on public health. Thus, we must distinguish these kinds of behavior from those kinds of behavior and/or sexual arousal which might be of a private preference without having any harming impact on neither individuals involved, nor public health. Newly introduced categories such as *coercive sexual sadism disorder, frotteuristic disorder,* and *other paraphilic disorder involving non-consenting individuals* intend to capture this former category. Thus, the current edition of ICD-11 followed a principle on the central relevance of public health in redefining some paraphilic disorders and changing the discourse on paraphilic disorders.

Diagnostic and statistical manual of mental disorders, *5th edition* (APA, 2013, p. 685) (hereafter referred to as DSM-5) defines paraphilia as "intense and persistent sexual interests in genital stimulation or preparatory fondling with phenotypically normal, physically mature, consenting human partners.". Also, "a paraphilic disorder requires both the presence of a paraphilic urges and the existence of distress, dysfunction, and/or acting on the urges." (Barnhill, 2013). To add, according to APA Dictionary (APA, 2023) a paraphilia is considered being paraphilic disorder only if it causes distress or impairment to the individual or if its practice has harmed or risked harming others. The current edition of DSM-5 (APA, 2013) thus sheds light on the relationship between paraphilia and paraphilic disorder. Some of the described diagnostics criteria for paraphilic disorder are:

- "feel personal distress about their interest, not merely distress resulting from society's disapproval;
- have a sexual desire or behavior that involves another person's psychological distress, injury, or death, or a desire for sexual behaviors involving unwilling persons or persons unable to give legal consent.".

According to DSM-5 (APA, 2013) the presence of paraphilia is considered as a potential marker which, however, on its own is not sufficient for the diagnosis of the corresponding paraphilic disorder. Paraphilia is the behavior which may manifest atypical sexual interests and should only be considered a criterion. However, by this definition the amount of possible identified paraphilias numbers in the hundreds (Kafka, 2010). Accordingly, paraphilia does not equal mental disorder and is not a diagnosis or pathology (Moran, 2013). Many people may engage in atypical sexual behaviors or experiencing paraphilic interests without meeting the criteria for being diagnosed with paraphilic disorder

(Kafka, 2010). Similarly, Weiss (2017) claims that paraphilia per se is not a sufficient condition for clinical intervention nor requires clinical intervention. On the contrary, paraphilic disorder is the disorder stemming from atypical sexual behavior (APA, 2013). It is a proper diagnostic unit i.e., pathological sexual preference which is described in two aforementioned diagnostic criteria. According to DSM-5, paraphilic disorder can be one of these eight identified paraphilias:

- Voyeuristic disorder
- Exhibitionistic disorder
- Frotteuristic disorder
- Sexual masochism disorder
- Sexual sadism disorder
- Pedophilic disorder
- Fetishistic disorder
- Transvestic disorder.

Even though there are substantial differences between ICD-11 and DSM-5, similar discourse is applied regarding diagnostic criteria. Both give attention to the difference between paraphilia and paraphilic disorder and emphasize the distinction between solicitary behavior or sexual behavior involving consenting individuals versus sexual behavior involving non-consenting individuals. In conclusion, paraphilia is considered an atypical sexual interest that does not necessarily require clinical intervention, while paraphilic disorder is a diagnosed mental disorder that causes distress or impairment to the individual or other individuals directly involved if acting upon the corresponding sexual desires (Moran, 2013).

1.1 Paraphilic Coercive Disorder

This thesis' starting point is a diagnosis specific to Czechoslovakian clinical practice, namely *paraphilic coercive disorder*. In the Czechoslovakian literature this diagnosis is called *patologická sexuální agrese*, translated into English as *pathological sexual aggression*. In English literature, paraphilic coercive disorder is also known as *biastophilia* or *rapism*. Whilst some claim that the term paraphilic coercive disorder replaced the two other terms (Holoyda, 2020), some current authors still use the term biastophilia (Seto et al., 2021). Pettigrew (2019) offers different definitions of the term biastophilia which all share

the predatory aspect of sexual attraction that is connected with violence, involvement of non-consenting individual, and rape preference. Even though Pettigrew's article partly criticizes the number of terms used for similar behavior and the number of same terms used for slightly or very different behavior, he is clearly pointing out the important distinction between *rapists* and *biastophilics.* As he points out it is important to emphasize that not all individuals who performed rape have a sexual preference for sexual aggressive behavior as such. Yet, other labels or terms can be found within the current literature such as *sexual aggression, sexual aggressors, coercive behavior, rapists, preferential rape pattern, non-sadist sexual offenders, erotic violence syndrome* etc. (e.g., Baur et al., 2016; Davis et al., 2014; Freund & Seto, 1998; Harris et al., 2012; Lalumière et al., 2003; Weiss, 2017). For this paper, the term *paraphilic coercive disorder* will be used and it will be the central focus of the empirical study.

Paraphilic coercive disorder falls under the new category in ICD-11 called Other Paraphilic Disorder Involving Non-Consenting Individuals which is characterized by:

a persistent and intense pattern of atypical sexual arousal— manifested by sexual thoughts, fantasies, urges, or behaviours— in which the focus of the arousal pattern involves others who are unwilling or unable to consent but that is not specifically described in any of the other named Paraphilic Disorders categories (e.g., arousal patterns involving corpses or animals) (WHO, 2019).

Weiss (2017, p. 49) characterizes paraphilic coercive disorder as a paraphilia in which: "sexual arousal and satisfaction (…) is achieved by overcoming the resistance of the assaulted anonymous woman and minimizing her cooperation". The term 'paraphilic coercive disorder' is specific to Czechoslovakian clinical practice and is based on the idea of capturing distressful and harmful atypical sexual behavior not found in coercive sexual sadism disorder. Another characteristics for this behavior is provided by Páv and Brichcín (2019, p. 18) by the following definition:

This disorder is characterised by sexually aggressive behaviour (sometimes referred to as predatory behaviour), skipping the phases of courtship (i.e. the stages of communication between partners that lead to the sexual act) and its object is usually an unfamiliar, erotically maladjusted woman who is assaulted to achieve sexual gratification from her attacker.

Other characteristics, for example abhorrent, humiliating, painful or terrifying experiences may contribute to sufficient sexual excitation or even increase in sexual arousal (Thornton, 2010). For more theories related to paraphilic coercive disorder, see Agalaryan (2014).

In correspondence with the general prevalence, paraphilic coercive disorder is more common among men, typically adult, although the onset is typically in one's teen years (APA, 2013). Individuals with paraphilic disorder become aware of their paraphilic proneness in their teen years (Saleh & Berlin, 2004). The majority of first delinquent activities has been documented around the age of 20, with the majority of offenders not being older than 30 (Weiss, 2017) or 40 (Dickey et al., 2002). This fact could potentially be explained by that the increasing age of an individual leading to developmental changes manifested by potential increases in impulse control and decreases in sexual drive, which in combination might result in a decrease of paraphilic sexual arousal (WHO, 2019). The additional diagnostic features section of ICD-11 states that this diagnose should not be given to children, and among adolescents, it should only be given with extreme caution. This is because some of the sexual acts might be a part of sexual experimentation in one's teen years, rather than a typical preferential pattern. Thus, at this age, there is an increased risk of false positive cases if extreme caution is not applied. Another specification in the diagnostic features section stresses the importance of the number of instances and forms of sexual behavior. If these numbers and forms are limited, or if the sexual behavior only manifests as a single form of behavior or as a single instance, then they are not sufficient for the diagnosis of paraphilic coercive disorder. These unique cases may be explained by other intervening factors (e.g., intoxication) (WHO, 2019).

1.1.1 Clinical Specifics of Paraphilic Coercive Disorder

The literature on paraphilic coercive disorder is scarce and often inconsistent in the samples used. Therefore, characteristics regarding clinical manifestation, paraphilic comorbidity, or typical patterns are insufficiently studied. Moreover, the available information is partly drawn from clinical praxis rather than thorough research. Historically, a strong connection between exhibitionism and paraphilic coercive disorder was considered in connection to courtship disorder (see below) (Freund & Seto, 1998). For a few individuals, a comorbidity with frotteurism and hypersexuality have been suggested (Siserman et al., 2020). A connection between paraphilic rape and voyeurism, and paraphilic rape and sexual

sadism has also been reported (Delcea, 2020). Some have also suggested that there might be comorbidity between paraphilic rape and hebephilia (Siserman et al., 2020), although there are contradictory data from other research (e.g., Androvičová et al., 2018; Páv & Brichcín, 2019).

Comorbidities with other (i.e., non-paraphilic) disorders have been investigated throughout the years with various results. Personality disorder, schizophrenia, schizoaffective disorder, organic syndrome, or depression were reported within different samples in Weiss (2017). Alcohol abuse, drug abuse, personality disorder, and psychosis were found in a sample of 535 rapists (Långström et al., 2004). Corroborative results from 2007 indicate a higher prevalence of alcohol abuse, other substance abuse, personality disorder, and psychoses among rapists (n=2671) (Långström & Grann). The higher prevalence of alcohol abuse, personality disorder, and affective disorders is further corroborated in a study from 2020 (Delcea). Furthermore, Delcea presents a summary of studies conducted on comorbidities among sex offenders where, in addition to those already mentioned, schizophrenia, and intellectual developmental disorder frequently occur. Most importantly, the cooccurrence of psychiatric diagnosis extensively complicated the diagnostic process of paraphilic disorder (Weiss, 2017). Thus, it is important to carry out thorough differential diagnosis when considering all the potential factors and anamnestic data.

As already mentioned, paraphilic coercive disorder is not a separate diagnosis in any diagnostic manual, but it has been used in Czechoslovakian clinical practice to diagnose individuals who have committed sexual offence against a woman (Švarc, 2017). These individuals, known as rapists, are then eligible for inpatient treatment alongside others who have been diagnosed with a paraphilic disorder and have been convinced of a sexual assault (Páv & Brichcín, 2019). The diagnosis of paraphilic coercive disorder has an old tradition in Czechoslovakian practice and has been thoroughly studied throughout the years (Perkins et al., 2020). Although not separately listed in ICD-11, paraphilic coercive disorder can be diagnosed if the diagnostic criteria of 6D35 Other Paraphilic Disorder Involving Non-Consenting Individuals are met (WHO, 2019). Typical examples of other paraphilic disorders falling under this category include zoophilia and necrophilia (Holoyda, 2020). However, paraphilic coercive disorder has been criticized for its inconsistency and potential false positive cases, which might be problematic (Páv & Brichcín, 2019). For example, Švarc (2017) criticizes the use of this diagnosis and claims that due to its poorly defined clinical

characteristics, it may excuse some cases of rape that do not involve paraphilic behavior, features, or paraphilic disorder itself. Another problem is that paraphilic coercive disorder is not an officially recognized diagnosis and has various definitions, which may result in unrealistic patient population profiles.

In the DSM (APA, 2013), paraphilic coercive disorder was considered as a new diagnosis since the publication of DSM-3. However, after many discussions trying to identify the common denominator of this type of sexual offences, the proposition to introduce the diagnosis into the DSM was declined (Krueger, 2012). The diagnosis has since then been repeatedly rejected due to the lack of adequate research support throughout the decades (Holoyda, 2020). The 11th edition of the ICD (WHO, 2019) was indirectly influenced by these discussions but chose instead to introduce the category of 6D35: Other Disorders Involving Non-Consenting Individuals in ICD-11. Yet this newly introduced category within ICD-11 has come under fierce criticism and is being called the "catch-it-all" category. According to these voices, such a category contributes to false diagnostic processes (Holoyda, 2020). The lack of adequate research for this category also supports concerns regarding the etiology of paraphilic coercive disorder. Neither the etiology nor the mechanism of action has been sufficiently researched in both cases.

As previously mentioned, many scholars take an approach that does not consider coercive sexual preferences a real diagnosis on its own. There are different reasons for this. One of them is the view that sexual aggression is a continuum. According to this view, paraphilic coercive disorder is not an ontologically distinct entity but a qualitatively different manifestation of an overall sexual preference (Liu et al., 2022). Another reason is embodied by scholars who opposed implementation of paraphilic coercive disorder within DSM-5 due to insufficient empiric evidence. Among those, Agalaryan and Rouleau (2014) tested the victim count hypothesis and proved that the original threshold (which was three and more victims) is arbitrary and misleading and may cause false positive cases. Interestingly, these authors do not reject the idea of paraphilic coercive disorder per se, but they claim that more objective markers associated with rape-proneness are needed. This is because the number of false positive cases declines if a victim count hypothesis is combined with another marker. This study goes hand in hand with Stern's (2010) call for more precise description of the diagnostic criteria that would prevent the overuse of the category formerly called Paraphilia Non Otherwise Specified and thus would give more attention and more resources to a group of individuals committing predatory sexual violence. A similar conclusion was attained by

Knight (2010). Moreover, Stern (2010) is among many who suspect that ideological preferences played a role in decision-making procedure when discussing the implementation of paraphilic coercive disorder.

However, the assumption that any man who commits sexual violence is a sexual aggressor/paraphilic coercive disorder rapist is far from truth, irrespective of the classification of paraphilic disorders. From the number of convicted rapists and sex offenders, only very small percentage of individuals had the paraphilic disorder. As Weiss (2017) states, it is even more reasonable to presuppose that the majority of perpetrators within sexual crimes could be diagnosed with other mental disorders (intoxication or drug abuse, personality disorder, etc.) than paraphilic disorders. It is, however, difficult to say in case of comorbidity, "which disease" is responsible for such behavior. To prove the direct effect in these cases is nearly impossible, thus also precluding a clear-cut account of etiology. Thus, instead all of the existing theories should serve as useful but incomplete tools in navigating these complexities when articulating paraphilic coercive disorder.

1.1.2 Paraphilic Coercive Disorder and Other Paraphilic Disorders Involving Non-Consenting Individuals

As stated above, paraphilic disorders involving non-consenting individuals are those paraphilic disorders mentioned in ICD-11 and are distinguished from the category that includes paraphilic disorders involving solitary behavior or consenting individuals. To be diagnosed with a paraphilic disorder, "the individual must have acted on the arousal pattern or be markedly distressed by it." (WHO, 2019). Paraphilic coercive disorder involves non-consenting individuals and is classified among the most dangerous paraphilic disorders due to the strong intrusive and intense behavior (Weiss, 2017). The strongest characteristics tend to be the specificity of sexual arousal. In normative sexuality, sexual arousal is partly or fully decreased if remarkable signals of experienced inconvenience from the sexual partner are presented. However, the reversed is true for paraphilic coercive disorder. Among these individuals, a strong sexual preference for coercive sexuality over the consensual sexuality is more common than usual (Thornton, 2010). In some cases, sexual responsiveness from the partner might inhibit arousal or decrease it (Weiss, 2017).

Important distinction has to be made between paraphilic coercive disorder and coercive sexual sadism disorder. These two diagnoses share certain properties, yet they are very different. ICD-11 finds coercive sexual sadism disorder being characterized by:

a sustained, focused and intense pattern of sexual arousal—as manifested by persistent sexual thoughts, fantasies, urges or behaviours—that involves the infliction of physical or psychological suffering on a non-consenting person (WHO, 2019).

It is important to note that paraphilic coercive disorder does not manifest any obvious sadistic role or interest in torturing the victim and purposefully prolonging the victim's suffering (Weiss, 2017). Similarly, different arousal patterns were found in studies conducted on individuals who committed rape. Both groups (coercive sexual sadism disorder rapists and paraphilic coercive disorder rapists) were aroused by depicted sexual violence used towards the victim. However, coercive sexual sadism disorder rapists were also aroused by depicted non-sexual violence used towards the victim, while this was not the case for paraphilic coercive disorder rapists. In addition, paraphilic coercive disorder rapists were aroused by depicted intercourse that was mutually consensual which was not the case for sadists (Marshall et al., 2013). Another piece of evidence has been brought by Thornton (2010) through studies conducted with a non-offender sample. These individuals showed greater arousal response to depicted rape and coercion than to consensual sexual activity. It should be pointed out that sexual arousal in coercive sexual sadism disorder is achieved through domination over the victim, that leads to victim's physical and mental suffering. The feeling that the victim is powerless contributes to the sexual arousal (Weiss, 2017). More specifically, DSM-5 (APA, 2013) gives examples such as inflicting humiliation, bondage, or other behavior involving pain suffering. According to the ICD-11 guidelines, "…the individual must have acted on these thoughts, fantasies or urges or be markedly distressed by them" to be diagnosed with coercive sexual sadism disorder (WHO, 2019). Similarly, in DSM-5 the criteria are divided into two clusters as follows:

A. Over a period of at least 6 months, recurrent and intense sexual arousal from the physical or psychological suffering of another person, as manifested by fantasies, urges, or behaviors.

B. The individual has acted on these sexual urges with a nonconsenting person, or the sexual urges or fantasies cause clinically significant distress or impairment in social, occupational, or other important areas of functioning (APA, 2013, p. 695).

However, Liu et al. (2022) claim that, even though these two manuals are complementary and nearly exhaustive regarding diagnostic criteria, the real diagnostic procedure is carried out poorly, and the methods and sources used in practice are

miscellaneous and not correspondent with the prescribed criteria. These authors conducted replication study aimed at extending the results for an alternative model of coerciveness. In this model, paraphilic coercive disorder and coercive sexual sadism disorder are both related to brutality because they exist within the same continuum. Based on the results, paraphilic coercive disorder and coercive sexual sadism disorder patterns are considered as manifestations of a single continuum ranging from coercive sexual fantasies and behavior to brutality and killing. This finding contradicts theory of courtship disorders (see below) on which the current diagnostic criteria in the DSM-5 are based. Similar criticism is summarized elsewhere (Knight, 2010).

Current literature suggests that paraphilic coercive disorder has some possible link with other paraphilic disorders involving non-consenting individuals. A small, but not insignificant link, has been shown to exist between paraphilic coercive disorder and frotteuristic disorder (Siserman et al., 2020). The most apparent difference (interestingly, in a similar vein to coercive sexual sadism disorder) is the mean of achieving sexual arousal. In the case of frotteuristic disorder, sexual arousal is achieved by rubbing up against anonymous and unknown individuals (Weiss, 2017). According to ICD-11 (WHO, 2019), frotteuristic disorder is characterized by „a sustained, focused and intense pattern of sexual arousal— as manifested by persistent sexual thoughts, fantasies, urges, or behaviours— that involves touching or rubbing against a non-consenting person in crowded public places.".

Likewise, to diagnose an individual with frotteuristic disorder, "the individual must have acted on these thoughts, fantasies or urges or be markedly distressed by them" (WHO, 2019). Given that frotteuristic activities often take place in public places, perpetrators are not typically detected. The victims are either unwilling to attract attention in public places, such as public transport, elevators, queues etc., or they find out they were targets retrospectively (Weiss, 2017). It is important to note that the fact that frotteuristic activities are often carried out in public does not mean that individuals prefer to carry them out in public. However, public places, by their nature, contribute to more successful anonymous perpetration of the activities (Ranger & Fedoroff, 2015). The latter seems to be similar in case of paraphilic coercive disorder in which the aspect of anonymous target seems to be responsible for sexual arousal. In these scenarios, victims are similarly also targeted in public places yet, as a dissimilarity, in hidden spots which make the victim unable to attract attention. Typically, a strong urge and compulsion tends to be present in individuals with frotteuristic disorder and paraphilic coercive disorder (Weiss, 2017). A notable difference is the cooccurrence of

frotteuristic disorder with toucheristic paraphilia (Ranger & Fedoroff, 2015). Interestingly, frotteurism is among the most prevalent paraphilic patterns in a non-offending Czech sample, together with voyeurism and fetishism (Bártová et al., 2021). Lastly, both frotteuristic disorder and paraphilic coercive disorder form part of the courtship disorders (Freund et al., 1983).

1.2 Courtship Disorder

The courtship disorder hypothesis is a conception proposed by Kurt Freund (1983) that is used to describe abnormality in human sexual behavior. The term *courtship* is derived from ethology literature and refers to the sequence of behavior understood as dyadic interactions that precede genital coupling and that can initiate genital coupling (Weiss, 2017). This hypothesis works on the assumption that there are four phases of human erotic and sexual interaction that follows one another in an order as follows:

a) location of a potential partner and initial appraisal of a potential partner
b) pretactile interaction
c) tactile interaction
d) effecting genital union (Freund & Blanchard, 1986, p. 79; Freund et al., 1983, p. 370).

The first phase manifests in visually selecting a suitable potential erotic partner, followed by non-physical pretactile interactions, such as looking, smiling, posturing, and/or talking to a potential partner as the second phase. This is followed by tactile, physical interactions such as touching, kissing, and finally resulting in genital interaction (Craig & Bartels, 2021; Freund et al., 1983). Freund in the twelfth chapter of Marshall's handbook (Marshall et al., 2013) highlights that this scheme is roughly made, and various order of phases may occur, the time between phases may differ, and some interactions will not continue into subsequent phases. The successful realization of the individual courtship behavior of both partners leads to successful progression of sexual interaction, where synchronicity and smooth transition between phases play its part (Weiss, 2017).

The idea of courtship disorder is based on disrupted sequences of aforementioned phases, where the disruption of sequences serves as the common denominator for certain paraphilias. In Freund's (Marshall et al., 2013, p. 195) words, "… various anomalous erotic preferences can be seen as expressions of a common "underlying" disorder". This disorder

is called courtship disorder. According to this theory, various anomalous erotic preferences (paraphilias) are intensified, exaggerated, and distorted versions of the ordinary phases. Among these, voyeurism is perceived as an exaggeration and distortion of the first phase, exhibitionism is perceived as a distortion of the pretactile phase, toucherism and frotteurism are perceived as a distortion of the tactile phase, and preferential rape pattern similar to paraphilic coercive disorder is perceived as a distortion of the genital interaction (Freund & Blanchard, 1986; Marshall et al., 2013). Telephone scatophilia was added later and is considered a distortion of the pretactile phase (Freund et al., 1983). This theory proposes a unified etiopathogenesis for voyeurism, exhibitionism, telephone scatophilia, toucherism, frotteurism and preferential rape pattern (i.e., paraphilic coercive disorder).

In the preferential rape pattern, only the first phase is fully expressed. All of the remaining phases are distorted or omitted (Freund et al., 1983). Freund & Blanchard (1986) carried out an experiment in which they tested this hypothesis on a sample of 11 rapists and 11 controls. Using penile plethysmography as a physiological marker of the sexual arousal they found different sexual arousal within different phases or stimuli between rapists and controls. In a similar approach, other physiological studies have contributed to the available findings by grounding a possible distinction of sexual arousal between rapists, sadists, and controls (Lalumière et al., 2003; Marshall et al., 2013). More specifically, in paraphilic coercive disorder the preference of women's erotic attunement is closer to the healthy male population as well as the aversion to women's non-erotic attunement during the sexual intercourse. However, these preferences are not as strong as in case of the healthy male population (Harris et al., 2012; Lalumière et al., 2003). These findings have three key aspects. First, sexual arousal/penile response within paraphilic coercive disorder almost copies the healthy male population's arousal in the first phase. Second, sexual arousal/penile response is not decreased as much as in healthy male population in case of woman's non-erotic attunement. Third, sexual arousal/penile response is more affected in paraphilic coercive disorder that the one in coercive sexual sadism disorder if non-erotic attunement is observable (Freund & Blanchard, 1986; Harris et al., 2012; Lalumière et al., 2003; Marshall et al., 2013).

The courtship disorder hypothesis has been extended to the so-called sexual motivation system which is a conception proposed by Kolářský, Madlafousek and Brichcín and is, according to authors, essential in studying etiopathogenetic of anomalous sexual preferences (Kolářský and Brichcín (2000a) in Weiss, 2017). The sexual motivation system is a

hierarchically organized system of human sexuality controlled by innate mechanisms. Part of this system responsible for sexual behavior is a communication process that is composed of sub-steps or sub-states. These sub-steps correspond to four phases of courtship hypothesis, i.e., the first phase consists of bonding and luring the potential sexual partner based on the criterium of attractivity. In the second phase glazing, smiling, looking, postures, gestures, or even a verbal communication dominate. These two phases are collectively referred to by the authors as proceptivity. Followed by the tactile interactions and eventually genital interaction, the acceptation phase is reached (Páv & Brichcín, 2019). Atypical sexual preference can be explained by an altered proceptive phase due to the wide range of processes present in decision-making regarding the potential sexual partner (Kolářský and Brichcín (2000a) in Weiss, 2017).

Kolářský and Madlafousek (1983) conducted a study in which they found that sexual arousal in healthy male population does not require only woman's erotic attunement, but also the ordinary sequence of phases. In other words, sexual arousal in healthy male population can decrease if proceptivity phase has been skipped. This finding is in correspondence with the aforementioned importance of synchronicity and smooth transition between phases in the courtship hypothesis (Weiss, 2017). On the contrary, if proceptivity phase has been skipped, the sexual arousal can increase in case of paraphilic coercive disorder. The order of phases thus makes stronger claim than the stimuli itself which was suggested already in their previous study (Kolářský & Madlafousek, 1977; Kolářský & Madlafousek, 1983).

1.3 Diagnostic Methods Used in Paraphilic Coercive Disorder

Considering how difficult it is to get to an agreement when it comes to the taxonomy and nosology of these disorders, it is no surprise that specificity, sensitivity, validity, and reliability of diagnostic methods in paraphilic disorders are dissatisfactory. Reliability is important since accurate diagnosis provides easier access to the relevant mental and medical health services and contributes to possible prevention measures (Craig & Bartels, 2021). It can be assumed that the diagnostic procedure is complicated by potential unwillingness to share information due to the seriousness of the enacted sexual violence. Thus, in both praxis and research, distinct psychodiagnostics methods are used to diagnose other characteristics traits comparable with general population i.e., personality characteristics and traits, task performance and motivation anomalies (e.g., Androvičová, 2012; Marshall & Kingston,

2018; Táborská, 2013; Weiss, 2017). Even though these indirect measures might be useful, they are not specific enough to accurately capture paraphilic coercive disorder. Therefore diagnosing paraphilic disorders using *only* these types of psychodiagnostics methods is not possible (Marshall & Kingston, 2018).

Anamnestic examination and questionnaires are important methods used in diagnostics of paraphilic coercive disorder. Anamnestic data serve as a great source of information regarding abnormalities in psychosexual development (Weiss, 2017). Among these, atypical manifestations in childhood, atypical behavior in childhood, hastened sexual development, occurrence of sexual dysfunctions, unstable or lacking close relationships, difficulties in partner relationships, lack of motivation for usual sexual activities, insufficient sexual empathy and behavior, partialist sexual orientation, occurrence and presence of paraphilic sexual fantasies, and history of sexual offences are typically being assessed (Páv & Brichcín, 2019; Perkins et al., 2020; Weiss, 2017). In paraphilic coercive disorder, the importance of other areas i.e., social adaptations and socialization, characteristics of personal development, cognitive characteristics, personality traits, violence history, somatic health, and other psychiatric disorders, syndromes and symptoms are indisputable. Weiss (2017) adds the importance of individual's abilities to detect risk situations and correspondingly their abilities to deal with these risk situations. Although many attempts have been made, questionnaires do not serve as a sufficient tool in diagnosing paraphilic disorders (Craig & Bartels, 2021). Another current attempt are so-called rating scales that might be useful in estimating the degree of paraphilia (Marshall & Kingston, 2018). Yet, the combination of anamnestic examination and questionnaires is still not sufficient for diagnosing paraphilic coercive disorder and therefore combination with more available methods is required (Páv & Brichcín, 2019). A good example is a combination with penile plethysmography where changes in sexual arousal are assessed, and with brain imaging techniques where changes in brain activation are examined.

Penile plethysmography, phallometry or PPG is a physiological laboratory method used in sexology for assessing sexual arousal via volumetric penile changes (Appelbaum, 2009; Perkins et al., 2020). Penile plethysmography (hereinafter referred to as PPG) assessment consists of presenting distinct sexual visual and/or auditive stimuli to an individual and the relative responses of the penis, i.e., changes in tumescence, which serve as outputs that are subsequently analyzed concerning different categories of stimuli (Perkins et al., 2020; Weiss, 2017). Through subsequent comparisons of responses to paraphilic and non-

paraphilic stimuli data regarding sexual preferences of the individual are then assessed (Weiss, 2017). In case of paraphilic coercive disorder, non-paraphilic stimuli such as depicted consent and usual sequences of sexual behavior are contrasted with paraphilic stimuli such as coercion and violence. According to study conducted by Harris et al. (2012), rapists share a sui generis phallometric pattern to depicted violence, and coercion detectable via PPG. In correspondence with the courtship disorder hypothesis, paraphilic coercive disorder rapists showed indifference to sexual consent in comparison with the control group. The absence of active consent is thus as important in explaining abnormal sexual preference as the detected sexual arousal when coercion and violence are depicted.

In paraphilic coercive disorder, the number of conducted studies regarding the brain imaging techniques is scarce. Within the last two decades, the focus was mainly on using magnetic resonance imaging (MRI) and functional magnetic resonance imaging (fMRI) simultaneously with PPG that substituted computed tomography (CT). Other methods such as diffusion tensor imaging (DTI), fractional anisotrophy (FA), single-photon emission tomography (SPECT), positron emission tomography (PET), electroencephalography (EEG), and magnetoelectroencephalography (MEG) can be found in literature regarding all paraphilias (e.g., Chen et al., 2016; Kirk-Provencher et al., 2020; Mokhber et al., 2021; Saleh & Berlin, 2004). In the Czech context a few studies using fMRI in paraphilic coercive disorder aggressors are being carried out (e.g., Androvičová et al., 2018; Androvičová et al., 2020). Other methods on cognition and paraphilic coercive disorder have been conducted through assessing and comparing cognitive functions of these individuals with control groups (e.g., Joyal et al., 2014; Langton & Marshall, 2001; Rodriguez et al., 2017) or with self-reported paraphilic interests (Longpré et al., 2022). More detailed findings are discussed in the third and fourth chapter. To conclude, a combination of available methods is currently the optimal way in both prevention, diagnostics, treatment, and research of paraphilic coercive disorder.

2. Etiology of Sexual Excitation in Human Sexual Behavior

2.1 Excitation as Cognitive Component of Sexual Arousal

Understanding cognitive functions responsible for sexual arousal, sexual excitation, sexual inhibition, and other relevant sexual behavior is of great importance. Cognitive and neurobiological models together with hypothesis help to expand the knowledge about

paraphilic coercive disorder and its etiology. Joyal's (2014) meta-analysis and literature review of twenty-three studies showed that sex offenders score lower in overall cognitive performance than general population. Similar result was found when sex offenders were compared to non-sex offenders. Interestingly, sex offenders against adults scored higher than child molesters. Similarly, impaired capacity in self-regulation, planning, judgment, and inhibition was found in a sample of fifteen sex offenders serving sentences for rape (Rodriguez et al., 2017).

Among other cognitive function, functions of sexual excitation and sexual inhibition are being discussed as potential factors (Phenix & Hoberman, 2015). The term *arousal* is in APA dictionary (APA, 2023) defined as "a state of physiological activation or cortical responsiveness, associated with sensory stimulation and activation of fibers from the reticular activating system". Previously, sexual arousal was studied primarily concerning sexual excitation, i.e., sexual arousal is either activated by relevant excitatory stimuli or is not activated (Janssen & Bancroft, 2007). Inhibition is in APA dictionary (2023) defined as "the process of restraining one's impulse or behavior, either consciously or unconsciously, due to the factors such as lack of confidence, fear of consequences, or moral qualms". Phenix and Hoberman (2015) equate inhibition with self-control, thus being the opposite of disinhibition – absent or reduced capacity to manage one's urges, wishes and wants, which may lead to an activity under influence of desires and arousal. The sexual excitation, and sexual inhibition thus form two mechanisms with different characteristics and different areas of interest. Sexual excitation is not simply the opposite of inhibition or the lack of inhibition. Historically, sexual excitation was believed to arise through sexual drive, desire or urge similarly to the other basic needs. This model assumed the presence of a homeostatic function, which also led to its replacement by other models (Basson, 2015). The current discourse understands sexual arousal as having physiological (e.g., erection) and psychological (e.g., feeling aroused) factors (Calabrò et al., 2019). Basson (2015) compiled the human sexual response into a motivation/incentive-based cycle where two arousal forms are presented together with variable order of phases and its overlap. This model, however, presupposes normative functioning of sexual excitation and sexual inhibition mechanisms. In paraphilic coercive disorder, presumptions have been made regarding that disinhibited and/or hyperexcitable behavior believed to be partially responsible for preferential rape pattern (Holoyda, 2020). To observe such disinhibited and/or hyperexcitable behavior, the increased sexual excitation and/or the decreased sexual inhibition must be present, since

sexual excitation and sexual inhibition are not opposing mechanisms, and both are relevant in the case of sexual arousal (Ward et al., in Phenix & Hoberman, 2015). Therefore, the possible differences between the sexual arousal components in paraphilic coercive disorder and normative sexuality must be addressed in order to understand the etiology of sexual excitation in paraphilic coercive disorder.

2.2 The Dual Control Model of Sexual Response

The dual control model works on the aforementioned assumption that both mechanisms, sexual excitation and sexual inhibition are important for sexual response. Previously, sexual excitation was given disproportionate emphasis but the intention with this model was to understand inhibition differently than simply a lack of excitation. Thus, in this model sexual inhibition is considered to be at a similar level as the role of sexual excitation (Janssen & Bancroft, 2007). The sexual response is then determined by the interaction of these processes (Knight et al., 2013). Whether or not sexual response happens is dependent on the balance between sexual excitation and sexual inhibition (Janssen & Bancroft, 2007). This neurophysiological system of sexual inhibition is responsible for suppression of the sexual response. Sexual excitation is then important in the sexual responsivity, in case that the neurophysiological system of sexual inhibition is not being activated. The equal importance of both systems has been illustrated by further studies. According to these, the suppression of sexual response can be activated in several ways. First, there are patterns of reciprocal activation where sexual excitation causes a sexual response that is in turn suppressed. Second, there are patterns of uncoupled activation where it can appear as an active suppression activated by some stimuli. Third, there are patterns of co-activation where it can appear as an independent process that then can result in sexual excitation (Janssen & Bancroft, 2007).

One of the main focuses of this model is the individual level of propensity towards sexual excitation and inhibition (Bancroft et al., 2009). This individual level of propensity is determined genetically but effected by learning together with other individual variabilities (Janssen & Bancroft, 2007). Individuals with above-average level of propensity towards excitation and/or below-average level of propensity towards inhibition more likely encounter various kinds of problematic and high-risk sexual behavior than individuals with normative levels of propensity. On the contrary, individuals with high propensity towards sexual inhibition more likely suffer from sexual dysfunction and show higher degrees of

vulnerability (Bancroft, 2010). The individual level of propensity might be influenced by personality characteristics (Phenix & Hoberman, 2015). For example, individuals with high propensity towards sexual excitation and low propensity towards sexual inhibition can become more sexually aroused when being in a bad mood. Interestingly, this phenomenon is reversed in individuals with normative sexuality. The influence of negative mood on sexual arousal is recognized more in men than in women as well as generally higher propensity towards sexual excitation and generally lower propensity towards sexual inhibition (Janssen & Bancroft, 2007). However, the disposition of sexual arousal lessens with age which is in correspondence with the age distribution of convicted individuals with paraphilic disorder (e.g., Dickey et al., 2002; Weiss, 2017). The higher propensity towards sexual excitation and lower propensity towards sexual inhibition seems to be characteristic in individuals with propensity towards hypersexuality and/or high-risk sexual behavior (Bancroft et al., 2009). Even though the two most significant high-risk sexual behaviors are sexually transmitted diseases and unintended pregnancy, similar mechanism can be presupposed in case of sexual offending behavior.

Resulting from research by Janssen et al. (2002) one type of sexual excitation and two types of sexual inhibition were recognized. The first type of sexual inhibition works on the assumption that certain sexual behavior is *inhibited due to threat of performance failure*. In this case, inhibition is more common in individuals who suffer from sexual dysfunction and/or show higher degrees of vulnerability. The second type is *inhibition due to the threat of performance consequences*. Given the dual control model, these three factors affect the resulting sexual response. In their study, Jansen and Bancroft (2007) found that individuals more prone to the first type of inhibition were more sexually responsive to depiction of consensual sexual activity than to depiction of coercive sexual activity, and those individuals less prone to the first type of inhibition were equally sexually responsive to depiction of coercive sexual activity and depiction of consensual sexual activity. In other words, the sexual excitation to coercive stimuli seems to be further supported by lack of inhibition. Similarly, Thornton's (2010) case illustration showed that lack of inhibition forms part of paraphilic coercive disorder. More importantly, Thornton argues for a specific erotic focus in paraphilic coercive disorder that triggers sexual excitation in these individuals. The sexual excitation in these studies is assessed by so-called rape index which is a ratio of volumetric penile changes measured by PPG to depiction of coercive sexual stimuli and consensual sexual stimuli. Studies of this kind contributed to the current classification (WHO, 2019).

By the nature of paraphilic coercive disorder, the presence of sexual arousal triggered by overcoming the victim's resistance is indisputable (see above). However, other explanations for the interaction between sexual excitation and sexual inhibition i.e., cognitive sexual inhibition, disinhibitors, and motivational sexual inhibition can be found in the literature (Rodriguez-Nieto et al., 2019).

2.3 The Failure of Inhibition Hypothesis

The failure of inhibition hypothesis is based on the idea that different factors exist that lead to the failure of inhibition control in sexual behavior. This hypothesis emphasizes the inability to suppress sexual arousal when overt disapproval is shown by the other person and the performance of the sexual act requires coercion and force (Knight et al., 2013). Thus, it is the inability to suppress sexual arousal rather than immense sexual excitation caused by coercion or violence per se that is at issue. This rationale of influential disinhibitors affecting sexual excitation is in correspondence with Knight's (2010) review which showed support for the lack of inhibition to coercive stimuli rather than presence of sexual arousal to coercive stimuli per se. A study by Molen et al. (2022) found factors that could serve as influential disinhibitors due to their enacting on paraphilic desires. The most general factors were a cluster of sexual self-control consisting of sexual excitation, sexual inhibition, and impulsivity. Other factors in play were perception of sexual consent, moral and interpersonal engagement, and empathy. In this study, the interconnectedness of aforementioned factors was tested. It found that an individual is more likely to act on the paraphilic interest if the level of sexual excitation and impulsivity is higher and the level of inhibition, moral engagement, and empathy is lower. In the case of paraphilic coercive disorder, the most significant factors were impulsivity, perception of sexual consent and moral disengagement. The latter seemingly contributes to reduced inhibition with the help of other cognitive distortions. Additionally, the higher impulsivity and the incorrect perception of sexual consent are mutually reinforcing which further strengthens the significance.

Although sexual excitation and sexual (dis)inhibition formed part of the statistically significant results, their effect was of minor significance (Molen et al 2022). Contrarily, higher sex drive was a significant predicting factor for paraphilic coercive disorder as well as for concordance of paraphilic coercive desire and acting on these desires (Seto et al., 2021). According to Chan (2022) lower self-control among sex offenders leads to being more impulsive, insensitive, short-sighted, and to physical, risky, and aggressive behavior.

Hoberman (2015) adds impulsivity, antisocial behavior, substance use, disinhibition, increased novelty-seeking, sensation seeking, hostility and aggression, and decreasing effect on executive functions and self-regulation. Chan (2022) further finds factors predicting paraphilic coercive disorder including the factors of self-control, perceived neighborhood disorganization, alcohol and drug use, risky sexual behavior, and social bonding. Surprisingly, the level of negative temperament was not statistically significant factor. One possible explanation for the heterogenous results may be the fuzzy definitions of the concepts offered by Hoberman (2015). Due to the strong overlap between the regions involving all of these concepts (i.e., self-control, self-regulation, inhibition, etc.) any empirical investigation will not sufficiently determine the factor involved. However, Chan (2022) sums up that low self-control has been recognized cross-culturally as present in individuals with paraphilic and offending behavior. Broadly speaking, the general factor of sexual self-control is undeniably of significance, nevertheless the imprecise definition of the concepts may be the cause of heterogenous results in studies addressing self-control, self-regulation, sexual excitation, sexual inhibition, sexual impulsivity, sexual disinhibitions, sexual drive etc.

As already mentioned, the study by Molen et al. (2022) found empathy, and moral engagement as noteworthy factors. In recognition of the fact that individuals who have sexually offended do not have the adequate skills in recognizing emotions, the aspect of empathy and moral engagement is of relevance (Kafka, 1997). Lalumière (2003) summarizes that rapists are generally negligent of other's feelings and preferences, and they evince other traits comparable with antisocial behavior. These characteristics are repeatedly found in individuals with paraphilic coercive disorder (Weiss, 2017). Other deficits in moral emotions are lack of guilt and remorse (Phenix & Hoberman, 2015). The lack of guilt is often linked to aforementioned cognitive distortion in moral disengagement (Molen et al., 2022). This claim is supported by the activation of brain areas responsible for mediation of sexual inhibition when performing moral judgements and guilt tasks (Basson, 2015). Individual's understanding of social situations can be further affected by alcohol and other substance (ab)use. Not only that alcohol changes the perception of circumstances, and is partly responsible for disinhibition mechanisms, but in some cases, may be consumed on purpose to be later used as an excuse for coercive sexual behavior and/or to accentuate sexual excitation and arousal (e.g., Craig & Bartels, 2021; Phenix & Hoberman, 2015).

Other confounding psychosocial factors (e.g., ADHD, personality traits, strains, …) can be found in the literature (e.g., Chan, 2022; Molen et al., 2022; Phenix & Hoberman, 2015). However, the disinhibiting factors alone cannot sufficiently explain the complexity of the various sexual responses to coercive stimuli and other sexual excitation parameters should be further analyzed.

2.4 Etiology of Sexual Excitation in Paraphilic Rape

As indicated in previous subchapters, sexual excitation is not an independent mechanism within an individual's sexual behavior. The etiology of sexual behavior is believed to be influenced by behavioral learning. Such behavioral learning applies to sexual fantasies as well as the enacted sexual behavior (Craig & Bartels, 2021). In extension the same logic may apply to sexual arousal and thus sexual excitation. For example, sexual arousal to fantasies about rape as well as sexual arousal to rape were found to be steady properties in paraphilic rape (Thornton, 2010). The sexual fantasies about rape may come into existence through traumatic experience in an early life resulting in psychological, emotional, and psychopathological problems that are not resolved efficiently due to lack of healthy coping mechanisms. The sexual fantasies about rape serve as an attempt of avoidance of the distressing psychological states and may be internalized (Maniglio, 2011). This internalization may result in "means to achieve intimacy, power, or control" which can become risk factor in sexual offending (Maniglio, 2012, p. 92). In other words, these internalized sexual fantasies may be sufficient for sexual arousal and for their enactment. Maniglio (2012) adds that the enactment of sexual fantasies i.e., sexual offense such as paraphilic rape may serve as another immature coping mechanism when avoiding distressing psychological states. Through a behavioral learning approach, i.e., through the repeated association of paraphilic sexual fantasies, and/or paraphilic sexual behavior with distress avoidance, this behavioral pattern is reinforced and normalized in one's sexual behavior. According to Stefanska et al. (2022), the sexual fantasies and sexual behavior are linked to problematic pornography consumption. The easy accessibility of pornography further contributes to the normalization of paraphilic sexual preference and the sexual excitation is thus less inhibited. The enactment of paraphilic sexual fantasies has been shown in a study with heterogenous group of sex offenders. Applying to all groups, the statistically significant similarity between the content of sexual fantasies and the acts committed was also found in paraphilic coercive rape (Woodworth et al., 2013).

The behavioral learning approach also further strengthens the sexual motivation (Phenix & Hoberman, 2015). The sexual motivation is believed to be driven by the reward system (Calabrò et al., 2019) or by two rewards systems and one pleasure system (Phenix & Hoberman, 2015). The reward system is dependent on behavioral learning such as conditioning and incentive sensitization. Hoberman (2015) likens the process of incentive sensitization to a similar behavioral learning which has been observed in addictions. More importantly, he adds that the impulse to act can be enhanced through cognitive awareness, desire, and temptations. The individual's propensity towards sexual excitation is thus linked to sexual motivation that is further affected by many contextual, personal, and behavioral learning processes. Factors include; self-control, self-regulation, impulsivity, sensation seeking, risk (sexual) behavior, ability to modulate temper, empathy and social emotions (e.g., Chan, 2022). Their effect is partly or fully linked to part of executive functions, i.e., effortful control. Effortful control consists, inter alia, of inhibition control, and perceptual sensitivity for pleasure (Phenix & Hoberman, 2015). In case of executive malfunctioning, the sexual excitation may be amplified by the lack of inhibition, disability to modulate tempers or impulses, or any other impaired self-control, and self-regulatory processes. According to Hoberman (2015), these executive and behavioral dysfunctions are often found in individuals with higher proneness to violent and delinquent behavior such as sexual offending. As Knight et al. (2013) summon up, the etiology of paraphilic rape is being nurtured by disinhibitors such as certain psychopathologies, psychopathic traits such as manipulation, callousness, egocentrism, and hypersexuality. Their interaction contributes to the paraphilic manifestations in both forms, i.e., paraphilic fantasies, and paraphilic behavior.

Heightened sexual excitation, and/or reduced inhibition is common in individuals with paraphilic coercive disorder, and individuals with hypersexuality (e.g., Janssen & Bancroft, 2007; Phenix & Hoberman, 2015). Thus, we can learn more about the etiology of sexual excitation in paraphilic coercive disorder by attending to the specifics of hypersexuality. In case of hypersexuality, sexual excitation may have the function of amplifying the motivational, emotional, and arousal components of sexual excitation (Phenix & Hoberman, 2015). This is a commonality with paraphilic coercive disorder, since all individuals with higher propensity towards sexual excitation and/or decreased propensity towards sexual inhibition tend to ruminate over sexually explicit content (Craig & Bartels, 2021). Another common property is the considerable influence executive malfunctioning in sexual

excitation and sexual inhibition (Phenix & Hoberman, 2015). Simply said, individuals with paraphilic coercive disorder and individuals with hypersexuality evince disinhibited and/or hyperexcitable behavior. Moreover, increased sexual arousal can debase all other self-control mechanisms discussed above.

Hypersexuality was considered as one of the potential factors inherent to rapists next to callousness, unemotionality, antisociality, and impulsivity. However, earlier analysis showed that these components are not specific enough in paraphilic coercive rape (Knight, 2010). Factors like those mentioned here, as well as those stated previously, also seem to be influencing sexual fantasies and sexual behavior (Knight et al., 2013). Another study found that hypersexuality, problematic pornography consumption, and personality traits mediate the linkage of traumatic experience in an early life and paraphilic sexual arousal (Longpré et al., 2022). Similarly, a literature review by Maniglio (2010) showed that traumatic experience in an early life together with paraphilic sexual fantasies, and sexual dysfunction were linked to sexual homicide. Considering the similarities between paraphilic coercive disorder and sexual homicide, the development mechanism of paraphilic coercive disorder may be of similar origin. Lastly, increased sexual arousal can be linked to the heterogeneity of sexual partners that is common in both, paraphilic coercive disorder, and hypersexuality (e.g., Bőthe et al., 2018; Craig & Bartels, 2021; Phenix & Hoberman, 2015). The heterogeneity may result partly from novelty seeking and may contribute to the higher propensity towards sexual excitation (Phenix & Hoberman, 2015). Importantly, the prevalence of hypersexuality traits in paraphilic coercive disorder is undiscovered (Kafka & Hennen, 2003). Therefore, the question whether hypersexuality and paraphilic coercive disorder only share similar properties, share similar base, cooccur, or are prevalent comorbidity, remains unanswered. To summarize, the etiology of sexual arousal seems to be influenced by both heritability, and other socializing factors such as behavioral learning approaches (Phenix & Hoberman, 2015).

3. Sexual Excitation and Brain Structures

Knowledge about normophilic sexuality and its underlying mechanisms is necessary for understanding any aberrations, and abnormalities that may be manifested via paraphilic sexuality (Calabrò et al., 2019). Sexual behavior is a complex behavior mediated by various brain areas and corresponding systems. Calabro et al. (2019) understands sexual behavior as a pleasure-seeking impulse mediated by contextually and culturally dependent cues. Basson (2015) describes similar elements of normophilic sexual response. First, the sexual response ensues after an adequate sexual stimulation. Second, the adequate sexual stimulation comes along in an appropriate sexual context (e.g., privacy, mood, freedom from any pain). Third, adequate motivation and attention are needed for the activation of sexual response. Fourth, the behavioral response requires activation of sexual arousal and sexual desire. Here a problem should be noted. In the scientific literature, these two processes are often interchanged, but it is important to clearly distinguish them as different albeit closely connected components (Pfaus, 2009). If not clearly distinguished, confusion can complicate our understanding of the linkages between sexual arousal as a function and respective brain structures and systems.

As stated in the second chapter, sexual arousal may have both physiological manifestations (e.g., central response, peripheral response, penile response) and psychological manifestations (e.g., subjective feeling of being aroused) (Calabrò et al., 2019). On the other hand, sexual desire is a conscious process of experiencing appetite for sex (psychological) where motivational processes are accompanied by physiological changes (Bancroft, 2010). Sexual desire is manifested through behavior (e.g., solicitation, courtship, choice between stimuli) (Pfaus, 2009). To better gain an overview several conceptual tools have been developed clarifying sexual response components such as desire and arousal. Pfaus (2009), for example, extended the dual control model into so-called *Sexual Tipping Point model* where the component of sexual desire, orgasm, and resolution response complement the original interaction of sexual excitation and sexual inhibition. Furthermore, reward is introduced as an especially important component and both processes of desire and arousal are associated with reward. On the one hand sexual arousal triggers the motivation necessary for the initiation of sexual behavior. This motivation is reward and pleasure driven. On the other hand sexual desire uses reward as one of few markers that will evaluate the incentive value of sexual stimuli (Bancroft, 2010). Thus, sexual desire can be

launched when individual is anticipating sexual reward. As a response to the reward anticipation, sexual excitation or sexual disinhibition may trigger sexual arousal and lead to sexual behavior (Pfaus, 2009). This interconnectedness of sexual arousal and sexual desire processes may be one reason why the sexual arousal and sexual desire tend to be confused or insufficiently distinguished. Generally speaking, both manifestations of sexual arousal i.e., physiological and psychological are not activated via single brain area nor few isolated structures, rather an extensive neuronal network is of importance (Mokhber et al., 2021).

Another model, called The Four Component model, suggests that sexual arousal stem from four-component types. These components are cognitive containing attention and appraisal, emotional working with hedonic quality, motivational assessing overt sexual behavior, and autonomic-physiological one. This model originates from brain neuroimaging that also showed the distinct brain areas of the four components of sexual arousal (Basson, 2015). Jordan et al. (2011) created a summary graphic showing the four components linked to brain structures and the systems involved together with the influence of testosterone. However, more areas than those in Jordan et al. (2011) were reported, therefore, a summary graphic, Figure 1, containing the available brain areas linked to the four component was created for the purpose of this thesis. This Figure 1 was inspired by the mentioned summary graphic by Jordan et al. (2011) and is for illustrative and summarizing purposes only. Figure 1 can be seen below as well as rationale for included areas, along with the sources and details provided.

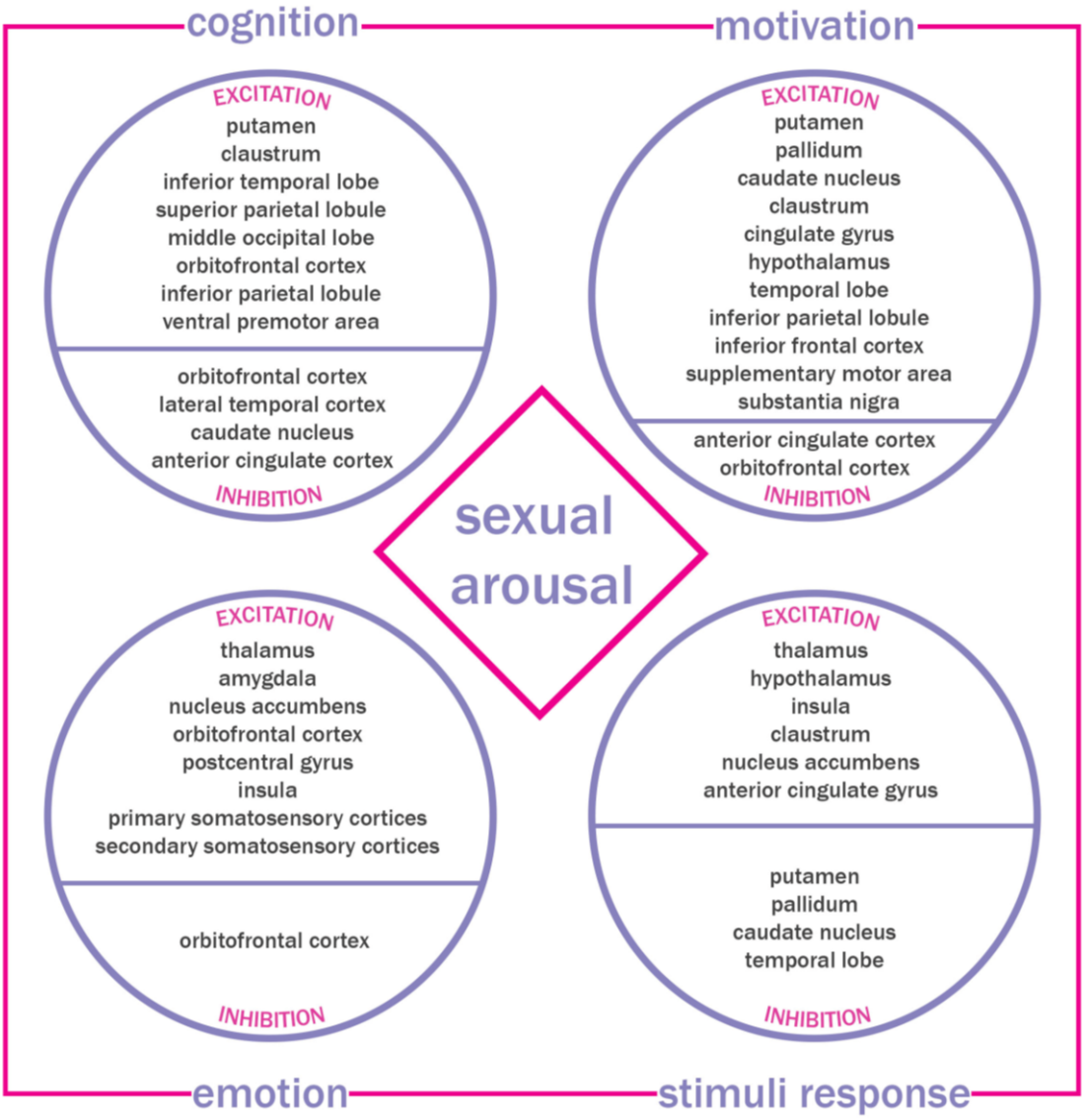

Figure 1 - Sexual Arousal Components (own picture)

From the presented overview, the diversity of areas involved is evident. The cognition component is responsible for appraisal of potential erotic stimuli where focused attention is necessary. Furthermore, the cognition component is responsible for motor imagery relevant for sexual behavior (Basson, 2015). This process is linked to areas of temporal lobe as well as to orbitofrontal cortex, its function is beside other things inhibiting sexual excitation in case of disadvantageous stimuli (Rodriguez-Nieto et al., 2019). Inversely, Mokhber et al. (2021) concluded that temporal and parietal areas effect cognition and motivation components of sexual arousal via their deactivation. This deactivation stems from the activation of putamen and claustrum during sexual arousal. Moreover, a wide-range of function dependent on orbitofrontal cortex are listed in Fabian (2012). Namely, mood

regulation, impulsivity, aggression, empathy, reward learning, goal-directed behavior, social inhibition, and behavioral control were mentioned. The orbitofrontal cortex is closely connected to limbic system. Thus, this area is linked to both processes, sexual excitation, and sexual inhibition in almost all components. The autonomic component is responsible for physiological reactions leading to readiness to relevant sexual behavior. Anterior cingulate cortex connects limbic system areas with areas known for cognition (Basson, 2015). Similarly, thalamus acts as a relay center that is active during the process of sexual arousal, sexual desire, and orgasm. Moreover, thalamus is responsible for processing the stimuli according to one's sexual preference that are further transferred to complex behavior via temporal lobes (Calabrò et al., 2019). Importantly, disinhibition of thalamus that can be caused by various preceding processes is the origin of rising excitation (Gazzaniga et al., 2019). Sexual desire process best corresponds to the activity of the areas falling under the component of motivation. This component involves areas, such as pallidum, putamen, caudate nucleus, or cingulate gyrus that stimulate goal-directed behavior. Lastly, the emotional component is without surprise connected to limbic system, specifically to nucleus accumbens, amygdala, and thalamus (see above). These areas are responsible for feelings of pleasure, mental excitement, and penile response awareness (Basson, 2015). Nucleus accumbens, amygdala, hypothalamus, orbitofrontal cortex, anterior cingulate cortex, and the superior parietal lobule were found to be components of so-called sexual interest network. In other words, these areas are responsible for detection of relevant sexual stimuli and mediating behavior towards the stimuli (Fabian, 2012).

The relevance of sexual stimuli relies on many underlying mechanisms and factors. One of them is the hedonic value, or the reward. This process requires a system known as the reward system, which activates relevant areas for reward when a rewarding stimulus is present. The reward system is responsible for stimuli response (e.g., autonomic response), emotional components (e.g., emotional processing), and motivational components (e.g., motivational states) (Calabrò et al., 2019). The neural mechanism of the reward system is common to different kinds of rewarding stimuli, i.e., the same or similar mechanism of action applies to food, drugs, or sex. However, many distinct areas contribute to this complex mechanism. For example, the prefrontal cortex has many different areas and systems which contribute to the reward mechanism. Similarly, subcortical limbic system areas, such as amygdala, nucleus accumbens, or pallidum are being activated (Berridge & Kringelbach, 2015). The amygdala processes emotional significance of sexual stimuli and subsequently

regulates sexual drive. The reward system together with amygdala and thalamus account for mate choice using both autonomic and cognitive cues. The amygdaloid complex cooperates with nucleus accumbens and hypothalamus through which the sexual responsivity is regulated (Calabrò et al., 2019). For example, hypothalamus, amygdala, and hippocampus contributes to the process of visual stimuli processing. In a correlations study, amygdala and hypothalamus activation was measured simultaneously with penile response to adequate sexual stimuli (Ferretti et al., 2005). Similarly, left caudate nucleus and putamen, insula region including the claustrum, and anterior cingulate cortex were found active during penile tumescence activation in a study of with fourteen normophilic healthy male (Arnow et al., 2002). The putamen is also involved in autonomic response regulation (Basson, 2015). The linkage between sexual excitation and the limbic system is also easily observed from the penile response and hypothalamic and limbic pathways activation (Calabrò et al., 2019). Lastly, nucleus accumbens was found as a key component in measuring neural responses to sexual stimuli. In this study, link between nucleus accumbens reward processing function and sexual excitation was undeniable (Safron et al., 2020). Thus, many different limbic system areas are involved in sexual arousal. It is important to note here, that any exhaustive list of limbic system areas has not been established, and further parts and subparts of limbic system relevant in sexual response mechanism can be found in the literature (Rajmohan & Mohandas, 2007).

The limbic system areas are particularly important within the mesolimbic dopamine pathway. The mesolimbic dopamine pathway is highly responsible for reward-seeking behavior and is notoriously known for being the origin of addictions of all kinds. This pathway is comprised of dopamine neurons that are mainly produced and released by ventral tegmental area (VTA) to limbic system structures such as amygdala, hippocampus, nucleus accumbens, and other mostly cortical and prefrontal cortex areas (Lewis et al., 2021). The dopamine release is regulated by other neurotransmitters and is followed by rewarding feeling (Blum et al., 2012). Due to the dopaminergic mesolimbic pathway, dopamine is believed to have major role in sexual motivation (Calabrò et al., 2019). This excitatory pathway relies on anticipation of sexual reward, and hormonal participation. Sexual excitation can be triggered by level of hormones as well as by stimulating external factors. Sexual excitation is thus activated by various hormones affecting dopamine, noradrenalin, melanocortin, and oxytocin systems. All these neurochemical systems distributed around limbic system contribute to sexual arousal regulation and attention regulation. Through

connection with hypothalamus, behavior is guided towards relevant sexual stimuli (Pfaus, 2009). Particularly, the mesolimbic dopamine system is stimulated by testosterone during process of sexual excitation. Testosterone falls under the category of sex hormones also known as androgens (Kafka, 1997). Jordan et al. (2011) assessed the role of testosterone with respect to the four component model. They found out that testosterone is to some degree modulating all the four components. However, the effect and level of testosterone concentration varies, thus unidirectional action of testosterone cannot be assumed. For example, sexual excitation is connected to dopamine systems as well as melanocortin, oxytocin, and norepinephrine system. Results showed that testosterone regulates dopamine and serotonin system, and that both dopamine and serotonin systems contribute greatly to the processes of sexual excitation and sexual inhibition. Testosterone thus participates in processes of sexual excitation and sexual inhibition. According to Pfaus (2009), sexual excitation and sexual inhibition can be similarly influenced by opioids.

Another influential neurotransmitter within the process of sexual arousal is serotonin. Serotonin is relevant to various brain system with various classes of receptors. Limbic system and serotonin are closely connected (Jordan et al., 2011). To specify, negative correlation was found between sexual arousal and the level of serotonin. This is in correspondence with the dopamine mesolimbic pathway's function. The level of released dopamine negatively correlates with the level of serotonin at that moment (Appelbaum, 2009). At the central level, dopaminergic and serotonergic systems appear to play a significant role in various factors of sexual response, although adrenergic, cholinergic, and other neuropeptide transmitter systems may contribute as well. Glutamate and GABA effect interaction between sexual excitation and sexual inhibition (Gazzaniga, et al., 2019; Poeppel et al., 2020). Important neuromodulators of sexual behavior are monoamines (Appelbaum, 2009). Their function is regulation of various states and behaviors such as focused attention, goal-oriented behavior, motor behavior, affective and physiological states, and appetitive states such as sleep, sex or appetite (Kafka, 1997).

Many of the described neurochemical processes contributes to the sexual excitation via blocking necessary inhibitory mechanisms when experiencing an orgasm or sexual reward (Pfaus, 2009). This is correspondence with the hyperexcitable behavior claim, i.e., disinhibited and/or hyperexcitable behavior can be caused either by increased propensity towards sexual excitation, or decreased propensity towards sexual inhibition, or by both. Basson (2015) summarizes three potential disinhibition processes relevant to sexual arousal

with the corresponding brain correlates. Firstly, orbitofrontal cortex plays major part within the first component of inhibition process. Impairment of this area, specifically gyrus rectus, evolve in higher propensity towards sexual excitation and other rewarding activities. Secondly, caudate nucleus, and putamen, regulate the sexual excitation after and during its initiation. Similarly, impairment in these areas were found in individuals with hypersexuality. Lastly, orbitofrontal cortex regulation of sexual stimuli is of relevance to both sexual arousal and moral decision-making. According to Bancroft, the anatomical brain areas involved in inhibition seem to be dispersed more than the areas relevant for sexual excitation (Bancroft, 2010).

To conclude, sexual arousal is regulated by subcortical structures. There, the limbic system together with relevant neurotransmitters pathways and cortical cortex brain areas (such as prefrontal cortex and relevant axis and pathways) are of great importance. Sexual response's complexity and versatility are thus conditioned by the interplay of various brain systems and processes.

4. Sexual Excitation and Structural Brain Characteristics in Paraphilic Coercive Disorder

Aforementioned brain structures, brain systems and related processes may suffer from diverse aberrations that can be found in individuals with paraphilic coercive disorder (Mokros, 2018). These aberrations may display in various forms and may lead to distinct paraphilic disorders. The exact same or very similar aberrations may lead to distinct mental, behavioral, or neurodevelopmental disorders different than paraphilic disorders. Furthermore, these disorders may stem from different aberrations (Joyal et al., 2014). This raises some questions useful for our discussion: Are cognitive impairments in sex offenders specific or generalized? Thus, is it possible to find distinct cognitive profiles among various paraphilic disorders? If so, how can we recognize paraphilic coercive disorder from other paraphilic disorders? If not, what are the commonalities and what are the differences between various paraphilic disorders? Similarly, Fabian (2012) starts one of his studies by posing important questions:

For example, do rapists, pedophiles, and exhibitionists all suffer from similar rates of structural brain/neurological impairment? How do these functional and structural abnormalities lead to the offender's sexual deviance? In what way do these biological risk factors integrate with other psychosocial risk factors that predispose a person to commit sexual offenses? Do these structural and functional abnormalities lead some sex offenders to lack such inhibition and be overpowered by heightened sexual drive that they are unable and/or unwilling to avoid committing aberrant sex offenses?..." (Fabian, 2012, p. 3).

All questions raise substantial conceptual, methodological, and statistical suggestions that ought to be explored further. One example of approaching these questions is Joyal's et al. (2014) review analysis that contributed immensely to the discussion regarding cognitive profiles of paraphilias. 23 studies including over 1700 participants were assessed. It could be concluded that higher neuropsychological impairment was found in sex offenders as one group. Sex offenders thus show undeniable decrease in social and cognition skill in comparison with the normophilic population. However, only few differences between subgroups of sex offenders were found. Sex offenders against adults scored generally higher than sex offenders against children but lower than non-sex offenders. Thus, the heterogenous cognitive profiles of different paraphilic disorders were not determined due to the various limitations affecting the conducted research. Another study addressing these questions is

offered by Saleh and Berlin (2004) whose research results suggest that some neurological basis for paraphilic disorder may be existing phenomenon. Similarly, comprehensive research has been done by Mokhber et al. (2021) to clarify neuroimaging findings regarding paraphilic disorders. Their findings supported the existence of neuroanatomical network of paraphilic disorders. However, majority of participants involved were diagnosed with pedophilic disorder or coercive sexual sadism disorder only. Individuals with pedophilic disorder manifest greater impairment than individuals with paraphilic coercive disorder (Fabian, 2012; Langevin & Curnoe, 2008). Moreover, neuropsychological impairments in pedophilic disorder appear to be more heterogenous and serious, with more severe deficits in social cognition also being exhibited (Joyal et al., 2014). Authors therefore suggest that the neurodevelopmental basis of paraphilic disorders should be further assessed with help of neuroimaging methods. Moreover, authors consider it important to assess individuals with a suspected diagnosis of paraphilic disorder primarily and immediately with imaging techniques (Mokhber et al., 2021). Similarly, Fabian (2012) and Saleh (2004) believe that sex offenders with known neurological disorders, traumatic brain injuries and impairment should at least undergo neuropsychological assessment. Ideally, this assessment would be completed by brain imaging techniques.

On the other hand, the specificity of the neuronal network is complicated by several other factors operating in humans. Sexual violent behavior is influenced by genetics, intrinsic drive states, motivation, temperament and other personality traits as well as environmental factors (Saleh & Berlin, 2004). Despite the fact that all of the above-mentioned questions are linked to the topic of paraphilic disorders, it is the question whether structural abnormalities lead to lack of inhibition and/or heightened excitation which is relevant for current purposes. Explaining the sexual arousal mechanism in individuals with paraphilic coercive disorder may be one of key components regarding the etiology of paraphilic coercive disorder.

It is noteworthy to repeat that majority of individuals convicted of sexual offenses cannot be diagnosed by paraphilic disorder and only in very small percentage of these individuals were some brain aberration found (Mokros, 2018). As stated in the first chapter, majority of individuals convicted of sexual offenses may be diagnosed with other mental, behavioral, or neurodevelopmental disorder (Weiss, 2017). However, the presence of paraphilic disorder or paraphilia is considered among primary risk factors regarding repetitive sexual offences (Lewin & Træen, 2008). Mokros (2018) claims that it is difficult

to prove whether paraphilic preference stems from brain aberrations gained throughout the prenatal, perinatal, and/or neonatal or later developmental phase, whether the brain aberrations work as a response to paraphilic preference, or whether they cooccur. According to Saleh & Berlin (2004), available data are in favor of some genetic predisposition regarding paraphilia but the current evidence for this is not clear-cut. Mokros (2018) adds that among many, impulsivity and decreased inhibition is of relevance. The author attempts to apply an original theory proposed by Barbaree and Marshall (for more see Barbaree & Marshall, 1991). This theory suggests two main models for explaining the underlying neural mechanisms of sexual offending. The first one, stimulus control model, suggests what is similar to higher propensity towards sexual excitation from the dual control model. i.e., sex offenders are easier aroused by sexual cues of paraphilic kind. According to the authors, this increase in sexual response is believed to be the results of conditioning. This mechanism is connected to temporal areas and limbic system. The second model, called the response control model, suggests decrease in sexual inhibition. Similarly, to the dual control model, the lower propensity towards sexual inhibition causes sexual response to inappropriate sexual cues. This decrease in sexual inhibition is linked to dysfunction in the frontal areas of the brain. However, various brain aberrations may be associated with paraphilic behavior (Mokros, 2018).

Even though sexual excitation is not mediated through frontal areas of the brain, some of them are relevant for sexual inhibition and therefore for sexual arousal. The trend in sex offenders seems in general to be injuries and impairments in frontal (e.g., prefrontal cortex, orbitofrontal cortex) and temporal lobes (Mokhber et al., 2021). For example, Fabian (2012) suggested that sexual offending is linked to cortical and subcortical brain structure, cingulate, frontal, and temporal lobe impairment, and aberration in prefrontal-striatal-thalamic circuits. Brain aberrations or injuries to the aforementioned brain areas may lead to disinhibited behavior, hypersexuality, increased impulsivity, antisocial behavior, and decreased mate selectivity. If the aberration occurs within the temporal-limbic system, the intensity of sexual drive is affected together with the mate selectivity. A specific example is given by Appelbaum (2009) via a case study where a convicted rapist underwent PET measurement where significant frontal lobe aberration were found. However, these areas are interconnected and the findings suggesting specificity for paraphilic coercive disorder are scarce. Similarly, processes of reward anticipation as well as decreased empathy and sexual inhibition are believed to be linked to so-called striato-thalamo-cortical network model.

Based on this model, changes within this network are responsible for both normophilic sexual response as well as sexually violent behavior (Tost et al., 2004, in Mokros, 2018). Bancroft et al. (2009) conclude three components of sexual inhibitions that have emerged from research conducted by Redouté et al. (2005) on the brain's processing of visual sexual stimuli in treated and untreated hypogonadal patients (i.e., reduced production of testosterone). The propensity towards sexual inhibition is related to the areas of the temporal lobes, the caudate nucleus, the putamen, and the medial orbitofrontal cortex. More specifically, the neurological origin of inhibited sexual response results from the process of deactivation of the temporal lobes. These areas share connection with limbic system where the left orbitofrontal cortex plays role in sexual inhibition regulation (Basson, 2015). More specifically as Bancroft et al. (2009) noted, the neurological origin of inhibited sexual response results from the process of deactivation of the temporal lobes. As explained above, the deactivation of temporal lobes stems from the activation of caudate nucleus and putamen. In other words, caudate nucleus and putamen are responsible for mediating and/or decreasing sexual excitation. Consistent findings are presented in Basson (2015) where lesions in caudate nucleus were related to hypersexuality. Lesions to subcortical structures such as thalamus, hypothalamus, caudate nucleus, putamen, pallidum, hippocampus, and septum are linked to paraphilic behavior as well as hypersexuality (Longpré et al., 2022). Also, compulsive sexual behaviors may be linked to increased volume of limbic system structures (Schmidt et al., 2017). Bancroft et al. (2009) also claims that the lack of deactivation of the medial orbitofrontal cortex causes low sexual desire. In the case of hypersexuality and sexually violent behavior, the overactivation of the medial orbitofrontal cortex might be the trigger. Inhibition on the neurobiological level thus prevents ending up in a dangerous or unfavorable sexual activity. Interestingly, activation of these areas seems to be necessary for moral decision-making and tasks requiring social emotions such as guilt or embarrassment. Lastly, an oral presentation was carried out by Longpré, Knight, and Guay (in Longpré et al., 2022) where results regarding sexually coercive behavior tended to correlate with overactivation in limbic system, more specifically in amygdala together with decreased activation in frontal areas. Interestingly, this correlation was mediated by psychopathic traits and hypersexuality. Similar findings were found in a study where hypersexuality, problematic pornography consumption, and personality traits mediated the linkage between childhood traumatic experience and paraphilic sexual arousal (Longpré et al., 2022).

Lesions in amygdala are linked to general as well as sexually violent behavior (Appelbaum, 2009). Overactivation or impairment during development of amygdala has been also inked to deteriorated willful and volitional behavior (Fabian, 2012). Impairments in limbic system are related to intense sexual desire that is hardly regulated by will. Specifically, impairments in brain circuits within limbic system were linked to worsened impulse control and aggression. More importantly, summarized data are in favor of connection between aberrations in orbitofrontal cortex and nucleus accumbens and affected functions of moral judgment, motivation, sensitivity towards rewarding stimuli, impulse control but also hypersexuality, aggression, and sexually violent behavior. Importantly, similar connections can be find in individuals manifesting antisocial behavior, nonsexual violence, or suffering from ADHD (Fabian, 2012).

Another relevant connection concerns temporal horn dilation and frontal-temporal regions impairment. Summary of studies from the previous century showed impairments and abnormalities in temporal lobes (e.g., dilatation of the temporal horns in left hemisphere), as well as abnormal release of sexual arousal connected to head and brain injuries affecting limbic system (Appelbaum, 2009). Similarly, impairments in frontal and temporal lobe areas were reported by Fabian (2012) such as temporal horn dilation, decreased blood flow and volumetry within these areas. These changes results in insufficient blood flow to limbic system and may be the cause of sexually coercive behavior (Basson, 2015). Moreover, neural impairments in temporal lobes and limbic system can be intensified via certain disinhibitors such as alcohol, other drugs or the lack of compassion or other social emotions resulting in increased sexual arousal, insufficient inhibition, or both (Covell & Scalora, 2002; Langevin & Curnoe, 2008). This general disinhibited behavior was found in older adults who were first time sex offenders through significantly lower scores in response inhibition measured via Hayling test. Authors presented strong similarities between sex offenders and patients with frontotemporal dementia (Rodriguez et al., 2017). Similar results were observed in a case study of young male who kidnapped and raped a young woman. Beside other anamnestic abnormalities and potential confounding influences, atrophy in the left medial temporal lobe, increased activation in frontal areas and amygdala were discovered together with relevant head injury, and alcohol and cocaine abuse (Husted et al., 2008). Basson (2015) claims that any sexual behavior involving risky behavior, harm or other stressful situation is, in normophilic sexuality, considered as disadvantageous. On the contrary, individuals

with higher propensity towards sexual excitation can experience increased arousal if some amount of inconvenience, risk, or other stress factor is necessary.

Volumetric abnormalities were found in a sample of male rapists where the abnormal white matter integrity was examined. Specifically, increases in fractional anisotropy (FA) were found in two regions. The first one is responsible for moral judgment and consists of white matter around the angular gyrus, caudate nucleus, and frontal pole. Aberration in these areas is also connected to obsessive thoughts. The second region, whose increased activity significantly adds to sexual arousal, covers the main areas of reward system regions e.g., pallidum, thalamus. Conversely, reduction of FA was present in the area responsible for conditioning, and fear conditioning, i.e., the upper part of the limbic lobe, and in the inferior fronto-occipital fasciculus whose function is besides other things processing of visual stimuli. Not surprisingly, individuals with these white matter abnormalities may labor under the misapprehension that the given context is of sexual valence. Distorted moral judgment, increased sexual excitation, higher sensitivity towards rewarding stimuli, decreased process of fear conditioning together with social misinterpretations and obsessiveness all contribute to potential sexually violent behavior (Chen et al., 2016). This is in correspondence with previously mentioned findings suggesting that characteristic misbehavior in rapists may origin from difference in social emotions such as empathy, lack of guilt, lack of remorse, i.e., in general in moral decision-making. Chen et al. (2016) offer an interpretation of their results in connection with higher propensity towards sexual excitation, reward sensitivity, fear conditioning, and inaccurate social emotions regulation. It is important to mention that their sample consisted of people incarcerated for rape against an adult female stranger. However, similar results can be expected in case of individuals diagnosed with paraphilic coercive disorder considering similar results were found in other sexual and non-sex offenders. Albeit volumetric brain differences were found in individuals with paraphilic disorder, this cannot be used as a marker for functional capabilities. In other words, the volumetric brain differences are not a unique marker for individuals who perform their sexuality in a coercive manner. In their summary, Kirk-Provencher et al. (2020) suggest that usage of neuroimaging methods in paraphilic disorders assessment has not been carried out enough to bring clearcut findings. However, it is a fruitful method of understanding the etiology of paraphilic disorders in general and, ideally, one by one.

Moreover, various sources suggested that a history of a brain damage, neurodevelopmental abnormalities, substance abuse, endocrine disorders, low intelligence,

learning disabilities can often be find among individuals with paraphilic disorder (Fabian, 2012; Langevin & Curnoe, 2008). Indisputable cooccurrence of sexually violent behavior and substance abuse has been mentioned more than once. Especially, alcohol abuse is linked to not only sexually violent behavior per se but also to what it precedes (Kafka, 1997). It is important to state here, that brain injuries of respective areas may be both a trigger to a predisposition for paraphilic disorder or a significant causative factor. Langevin (in Appelbaum, 2009) offers a typical profile of an individual suffering from paraphilic disorder. Typically, an average intelligence or low average intelligence is present, often accompanied by learning disabilities and general neuropsychological deficits such as aberration or other deterioration of executive functions. This can be linked to previous head and traumatic brain injuries, alcohol, and drugs abuse. However, confounding variables of substance abuse and low intelligence may affect the assessment process and lead to misapprehension (Fabian, 2012).

As stated above, different neurotransmitters mechanisms correlate with sexual excitation. Due to the dopaminergic mesolimbic pathway, dopamine is believed to have major role in sexual motivation. Higher increases of dopamine were found in individuals with hypersexuality (Calabrò et al., 2019). Considering the similarities between hypersexuality and paraphilic coercive disorder, the dopamine level may be of importance in both the etiology of higher propensity towards sexual excitation and the etiology of paraphilic coercive disorder. Kafka also suggested a so-called monoamine hypothesis, i.e., symptoms and/or manifestations inherent to paraphilic coercive disorder may be amplified by aberrations in central monoamines neurotransmitters. Knowing the effect of other neurotransmitters in human sexual response, some of the manifestations can be regulated via changes in serotonin, norepinephrine, and dopamine. More specifically, an increase of sexual arousal is correlated with decreased serotonin level and aberrations in dopamine levels. Any irregularities in the interplay between those neurotransmitters together with other neurohormones, and hormones are considered as the neurobiological contribution to sexually violent and paraphilic behavior (Appelbaum, 2009). However, Fedoroff (2009) claims, that for example serotonin and dopamine aberrations are present in vast number of other mental, behavioral, or neurodevelopmental diseases.

In summary, disinhibition, hypersexuality, limited mate selectivity, impulsivity, response regulation, impulse control regulation, and aggression are related to areas of frontal brain areas, striato-thalamo-cortical network, orbitofrontal cortex, temporal-limbic system,

limbic system areas such as amygdala, putamen, pallidum, caudate nucleus, and nucleus accumbens. The incidence of brain changes in the limbic system and areas related to the rewards circuits is not negligible. These findings suggest an association of sexual compulsion with hypertrophy in these structures that has been found in hypersexuality (Schmidt et al., 2017). However, problematic cooccurrence is threefold. First, these functions can be related to other brain areas, such as hypothalamus (Jordan et al., 2011). Second, these areas and their relevant changes may be find in different individuals whose sexuality is performed in a normophilic manner but who can suffer from other mental, behavioral, or neurodevelopmental disease. Typical example is ADHD (e.g., Chan, 2022; Molen et al., 2022; Phenix & Hoberman, 2015). Last, immense number of factors are at once part of confounding factors, risk factors, possible causes or accentuation, or, in case of alcohol, a way of excuse (e.g., Craig & Bartels, 2021; Phenix & Hoberman, 2015).

Empirical section

5. Research Objectives

The exact cause of paraphilic coercive disorder, as with other paraphilic disorders, remains unknown. The empirical part of this thesis attempts to contribute to this process through the use of the dual control model by Bancroft and Janssen's. Thus, the research project builds on this theory that assumes increased excitation, decreased inhibition or both in case of hyperexcitable behavior. In view of the links between hyperexcitable behavior and paraphilic coercive disorder, it is possible to infer a close link between increased excitation, decreased inhibition or both, and the development of paraphilic coercive disorder. Importantly, questions regarding specificity or generality of cognitive impairments, brain injuries etc., is of importance when assessing one distinct paraphilic disorder and its origin. Especially pertinent is the question: could structural and functional abnormalities cause increased excitation, decreased inhibition, or both with the consequence of enacted sexually violent behavior, thus committing sexual offenses of paraphilic kind? Although knowledge about the brain's characteristics in paraphilic disorders is still in its early stages, available results highlight the importance of using brain imaging techniques. Function of sexual arousal has its basis in various brain systems, however, a strong foundation can be found in the limbic system. In the view of the model of sexual arousal described in chapter 3 and considering the neuroscientific findings summarized in chapter 4, a connection of the function of sexual excitation with the limbic system and reward circuits can be postulated. Thus, this thesis's empirical section seeks to contribute to available knowledge regarding differences in brain volumetry between males diagnosed with paraphilic coercive disorder and healthy males. Therefore, MRI examination of selected limbic system structures was intended to potentially observe differences in size of selected limbic system structures between individuals diagnosed with paraphilic coercive disorder and healthy male controls. Considering normophilic sexuality in healthy male control individual, hypertrophied areas of the selected limbic system structures may be expected. That may further help answer the question regarding differences in sexual preference. In case of paraphilic sexual preference involving non-consensual individuals, threats, violence etc., link can be drawn between the hypertrophy of selected areas and manifestation of hyperexcitable behavior.

Following the research objectives regarding connectivity of limbic system and sexual arousal, namely functions of sexual excitation and sexual inhibition, the research questions are stated as follows:

Is it possible to observe differences in volume of selected limbic system structures between males diagnosed with paraphilic coercive disorder and healthy male controls?

Is it possible to find hypertrophied areas (greater volume) of the selected limbic system structures in individuals diagnosed with paraphilic coercive disorder versus healthy male controls?

Is it possible that the hypertrophy (greater volume) of limbic system structures in individuals diagnosed with paraphilic coercive disorder leads to increased sexual arousal (increased excitation, decreased inhibition, or both) and thus to sexual assaults/paraphilic sexual preference?

The goal of the empirical section is to provide relevant information for enhancing the understanding of sexual excitation in paraphilic coercive disorders through the use of functional magnetic resonance imaging. Specifically, the study assesses the hypertrophy of selected limbic system structures and its connection to increased sexual excitation using brain volumetric data from individuals diagnosed with paraphilic coercive disorder and healthy control individuals in a Czech sample. The possible difference in the size of selected limbic system structures between the two groups can be interpreted as hypertrophy of these regions in the group of individuals diagnosed with paraphilic coercive disorder, provided that the sizes of selected limbic system structures in the control group are both homogenous and smaller. Considering the complex involvement of limbic system structures in the process of sexual response, and sexual arousal, the difference between the sizes of just one structure may be relevant and may be reported.

To explore the research questions, following hypothesis were formulated.

H1: Volume of each selected limbic system structure differs significantly between the groups of individuals diagnosed with paraphilic coercive disorder and healthy male controls.

H2: Volume of each selected limbic system structure is significantly larger in the group of individuals diagnosed with paraphilic coercive disorder than in the group of healthy male controls.

6. Methods

6.1 Participants

The sample consisted of 54 male volunteers including 21 individuals diagnosed with paraphilic coercive disorder, more precisely with "*Other paraphilic disorder involving non-consenting individuals"* (WHO, 2019), and 33 healthy control men. Individuals in both groups were heterosexual and teleiophilic (sexual attraction to adults). All participants in the patient group had a history of hands-on sexual offending. Mean age of patients was 35 years (SD = 10.1) and mean age of controls was 39 years (SD = 9.05). Modal education in both groups was high school. All participants were Czech.

In total, 89 patients convicted of sexual offense were contacted, with 71 of them being out-patients who received postal mail. Of those, 14 letters were returner by the postal office, while 57 were successfully delivered. However, only 3 of the 57 patients responded. Thus, volunteers from among individuals diagnosed with paraphilic coercive disorder were in most cases recruited as in-patients by their senior doctors working at facilities that provide sexological treatment for convicted sex offenders. These in-patients were transported to National Institute of Mental Health were accompanied by medical personnel from their facilities during their transportation. For that, professional medical transportation services were used. The rest of volunteer from among individuals diagnosed with paraphilic coercive disorder were approached by sexologists in their sexological practices. These sexologists were thus informed about the research rationale and design as well as about practical information regarding participation of their patients. They were provided with contact information and informed consent. Moreover, they were informed about necessary information for the research such as time commitment, multiple contraindications, and other entry requirements. Among those, age between 18 and 40 years, right-handedness, absence of systemic and psychiatric disease, heterosexual gynephilic sexuality, and no medication influencing sexuality (the only exception is anti-androgen pharmacotherapy were listed. Based on these criteria, informed consent was then signed, and the research team was contacted for the next stages of the research procedure. In the next phases of the research project, communication between the volunteers from among individuals diagnosed with paraphilic coercive disorder and the volunteer coordinator and other stakeholders took place. Two more patients dropped out during the recruitment process. This group was eventually composed of 21 patients diagnosed by with F65.5/6/8/9 based on the diagnostic manual in

effect at the time. All these 21 patients were found guilty of physically engaging in a hands-on sexually aggressive behavior towards an adult female stranger.

Advertisements in print and electronic media were used to recruit volunteers from among individuals with normophilic preference. These individuals were later contacted via e-mail to ensure that they meet the entry criteria and were matched to the first group in age and education. Moreover, similar criteria as in the first group must have been met: age between 18 and 40 years, right-handedness, absence of systemic and psychiatric disease, heterosexual normophilic gynephilic sexuality, be sexually active, not suffering from any sexual difficulties according to an official medical diagnosis and no medication influencing sexuality. As stated above, standard conditions for MRI examination, i.e., no metal objects in their body, had to be met by all volunteers. In this group, there were no dropouts. All participants received a small monetary compensation for their participation.

6.2 Procedures

To begin with, the empirical part of this thesis processes data from a grant project called Decoding unusual sexual preferences: brain correlates and cognitive-behavioral aspects of romantic dyadic interaction in non/delinquent paraphilics with the principal investigator Prof. Petr Weiss. The grant number is 9-19812S and was funded by the Czech Science Foundation. Data collection took place in October and November 2019 at the National Institute of Mental Health (NIMH). i.e., at the master thesis supervisor's, Dr. Androvičová, workplace prior to the current research design. There, volumetric data were collected together with other physiological markers that were not of importance for this thesis. Relevant volumetric of selected regions of limbic system were collected by MR device Siemens 3 T.

The following data analysis was carried out with the help of a licensed copy of the MATLAB® software (matrix laboratory) for standard MRI data analysis (The MathWorks Inc.2022). Together with a licensed copy of SPSS 18.0 statistical software (IBM Corp., 2020), these tools were available at National Institute of Mental Health. The FreeSurfer image analysis suite was used for cortical and subcortical reconstruction and volumetry (e.g., Dale et al., 1999; Dale and Sereno, 1993; Fischl and Dale, 2000; Fischl et al., 2001; Han et al., 2006; Jovicich et al., 2006; Segonne et al., 2004, Reuter et al. 2010, Reuter et al. 2012, 2022). Volumetry and subcortical segmentation work on the assumption from so-called Aseg

Atlas. This atlas provides summary of probable locations of brain structures (Fischl et al., 2002). The FreeSurfer image analysis suite can be downloaded for free from the internet (Fischl, 2012).

For statistical analysis of the empirical data, the Mann-Whitney U test was used (Mann & Whitney, 1947). The rationale for choosing this test is described in more detail, along with a more detailed statistical analysis, in corresponding subchapter. Among other relevant methods, logistic regression could also be used as an alternative method, mainly because it has the least assumptions about the data and as a robust method, it would be suitable for small sample sizes with a binary independent variable. However, since the research aim is focused more on the relationship between the independent variables and the dependent variable, rather than on prediction and modelling the relationship itself, non-parametric Mann-Whitney U test was used (Mann & Whitney, 1947). An open-source statistics software JASP was used for the statistical data analysis (JASP Team, 2019).

6.3 Study Design

For the purposes of this thesis, MRI examination of limbic system structures in the aforementioned groups is further described. As already stated, two groups of volunteers were involved in this research. As stated above, volunteers from among individuals diagnosed with paraphilic coercive disorder were approached by their sexologists in their sexological practices where they signed the informed consent, and the research team scheduled their participation via e-mail with detailed descriptions of necessary information regarding practical information and information about the research itself. Moreover, instructions regarding contraindications and other entry requirements were stated in the e-mail correspondence as well. All volunteers were asked to refrain from drinking beverages containing alcohol and caffeine for 24 hours prior to their MRI examination. The same applied for any sexual activity. These requirements were carried out in order to diminish any effect caused by uncontrollable variables within the examination. All volunteers were given detailed information about the experimental procedures and data safety by the leader of the research team, my supervisor, Dr. Androvičová.

Volumetric data from limbic system structures were of interests in this study. More specifically, collected data consist of volumetry measured in mm^3 of caudate nucleus, putamen, pallidum, hippocampus, amygdala, nucleus accumbens, and thalamus. Even

though thalamus is not officially a component of the limbic system, it has important functions within sexual response and reward circuits and was therefore included in the final selection of relevant areas. Data were collected by MR device Siemens 3 T in approximately 60 minutes per person. To collect data, researchers used T1-weighted (T1W) 3D MPRAGE sequence (voxel size of 1 × 1 ×1mm, 224 sagittal slices, TE=4.63ms, TR= 2300ms, TI= 900ms, FA= 10°, TA= 5:30, FOV= 256mm). Data were then stored in a protected local server. After they were exported, they were pre-processed and computed by an experienced data analyst in the FreeSurfer software (e.g., Dale et al., 1999; Dale and Sereno, 1993; Fischl and Dale, 2000; Fischl et al., 2001; Han et al., 2006; Jovicich et al., 2006; Segonne et al., 2004, Reuter et al. 2010, Reuter et al. 2012, 2022).

Two trained MR technicians and members of the research team were present during the data collection. After the actual examination procedure, a psychologist carried out debriefing with volunteers from both groups at the MRI unit. If the volunteers did not have any further questions, the data collection was hereby deemed to be successfully completed. All volunteers were given the option to terminate their participation at any time of the procedure. In order to preserve anonymity, the collected data were stored on an external disk to which only selected personnel had access.

6.4 Research ethics

Considering specifics of paraphilic coercive disorder diagnosis, individuals diagnosed with paraphilic coercive disorder were approached by their sexologists that were informed about the necessary details of conducted research. In various sexological practices, volunteers from among individuals diagnosed with paraphilic coercive disorder were given information about the purpose of the study, the study procedure and other practical information regarding MRI. Moreover, information about contraindication for inclusion to the study for all its parts was provided prior to their consent. The informed consent was handed out in various sexological practices to volunteers from among individuals diagnosed with paraphilic coercive disorder. After signing the necessary documentation, volunteers from among individuals diagnosed with paraphilic coercive disorder were given further details and contact information together with the information about following communication with the project team. Project was approved by the ethics board of the National Institute of Mental Health (approval nr. 119/18). The relevant documents including approved version of informed consent can be obtained from the thesis supervisor. Individual-

level data were anonymized, and only approved personnel could access them. Psychological debriefing took place after each measuring procedure.

6.5 Data Analysis

The process of converting the data from the values obtained from the MRI measurements into volumetric values for each selected area for each research participant was handled by an experienced data analyst at the National Institute of Mental Health. Once the data were obtained in the form of volumetric values, statistical analysis was performed. The data were first converted and edited into the necessary format for relevant statistical software. Microsoft Excel was used for the conversion and editing of the data (Microsoft Corporation, 2018). Statistical data analysis was carried out in JASP (JASP Team, 2023), version 0.17.1.

Initially, volumetric data were collected for seven selected limbic system structures, namely, thalamus, caudate nucleus, putamen, pallidum, hippocampus, amygdala, and nucleus accumbens. Due to the nature of the measurements, the data were extracted in the form of values for the left and right part of the aforementioned structures, However, for the purposes of this research, a detailed distinction between the left and right parts of the selected limbic regions was not an essential aspect of the research. Similarly, the literature-review section was not aimed at describing the difference between the halves of the selected limbic system structures. Furthermore, with the increasing number of independent variables, the correction for multiple comparisons makes it harder to detect relationships, especially with a sample size this small. As such, for the subsequent statistical analysis of the extracted MRI examination data, the left and right regions were merged. To ensure that the left and right parts of each area can be indeed merged (i.e., summed up), correlations between left and right parts of selected limbic structures were calculated using the JASP software (JASP Team, 2023). The lowest Pearson correlation coefficient was 0,632 for pallidum and the highest was 0,938 for caudate, which supports the assumption that the volume between left and right parts is largely correlated, and the distinction between them is therefore unnecessary for the purpose of this study. For exact values of Pearson correlation coefficient see Table 1.

Secondly, normal distribution of the independent variables was tested via the Shapiro-Wilk test (Shapiro & Wilk, 1965). This test can detect possible outliers that would subsequently be eliminated from the analysis (Goss-Sampson, 2019). The Shapiro-Wilk test

revealed 4 structures with non-normal distribution (thalamus, caudate nucleus, hippocampus, amygdala). The exact values are attached through the Table 2 in the following chapter. Based on the statistically non-significant results of the Shapiro-Wilk test, the Mann Whitney U test was selected to compare volumetry between the two groups in case of thalamus, caudate nucleus, hippocampus, and amygdala, and independent samples t-test was used in case of putamen, pallidum, nucleus accumbens.

Even though there was no prior assumption of unequal variance within the data, to ensure that there is an equal variance between the two groups, Levene's test was used (Levene, 1960). In other words, statistical significance means that the null hypothesis is rejected, making it likely that the variances are unequal. It showed that the variances of the two groups are equal, rejecting the alternative hypothesis and thus satisfying the necessary assumption. The exact values are attached through the Table 3 in the following chapter.

To determine the difference of means between the two aforementioned groups, an independent samples t-test was meant to be used. Given the characteristics of the data, i.e., independent variable being nominal-binary variable, dependent variable being quantitative continuous variable, and the independency of the two tested groups from each other, an independent samples t-test (also known as Student's t-test) was selected for analysis. More specifically, statistical difference between the volumetry in each of the seven areas of the limbic system between individuals diagnosed with paraphilic coercive disorder and group of healthy male controls is thereby tested. However, the use of an independent samples t-test is conditional on fulfilling several assumptions about the data (Goss-Sampson, 2019). Firstly, it assumes the equality of variances of the two groups. Secondly, a normal distribution of the independent variables is required. Only three areas, putamen, pallidus, and nucleus accumbens, fulfilled these assumptions and were thus tested via the independent samples t-test.

Due to the failure to meet the assumption of a normal distribution in case of thalamus, caudate nucleus, hippocampus, and amygdala, the Mann-Whitney test, a non-parametric test suitable for non-normal data distribution that also tests the difference between two groups of within a continuous independent variable, was used for these four structures. The only assumption of this test is ordinality of the independent variables and independence of the groups, which are both met. Due to the nature of this test, it does not assume a normal distribution or homogeneity of variances (Goss-Sampson, 2019). The comparison was made

for each selected structure separately. Given the fact that this results in several independent comparisons, a Bonferroni correction to compensate for multiple comparisons was applied to reduce the chance of a false discovery. This correction adjusts the significance level for the number of comparisons performed, dividing the chosen significance level by the number of comparisons (Bitnun, 2009). The typical significance level for these types of studies $\alpha = 0{,}05$, was divided by the number of comparisons made, i.e., 7. Based on this calculation, the significance level was set at $\alpha = 0{,}007$.

7. Results

The data from a descriptive statistical analysis can be summarized as follows. Out of a total sample of 54 people (N=54), 21 individuals were diagnosed with paraphilic coercive disorder and 33 individuals were healthy male controls. The other descriptive statistics only relate to age and education, which are reported in the corresponding subchapter (see above).

For completeness of the results, Table 1 outlines correlations between the left and right parts of the selected limbic system structures. Pearson's correlation coefficient was used. The correlation matrix was created in Microsoft Excel (Microsoft Corporation, 2018).

Table 1

Correlation Matrix

Correlation Matrix								
Pearson Correlations								
		Left Thalamus	**Left Caudate**	**Left Putamen**	**Left Pallidum**	**Left Hippocampus**	**Left Amygdala**	**Left Accumbens**
Right Thalamus	Pearson's r	0.924						
	p-value	< .001						
Right Caudate	Pearson's r		0.938					
	p-value		< .001					
Right Putamen	Pearson's r			0.772				
	p-value			< .001				
Right Pallidum	Pearson's r				0.632			
	p-value				< .001			
Right Hippocampus	Pearson's r					0.933		
	p-value					< .001		
Right Amygdala	Pearson's r						0.806	
	p-value						< .001	
Right Accumbens	Pearson's r							0.700
	p-value							< .001

The results of the Shapiro-Wilk test with the exact p-values for each selected limbic system structure are presented in Table 2.

Table 2

Test of Normality (Shapiro-Wilk)

Test of Normality (Shapiro-Wilk)			
		W	**p**
Thalamus	C	0.645	< .001
	P	0.980	0.923
Caudate	C	0.870	< .001
	P	0.910	0.055
Putamen	C	0.975	0.626
	P	0.944	0.263
Pallidus	C	0.961	0.276
	P	0.976	0.857
Hippocampus	C	0.527	< .001
	P	0.983	0.963
Amygdala	C	0.695	< .001
	P	0.963	0.579
Accumbens	C	0.969	0.466
	P	0.944	0.266

Note. Significant results suggest a deviation from normality.

The following Table 3 shows the results of the test of equality of variances, Levene's test, with specific values for each selected limbic system structure.

Table 3

Test of Equality of Variances (Levene's)

Test of Equality of Variances (Levene's)			
	F	**df**	**p**
Thalamus	0.395	1	0.532
Caudate	0.073	1	0.788
Putamen	2.623	1	0.111
Pallidus	0.211	1	0.648
Hippocampus	0.045	1	0.832
Amygdala	0.368	1	0.547
Accumbens	0.277	1	0.601

Two tests were used to compare the volume of each selected limbic system structure between the two groups. The Mann-Whitney U test was selected for four structures, thalamus, caudate nucleus, hippocampus, and amygdala. The results for each structure are shown in Table 4 below. Three values are reported for each structure. The first is the Mann-Whitney W test statistics, followed by the p-value and finally, the Rank Biserial Correlation shows effect size. The Mann-Whitney test showed that volumetry of selected limbic system structures does not differ ($\alpha_{corr.} = 0.007$) between individuals diagnosed with paraphilic coercive disorder and healthy male controls: $W_{Thalamus} = 409$, $p_{Thalamus} = 0.274$; $W_{Caudate} = 352$, $p_{Caudate} = 0.930$; $W_{Hippocampus} = 334$, $p_{Hippocampus} = 0.833$; $W_{Amygdala} = 257$, $p_{Amygdala} = 0.115$.

Table 4

Results from the Mann-Whitney U Test

	Mann-Whitney U test		
	W	**p**	**Rank-Biserial Correlation**
Thalamus	409.000	0.274	0.180
Caudate	352.000	0.930	0.016
Hippocampus	334.000	0.833	-0.036
Amygdala	257.000	0.115	-0.258

Note. For the Mann-Whitney test, effect size is given by the rank biserial correlation.

For putamen, pallidus, and nucleus accumbens, the Shapiro-Wilk test showed normally distributed data, and the Levene's test showed homogeneity of variance (as shown above). Therefore, the independent samples t-test was conducted. The results of the independent samples t-test are presented in Table 5. There was not a significant difference in any of the three selected limbic system structures i.e., putamen (M = 3.367e-5, SD = 1.792E-4), pallidus (M = -7.054E-5, SD = 1.792e-4), nucleus accumbens (M = -1.741E-5, SD = 2.311e-5) between the two groups; $t_{putamen}$ (52 = 0.188), $p_{putamen} = 0.852$; $t_{pallidus}$ (52 = -1.198), $p_{pallidus} = 0.236$; $t_{accumbens}$ (52 = -0.754), $p_{accumbens} = 0.454$. Similarly to Rank-Biserial Correlation, the effect size is shown via Hedges'g.

Table 5

Results from the Independent Samples T-Test

Independent Samples T-Test						
	t	df	p	Mean Difference	SE Difference	Hedges' g
Putamen	0.188	52.000	0.852	3.367e -5	1.792e -4	0.052
Pallidus	-1.198	52.000	0.236	-7.054e -5	5.887e -5	-0.330
Accumbens	-0.754	52.000	0.454	-1.741e -5	2.311e -5	-0.207

Note. Student's t-test.

According to Goss-Sampson (2019), the interpretation of the effect size corresponds to that of the Pearson's correlation coefficient. Based on this information, it is safe to say that the effect size of each difference ranges from small to negligible. With that said, interpreting effect sizes is a secondary step. More importantly, Table 4 and Table 5 show that none of the seven selected limbic system structures differed in between the groups based on the available data and selected significance level. Although the largest difference can be seen in the amygdala structure, none of the tests were even close to the required level of significance $\alpha = 0.007$. As a result, the null hypothesis was not rejected in any of the seven cases because this sample did not provide sufficient evidence to show the existence of a difference between the two groups. In other words, the alternative hypothesis was rejected due to the insufficient statistical evidence. Therefore, volumetry of each selected limbic system structure does not differ significantly in either direction between the groups of individuals diagnosed with paraphilic coercive disorder and healthy male controls.

8. Discussion

The presented study examined brain structural differences in seven selected limbic system structures between patients diagnosed with paraphilic coercive disorder and healthy male controls. Selected limbic structures, such as thalamus, caudate nucleus, putamen, pallidum, hippocampus, amygdala, and nucleus accumbens were expected to be hypertrophied in patients compared with control subjects. No statistically significant differences between groups were found. This finding, contrary to the expectations, points towards normal, not heightened, excitability of limbic structures in paraphilic rapists.

This result comes as a surprise given that the general findings within the literature is limbic system implication in sexual arousal. Currently there is only a small number of studies examining the diagnosis of paraphilic coercive disorder with the help of brain imaging techniques. As already mentioned, study by Chen et al.. (2016) assessed abnormal white matter integrity in a sample of 15 male individuals diagnosed with paraphilic coercive disorder and 15 healthy male controls matched for age and education. Statistically significant differences in white matter integrity between the two groups were found. This could serve as a possible indication that there would be differences in the limbic structure between the two groups. Although the sample in this study was not larger and the exclusion criteria did not differ significantly from the study conducted as part of this thesis, the results in the study by Chen et al., are unambiguous. A significant difference is the method used for brain imaging (i.e., DTI) and targeting a wider range of brain areas. Another relevant study was in the Czech context, conducted at NIMH under the direction of the supervisor of this thesis, Dr. Androvičová. This study investigated a sample of individuals diagnosed with paraphilic coercive disorder using fMRI and PPG examination during presentation of relevant stimuli. The results contributed to the belief that the sexual inhibition response is lower in individuals with a history of stranger rape compared to healthy male controls (Androvičová et al., 2018). To the best of my knowledge, no studies examining hypertrophy of the limbic system in rapists could be found, although studies documenting the link between the limbic system and sexual arousal are not scarce. Most studies examining aberrations in limbic system have focused on sex offenders against children and individuals diagnosed with pedophilic disorder (e.g., Mohnke et al., 2014; Walter et al., 2007). Higher activation of the amygdala was documented in individuals diagnosed with pedophilic disorder compared to normophilic controls in Sartorius et al. (2008). Similarly in sadists, when viewing pictures of pain,

individuals with sadistic tendencies exhibited more significant activation in their amygdala (Harenski et al., 2012).

Given this negative finding, other causes for sexual preference difference have to be considered. Reflecting on the dual control model, the other function, sexual inhibition, may be of greater importance than the function of sexual excitation. As stated, disinhibition does not equal to lack of excitation. Simply said, disinhibition is characterized by the reduction or absence of the typical control that can lead to uncontrolled or unrestrained actions. Some studies suggest that lack of inhibition is responsible for sexual arousal to coercion rather than sexual excitation caused by depicted coercion (e.g., Frances & First, 2011; Holoyda, 2020). Because the findings of hypertrophy in the limbic system were negative, the failure of inhibition hypothesis depicted in the second chapter should be considered. This hypothesis suggests that the problem at hand is not the overwhelming sexual arousal brought about by depicted sexual violence or coercion, but rather the difficulty in suppressing sexual arousal in such case. The lack of ability to suppress such sexual arousal can be caused by various disinhibitors. Among those, lack of self-control, higher impulsivity, antisocial behavior or aggression can be listed (Chan, 2022; Phenix & Hoberman, 2015). Molen et al. (2022) claim that reduced inhibition in individuals diagnosed with paraphilic coercive disorder may be caused by perceptual errors, such as errors in the perception of sexual consent, moral disengagement, or other cognitive distortions. Ó Ciardha and Ward (2013) concluded that sex offenders exhibit cognitive distortions such as irrational beliefs, attitudes or other misconceptions that defy commonly accepted norms of rationality. Authors have demonstrated that cognitive distortions can be linked with the initiation and perpetuation of sexual offenses. It is worth noting that offending behavior was found to be more strongly correlated with cognitive empathy than with affective empathy (Van Langen et al., 2014). Additionally, lack of guilt and remorse exhibited frequently in sex offenders is associated with cognitive distortions in moral disengagement. Basson's (2015) study provides support for this claim by demonstrating that brain areas responsible for mediating sexual inhibition are activated during moral judgments and guilt tasks. Generally said, instead of hypertrophy of limbic system structures, a preference for paraphilic coercive behavior could be attributed to a range of disinhibitors. These disinhibitors may include reduced inhibition resulting from perceptual errors, moral disengagement, cognitive distortions, lack of self-control, higher impulsivity, antisocial behavior, or aggression. It is necessary to identify and address the

underpinnings of etiology of paraphilic coercive disorder in order to develop effective prevention measures, diagnostics, and treatment strategies.

Another plausible explanation for the absence of hypertrophy of limbic system in individuals diagnosed with paraphilic coercive disorder is the possibility of structural and/or functional alterations in alternative brain regions. Sexual excitation and hyperexcitable behavior may have more complex neurological underpinnings than those examined in this study. According to Appelbaum (2009), any disruptions in the interactions between neurotransmitters, neurohormones, and hormones are viewed as a neurobiological factor in the development of sexually violent and paraphilic behaviors. Given the entanglement of neurobiological systems in the brain, it is reasonable to consider the existence of more sophisticated mechanism underlying the etiology of paraphilic coercive disorder. Given the listing of brain areas related to sexual arousal in Figure 1, it is appropriate to deliberate effects of other brain structures. For example, orbitofrontal cortex seems to be relevant in the whole sexual response in human sexual behavior (Jordan et al., 2011). Besides its relevance in sexual arousal, important connection between orbitofrontal cortex and limbic system structures exists. They share similar link to moral decision-making, impulse control, or sexually violent behavior. Other aberrations in frontal lobe, and temporal horns was discussed. According to Appelbaum (2009), these areas are most commonly damaged or impaired among sex offenders and are linked to disinhibition. Moreover, in our study, effect size was negative in case of pallidus, hippocampus, amygdala, and nucleus accumbens. Thus, different neurological underpinnings than those examined in this study may be relevant in etiology of paraphilic coercive disorder. For a more detailed review of neurostructural findings see Krueger & Kneer in Craig and Bartels (2021), or Mokros (2018).

This study has certain limitations that may have influenced the results. There could be several reasons why no statistically significant differences were found between the average sizes of the selected limbic system structures in individuals diagnosed with paraphilic coercive disorder and healthy male controls. First and foremost, the sample size of the study may not have been large enough to detect small differences between the groups. Considering that the sample size consisted of 54 individuals in total may be reason why no reliable conclusion has been drawn from the statistical analysis. There is no exact rule of thumb for sample size within the Mann-Whitney test as it depends on the effect size or the significance level. However, a larger sample size (at least 30 participants per group) generally increases

the aforementioned properties of the test sample. The same is true for the reliability of the test (Button et al., 2013) and for the appropriate level of statistical power (Kirk-Provencher et al., 2020). On the other hand, one has to consider the specificity of this diagnosis and the difficulty of recruiting participant for the necessary scientific purposes. Given the nature of the paraphilic coercive disorder diagnosis, it is conceivable that the willingness of individuals to be retested and repetitively interviewed may be lower. Another sample limitation may be potential selection bias caused by the fact that the control group was self-recruited via advertisement.

Secondly, there may have been specifics within the individuals diagnosed with paraphilic coercive disorder that effected the results. For example, these individuals may have had different degrees of severity of the diagnosis, or there could have been various comorbidities in the play. Comorbidities that may directly or indirectly affect the limbic system include personality disorders, that may be linked to aberrations in fronto-limbic circuits (McCloskey et al., 2005), alcohol and drug abuse and their connection to limbic system (Boileau et al., 2003), schizophrenia with limbic structures aberrations (e.g., significantly smaller pallidum) (Bogerts et al., 1985), psychosis (Craig & Bartels, 2021), intellectual developmental disorder (Blasi et al., 2020), schizoaffective disorder (Baumann et al., 1999), or depression (Becker et al., 2001).

These assumptions suggest a greater complexity of paraphilic coercive disorder. Thus, another limitation of this study may be isolated focus on limbic system structures without broader connections to other brain regions or other neuroanatomical contexts. Given this above consideration, it would be interesting to examine both functions from the dual control model more closely. Thus, the most logical extension of the research question regarding hypertrophied regions of the limbic system in individuals diagnosed with paraphilic coercive disorder would be to simultaneously examine the volumetry of brain areas associated with inhibition. These areas include anterior cingulate cortex, parts of frontal lobe such as the inferior frontal gyrus, areas of temporal cortex such inferotemporal cortex and specific temporo-occipital structure called the fusiform gyrus, or prefrontal cortex areas such as the dorsolateral prefrontal cortex and the orbitofrontal cortex (e.g., Basson, 2015; Redouté et al., 2005; Rodriguez-Nieto et al., 2019).

To conclude, study results were not significant in any of the seven selected limbic system structures, i.e., thalamus, caudate nucleus, putamen, pallidus, hippocampus,

amygdala, and nucleus accumbens. These results did not supported the hypothesis regarding hypertrophied limbic system structures in individuals diagnosed with paraphilic coercive disorder. Alternative explanations for etiology of paraphilic coercive disorder were presented as well as limitations of this study that may have impacted the results. Relevant comorbidities, neurobiological, and neuroanatomical context should be considered in further research. It is necessary to further study these issues in order to find commonalities and specifics between various psychiatric, behavioral, and neurodevelopmental diseases. More studies investigating paraphilic disorders using MRI and other brain imaging techniques should be carried out.

Conclusion

This thesis presented current knowledge regarding paraphilic coercive disorder with its specifics and possible explanation of its etiology. The main focus of this thesis was to analyze data from the study that tested a hypothesis regarding the hyperexcitable behavior and its connection to limbic system structures. Hypertrophy was expected in selected areas of limbic system in individuals diagnosed with paraphilic coercive disorder. Volumetric analysis was carried out on 7 selected regions of limbic system i.e., thalamus, caudate nucleus, putamen, pallidum, hippocampus, amygdala, nucleus accumbens. Two groups (individuals diagnosed with paraphilic coercive disorder and healthy male controls) were compared in their volumetry of these selected limbic system structures using MRI examination. The obtained results of this study were statistically non-significant, thus suggested that there is currently no evidence to support the hypothesis that individuals diagnosed with paraphilic coercive disorder show hypertrophied limbic system structures in comparison with healthy male controls.

Albeit the current state of knowledge regarding brain characteristics of paraphilic coercive disorder is still in its infancy, available results shed light on the importance of thorough assessment where brain imaging techniques play its role. Further research on this topic may thus provide relevant information for enhancing the understanding of paraphilic coercive disorders. Fruitful findings may be of importance for prevention, diagnostics, and development of treatment approach for individuals with this condition. That is in correspondence with the principle on the central relevance of public health where precisely captured behavior helps with the relevant processes (Krueger, 2012). To summarize, according to Schober and Pfaff (2007), sexual arousal depends on various cognitive processes, physiological processes, hormonal factors and genetic factors the combination of which either does or does not lead to sexual behavior. Generally speaking, the origin of sexual behavior in individuals diagnosed with paraphilic coercive disorder cannot be explained solely through the function of sexual excitation, hyperexcitable behavior, and its connection with limbic system structures. However, based on the summarized findings from the available studies, a partial influence of areas associated with the reward system can be assumed. Further research with larger and more homogenous samples is needed as well as more studies examining neuroanatomical networks related to sexual behavior.

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