

The Neuroscience of Pedophilia

Methods, Concepts, and Ethics

I Abstract

Neuroscientific pedophilia research has advanced over the course of last few years. Eighteen publications on the structural and functional characteristics of the brains of pedophilic individuals from the past decade, identified through a *Medline* search, provide the basis for this paper. With the goal to make recommendations for improvements of future research on methodological, conceptual, and ethical levels, this analysis first summarizes prevalent definitions and etiological concepts of pedophilia. It then transitions into concise summaries of individual pedophilia studies, illustrating their methodological variability. Experimental stimuli used in functional imaging studies are discussed in more detail before the concept of 'the pedophile', as it informs and is informed by the selection of study participants, is analyzed. Finally, the paper points to ethical concerns regarding the use of erotic visual child stimuli, the attitude towards study participants, and the use of research findings. It is suggested that future studies may benefit from attending to these concerns and from employing more coherent methods in order to make the yet inconsistent findings on the neural correlates of pedophilia more conclusive.

II Introduction

[Neuroscientifically determined] indicators do not cause pedophilia, but predict a correlation ... [I]t can be stated that there is no determinant explanation for the reasons that lead a person to pedophilia, but that the results of these studies suggest that the origin can be found, in part, in brain dysfunctions produced by adverse events occurring during neurodevelopment. However, these anomalies are problems that do not free these individuals from being responsible for their acts. (Becerra García, 2009: 195)

Neuroscientific research on pedophilia, as well as potential treatments and diagnostic tools for this paraphilia, has significantly increased over the course of the last few years. The past decade in particular has seen many innovations in the methodological approach to the subject: The first high-resolution structural studies of the brains of child offenders were published in 2007 (Schiffer et al., 2007; Schiltz et al., 2007), the first functional studies on the topic came out the same year (Walter et al., 2007),¹ and the first experiments distinguishing between pedophilic and non-pedophilic child offenders were reported shortly after (Suchy et al., 2009). A few years later, researchers identified the patterns of brain activation in pedophilic sexual arousal for the first time (Ponseti et al., 2012), and another group pioneered in integrating functional neuroimaging results with behavioral data from a continuous performance task (Habermeyer et al., 2013b). In 2014, a study investigating into the roles of automatic *versus* controlled attentional

¹ Sartorius et al. (2008: 274), however, suggest that their study is "the first demonstration of altered brain activation in pedophiles in a visual stimulation paradigm."

processes for sexual arousal in pedophiles was published (Jordan et al., 2014). Even more recently, a study came out that integrated morphological characteristics of the brains of pedophiles with connectivity patterns and the functional roles of those areas (Poepl et al., 2015).

This paper provides an overview of recent neuroscientific studies of pedophilia, in order to identify potential fields of improvement for future investigations—on methodological, conceptual, and ethical levels. The goal is *not* to report the findings of an exhaustive sample of individual studies in detail. Instead, selected publications from the past ten years will serve as exemplars of the diverse methods and conceptual frameworks that have been used to better understand pedophilia and pedophilic individuals.²

In the following section of this paper, the current knowledge about the neural correlates of pedophilia will be presented as it illuminates the etiology of pedophilia. Second, the analysis will turn to the variability in methodological approaches within the neuroscience of pedophilia in the past decade. A close examination of experimental stimuli used for functional examinations will be provided as well. Through those analyses, it will become clear that inconsistent results may in part be caused by a significant variability of methods used in studies of pedophilia. Next, the selected publications will be scrutinized for the concept of ‘the pedophile’ that underlies those investigations and which determines the limits of knowledge we can acquire about the brains of pedophilic individuals. Where the study participants come from, how their pedophilic nature is determined, and how the group of ‘pedophiles’ is subdivided, are some of the avenues explored. This investigation will support the proposition that more coherent methods and careful scrutiny in the recruitment of study participants, in experimental design, and in the combination of technologies used to investigate into the neural characteristics of pedophiles may lead to more consistent results. Lastly, the paper will highlight ethically questionable practices in the recruitment of research subjects, in the use of experimental stimuli, and in the potential uses of study results for diagnoses or treatments of pedophiles. This will lead to suggestions for the implementation and uses of future research on pedophilia, with which the paper will close.

III Definition and Etiology of Pedophilia

All of the selected neuroscientific articles draw a connection between pedophilia and sexual offenses against children. In fact, numerous of the publications introduce their research by referring to the numbers of sexual abuse in children (e.g., Becerra García, 2009: 191; Schiffer and Vonlaufen, 2011: 1975; Schiffer et al., 2008a: 24; Schiltz et al., 2007: 737; Suchy et al., 2009: 248). Pedophilia is referred to as a “problematic, harmful, and serious behavior” (Mendez and Shapira, 2011: 1098) of “high public concern” (e.g., Walter et al., 2007: 698). The paper selection contains only one publication that does *not* refer to the affected children but only to the rising

² The studies this paper draws on comprise all of the hits of a *Medline* search with the criteria ((pedophilia) AND brain) AND (neural OR neuronal OR cognitive), limited to the years 2005–2015. One of the search results, an article from Phenix and Sreenivasan (2009), was excluded from further analysis due to a lack of relevance for this paper. Additional studies were identified through the references of the papers obtained through the aforementioned search. This led to an overall number of eighteen original research articles from the years 2007–2015 and five review papers from 2009–2014. (Note: no publications on the neuroscience of pedophilia were found for the years 2005 and 2006.)

numbers of convicted pedophiles (Sartorius et al., 2008). Yet, most researchers identify it as their goal to serve both the offenders and the offended by “help[ing to] develop effective, targeted interventions for this egregious behavior” (Mendez and Shapira, 2011: 1093). In other words, the research consistently aims at supporting pedophiles by providing treatment, protecting children by diagnosing pedophilia in suspicious individuals, and preventing future abuse by determining the risk of recidivism in identified pedophiles.

Most of the selected publications define pedophilia according to the DSM-IV. According to the Manual, pedophilia is described as a paraphilia in adults that “involves sexual activity with a prepubescent child,” with an individual preference for children of a specific sex/gender³ and age on the pedophile’s part (American Psychiatric Association, 1994: 527). Pedophilia that coincides with sexual attraction to other adults is defined as the “Nonexclusive Type,” and being only attracted to prepubescents is termed pedophilia of the “Exclusive Type” (American Psychiatric Association, 1994: 527). In affected individuals, pedophilia is supposed to form during adolescence, but it can also occur later in life. The DSM-IV defines pedophilia as a chronic condition with high rates of recidivism (American Psychiatric Association, 1994: 528).

There are, however, some exceptions to this general trend of defining pedophilia according to the DSM-IV. Mohnke et al., for instance, used the DSM-5 definition of pedophilic disorder to recruit their subjects. According to the fifth edition of the Manual, pedophilic desires that do not cause distress to the affected individual and do not lead to sexual offenses against children are non-pathological. Moreover, Sartorius et al. and Poeppel et al. employed the definition of the ICD-10, where “paedophilia” figures amongst one of several “Disorders of Sexual Preference” (Sartorius et al., 2008; Poeppel et al., 2013).⁴

Notwithstanding the above-mentioned view that pedophilia deserves broad attention in the public and in scientific research, not much is known about this disorder. The prevalence among adult human males is estimated to be in the 0.5 to 1 % range (Poeppel et al., 2015: 1), and important etiological factors seem to be experience of sexual abuse, genetics, and neurodevelopmental problems (Mohnke et al., 2014: 4). It has been reported that the latter perturbations can also become visible in diminished intelligence, left-handedness, and smaller stature, and that pedophilia is a neurodevelopmental problem (Becerra García, 2009). Many more publications report that pedophilia is closely associated with multi-faceted emotional and cognitive impairments (e.g., Georgiadis and Kortekaas, 2009; Poeppel et al., 2015; Sartorius et al., 2008; Schiffer et al., 2007; Suchy et al., 2009; Wiebking and Northoff, 2013).

In addition to developmental, genetic, and experiential factors, late-life changes of sexual preferences from teleiophilia, the sexual preference for adults, to pedophilia have been observed in neurological and psychiatric patients. Mohnke et al.’s compilation of different case studies from the past century, for example, illustrates that pedophilia can occur after brain tu-

³ The term “sex/gender,” as employed by Kaiser et al. (2009), acknowledges both the intermingling of nature and nurture and the fact that ‘sex’ and ‘gender’ are often used interchangeably in neuroscientific publications.

⁴ The papers of Sartorius et al. (2008) and Poeppel et al. (2013) use the definitions of the ICD-10, and the study of Mohnke et al. (2014) used the DSM-5 definition. Overviews of the diagnostic criteria for “paedophilia” (ICD-10), “pedophilia” (DSM-IV), and “pedophilic disorder” (DSM-5) can be found in the Appendix (sections IX.1, IX.2, and IX.3). In the remainder of this paper, I will refer to the condition simply as “pedophilia,” as most of the selected papers do.

mors, certain types of dementias and neurodegenerative diseases, hippocampal sclerosis, or brain lesions due to injuries or surgical procedures (Mohnke et al., 2014: 5–8). Research on the association between pedophilia and brain diseases or lesions has furthermore suggested that deviant sexual arousal provoking pedophilic desire can be classified in three groups: (1) general disinhibition due to insufficiencies of frontal brain regions, (2) sexual preoccupation associated with diseases of the right temporal regions, or (3) hypersexuality as a result of subcortical impairments in parts of the basal ganglia, hypothalamus, or septal nuclei (Mendez and Shapira, 2011: 1092).⁵

One possible interpretation of the findings is that the aforementioned impairments do not cause pedophilia, but that individual pre-existing susceptibilities are simply “unmasked” ... or [that] the patients’ ability to recognize fitting sex partners [i]s disabled” by neural deficiencies (Georgiadis and Kortekaas, 2009: 193). In other words, pedophilia may depend on a predisposition that only leads to behavioral and emotional manifestations after the onset of brain impairments and/or in the presence of contributing environmental factors. This interpretation is corroborated by Mohnke et al.’s review of studies suggesting that hypersexuality may lead to an “unselective search for sexual partners” provoked by a lack of behavioral control due to impairments in the medial frontal areas (Mohnke et al., 2014: 7).⁶

It is noteworthy that the brain areas that seem to be associated with pedophilic desire and behavior have substantial overlaps with the networks employed in other types of sexual arousal.⁷ Thus, it makes sense that most of the selected studies present pedophilia as a sexual preference and compare it to publicly recognized sexual orientations rather than referring to the disorder as a psychopathology. Hence, pedophilia is occasionally mentioned in the context of behaviors such as transvestitism and transsexuality or sadomasochism (Georgiadis and Kortekaas, 2009: 183; 192–193; Schiltz et al., 2007: 744).

One of the selected papers supports the view that pedophilia is indeed better described as a sexual preference than as the product of a disinhibited search for sexual partners born out of hypersexual desire as mentioned above. A study on the effects of anti-androgens on pedophiles has shown, for example, that the sexual preference of a pedophilic individual remained unaltered despite a suppression of androgens to castration level. Based on eye-tracking results, the investigators inferred that the preference for children as sexual partners persisted unconsciously in the androgen-suppressed individual, even though the subject was lacking any form of sexual desire and function certain weeks after the onset of the treatment (Jordan et al., 2014).

It is thus assumed that pedophilic sexual arousal looks very similar to teleiophilic sexual arousal as far as brain activation is concerned. The most significant difference is, of course, that the arousal is provoked by children, and not adult, sexual stimuli. Tying the above-mentioned factors together, researchers have theorized that pedophilia may stem from an impairment of

⁵ More information on the etiology of pedophilia is provided by Mokros et al. (2012).

⁶ Mendez and Shapira (2011: 1097–1098) provide a summary of research literature on morphological and functional investigations into hypersexuality and paraphilia.

⁷ A graphical overview of brain areas implied in teleiophilic sexual arousal due to visual sexual stimuli can be found in the Appendix (section IX.4). A textual summary of the regions and networks was provided by Georgiadis and Kortekaas (2009). Juxtapositions of brain activations in teleiophilic sexual arousal and paraphilia can be found in the work of Mendez and Shapira (2011: 1096–1097); Mohnke et al. (2014: 4); Wiebking and Northoff (2013: 352–353).

the amygdala during sexual maturation followed by sexual conditioning towards children and a skewed sexual appetite (Poeppel et al., 2015: 10; Poeppel et al., 2013: 680; Schiltz et al., 2007: 744). Those tendencies presumably become overt only after the additional impairment of frontal and temporal regions leading to executive dysfunctions, limited inhibition, and impulsivity (Joyal et al., 2007: 156–158; Mendez and Shapira, 2011: 1092; Poeppel et al., 2013: 682; Schiffer et al., 2008b: 89; Schiffer and Vonlaufen, 2011: 1975; 1980–1982; Suchy et al., 2009: 253–254). Perturbations of this sort often lead to brain activation patterns similar to those in individuals with disorders in the obsessive-compulsive spectrum (Schiffer et al., 2007). Those explanations, however, are not uncontested, mostly because of inconsistent findings due to the heterogeneity of methods used in the studies, as will be spelled out in the following section.

IV Methods of Investigation

The selected studies can be roughly divided into three groups: original papers reporting structural studies (Poeppel et al., 2013; Schiffer et al., 2007; Schiltz et al., 2007), reports of functional studies (Habermeyer et al., 2013a; Habermeyer et al., 2013b; Jordan et al., 2014; Poeppel et al., 2015; Poeppel et al., 2011; Ponseti et al., 2012; Sartorius et al., 2008; Schiffer et al., 2009; Schiffer et al., 2008a; Schiffer et al., 2008b; Schiffer and Vonlaufen, 2011; Suchy et al., 2009; Walter et al., 2007), and review papers on pedophilia or sexual arousal more generally (Becerra García, 2009; Georgiadis and Kortekaas, 2009; Mohnke et al., 2014; Mokros et al., 2012; Wiebking and Northoff, 2013). Two papers fit two or neither of the categories: one publication is half review of structural findings pertaining to pedophilia and half a study on cognitive function in pedophiles (Joyal et al., 2007); the remaining article is a clinical report associating brain disease with pedophilic behavior (Mendez and Shapira, 2011). In the following, the methods used and results obtained in the identified non-review papers will be surveyed, and a detailed analysis of the stimuli used in functional experimental designs will be delivered. At the end of this section, a short reflection on the relation between the variability in methods and inconsistencies in results will be provided.

IV.1 Methods and Results

Morphometric studies have the longest tradition amongst contemporary neuroscientific approaches to the brains of pedophiles. In a review paper, Mohnke et al. summarize how CT and MRI studies since the 1980s have identified perturbations in temporal regions as well as reductions of gray and white matter in the amygdala and several other brain regions of sexual child offenders (Mohnke et al., 2014: 8–12). Despite these early inquiries and the availability of structural imaging methods, however, the use of those technologies in neuroscientific pedophilia research was still uncommon in the later 2000s (Joyal et al., 2007: 158–159).

Some of the few existing structural MRI studies have found reduced amounts of gray matter, when compared to teleiophilic controls, in the orbitofrontal cortex (Poeppel et al., 2013; Schiffer et al., 2007), in the dorsolateral prefrontal cortex (Poeppel et al., 2013), in the angular gyrus (Poeppel et al., 2013), in limbic gyri (Schiffer et al., 2007), in the amygdala (right: Poeppel et al., 2013; bilateral: Schiltz et al., 2007), in and around the insula (Poeppel et al., 2013; Schiffer et al.,

2007), in the ventral striatum, including the nucleus accumbens (Schiffer et al., 2007), in the cerebellum (Schiffer et al., 2007), as well as in other regions of the brains of pedophiles. Gray matter increase was found in the right temporal horn (Schiltz et al., 2007). Most of these results, however, were only marginally significant, and many differences in gray matter volume between the brains of pedophiles and teleiophiles in specific areas did not reach satisfactory levels of significance or did not survive statistical corrections (e.g., Poepl et al., 2013: 679–680). Mendez and Shapira, who did not use structural MRI but associated impairments in eight patients with located brain disease with their paraphilic behavior, were able to report correlations between pedophilia and perturbations in frontal regions (bilateral) and temporal regions (right) as well as in the basal ganglia, septal nuclei, and the hypothalamus (Mendez and Shapira, 2011).

Two and a half of the functional studies did not use any form of neuroimaging, but instead a series of neuropsychological and neurocognitive tests (verbal fluency, auditory and visual memory, processing speed, motor speed, behavioral inhibition, general intelligence, etc.). Joyal et al.'s study, which is half review of structural findings pertaining to pedophilia and half pilot study on cognitive functions in pedophiles, tested three groups of subjects: rapists of women, child offenders, and non-criminal controls. The article reports that rapists of children have the lowest IQ across the three groups and that both offender groups showed slower processing speed, decreased behavioral inhibition, and less verbal fluency than non-criminal controls (Joyal et al., 2007). Suchy et al. tested three subject groups: pedophilic and non-pedophilic child offenders as well as non-offender controls. They found that pedophiles had slower processing speed than both other subject groups and also that they had weaker executive functions than the controls (Suchy et al., 2009: 248). Schiffer and Vonlaufen, however, could not find significant differences between pedophiles and any of the three other subject groups they tested: non-pedophilic child molesters, non-sexual offenders, and non-criminal controls. None of the differences they detected survived the Bonferroni correction they performed (Schiffer and Vonlaufen, 2011).

The remaining functional studies used fMRI data for their investigations. Similar to the timid use of structural MRI as mentioned above, fMRI studies on pedophilia were quite unpopular until very recently (Wiebking and Northoff, 2013). Nonetheless, ten fMRI studies on pedophilia are amongst the selected publications for this paper. Two of these studies aimed at revealing unconscious aspects of the processing of visual sexual stimuli in pedophiles. Jordan et al., for example, had one androgen-suppressed pedophile watch visual stimuli in the scanner. The stimuli were displayed for only 50 ms, in order to investigate into the processing of subliminal perception. In addition to the fMRI experiment, the subject was shown the same stimuli for a longer period of time outside of the scanner while his eye movements were tracked. Based on brain activity and measurements of tracking latency and fixation time for pedophilic erotic as well as non-erotic stimuli, the researchers conclude that only controlled attentional processes are influenced by anti-androgen therapy and that automatic and unconscious processes, including a sexual preference for children, persist under androgen suppression (Jordan et al., 2014).

Even though Sartorius et al. also aimed at unconscious processing of visual child stimuli, their experimental design is more traditional than Jordan et al.'s in the sense that the research group relied on a task fMRI design, like the remaining eight of the functional neuroimaging studies that will be summarized below. While the participants were solving an odd-ball task in

Sartorius et al.'s study, erotic stimuli were embedded in some of the non-erotic geometric target figures for the task. This allowed the researchers to determine that pedophiles display more activation of the right amygdala for child stimuli than controls, even if they focus on something else (Sartorius et al., 2008).

Claiming to have conducted the first fMRI study on pedophilia, Walter et al. report that the brain activation during blocks of erotic adult (sic) stimuli in pedophiles differed from the brain activations of teleiophilic controls in the same condition. Significantly less activity in the hypothalamus, the periaqueductal gray, and dorsolateral prefrontal cortex in pedophiles than in adults were found (Walter et al., 2007).

Ponseti et al. had their pedophilic and teleiophilic subjects view blocks of visual stimuli of nude and dressed children and adults in order to describe the patterns of neural activation in the respective subject groups during the various conditions. They did so with the intent to prove the usefulness of fMRI for a diagnosis of pedophilia and to promote it as a substitute for methods such as phallometry. Their analysis allowed them to predict the sexual preference of pedophiles and teleiophiles with an accuracy of ca. 90 % (Ponseti et al., 2012).

Schiffer et al. also used a block design with erotic and non-erotic stimuli of prepubescent and adult males respectively. They determined significant activations in the striatum and globus pallidus in response to the boys stimuli in homosexual pedophiles that did not show in teleiophilic controls in response to the men stimuli (Schiffer et al., 2008a). In a similar study on heterosexual pedophiles and teleiophiles, Schiffer et al. again found many overlaps between the two groups in brain activity in response to the preferred erotic stimulus. They also report many similarities in the brains of pedophiles and teleiophiles in response to the respectively non-preferred stimulus. Differences were only found in the form of an orbitofrontal deactivation during visually induced arousal in pedophiles and increased activation in the dorsolateral prefrontal cortex (Schiffer et al., 2008b).

The group published another fMRI study in the following year that reports the case of one pedophile treated with long-acting luteinizing hormone-releasing hormone (LH-RH) agonists. The substance promises to suppress pedophilic desires by reducing testosterone levels and thus sexual urges. The study suggests that LH-RH agonist treatment indeed lowers the level of brain activation that would normally be induced by an erotic stimulus in the pedophile, but only in subcortical regions (Schiffer et al., 2009).

One of the selected fMRI studies pioneered in administering a continuous performance task in the scanner, in order to acquire behavioral and functional data at the same time (Habermeyer et al., 2013b). This study design allows for a superior investigation into response inhibition compared to the two above-mentioned studies, which used neuropsychological and neurocognitive tasks only. In addition to difference in performance on the behavioral tasks, Habermeyer et al. were able to detect sustained activation of the brain default network while pedophiles were solving the tasks in the scanner, whereas controls in the same condition showed deactivations in those areas. One possible interpretation is that self-related processes are more pervasive in pedophiles than in non-pedophilic subjects (Habermeyer et al., 2013b).

Poepl et al. examined the cognitive, emotional, and motivational aspects of pedophilic sexual arousal, barring autonomic responses such as erection, by administering a choice reaction time task in the scanner. In order to not induce full sexual arousal, they employed a design

with relatively short blocks (18 s) of erotic stimuli. The measured neural response in pedophiles and teleiophiles to their respective arousing stimuli was comparable. Nevertheless, a heightened BOLD response in the cingulate gyrus and the bilateral insula as well as a relative deactivation of the right amygdala was found in pedophiles when compared to the controls. In addition to that, the pedophiles displayed significantly longer reaction times (Poeppel et al., 2011).

Two years later, Habermeyer et al. decided on an event-related design for their study on immediate processing of visual sexual stimuli in heterosexual pedophiles and teleiophilic controls (Habermeyer et al., 2013a: 88). The researchers found, in accordance with earlier block design studies, that both subject groups had similar activations in response to their preferred stimuli (girls and women respectively), but that pedophiles showed additional activation in right-lateral prefrontal areas that have been found to be involved in the processing of reward and punishment. No block-design fMRI study had been able to identify comparable activations prior to that (Habermeyer et al., 2013a).

Very recently, Poeppel et al. made an attempt to link morphological characteristics of pedophilic men with functional and connectional properties of non-clinical brains. Their paper is original in the sense that it combines previously acquired data in a new way, but it is not based on an examination of new subjects, either pedophilic or non-pedophilic. Drawing on reports of morphological specificities in the brains of pedophiles and on data for non-clinical brains from databases such as *BrainMap*, the researchers performed functional connectivity analyses using meta-analytic connectivity modeling (MACM).⁸ These analyses revealed that regions that have been found to be morphologically distinct in pedophiles are functionally connected to areas involved in the processing of sexual stimuli. Consequently, the authors suggest, the pre-established characteristic morphological properties in the brains of pedophiles are directly linked with their paraphilia (Poeppel et al., 2015).

IV.2 Experimental Stimuli

As demonstrated in the preceding section, ten of the selected studies used functional neuroimaging, and most of them use visual sexual stimuli. Experimental designs that use child stimuli usually employ pictures of both nude and dressed children (e.g., Mohnke et al., 2014; Poeppel et al., 2011; Schiffer et al., 2009; Schiffer et al., 2008a; Schiffer et al., 2008b)—whereas ‘dressed’ can mean wearing underwear or a swimsuit (e.g., Habermeyer et al., 2013a; Sartorius et al., 2008)—and alternate them with comparable pictures of adults in an event-related or block design.

The widest range of pictures was used by Ponseti et al., who administered 490 different photographs comprising fourteen different types of visual stimuli to study participants: whole-body frontal views, genitals, and faces of nude children and nude adults respectively, in both male and female versions, plus groups of non-sexual pictures from the International Affective Picture System with low and high arousal scores respectively (Ponseti et al., 2012). The origin of the child stimuli used for this study is not specified in the publication, which is a recurring procedure observable in the selected papers. In coherence with Ponseti et al.’s aforementioned

⁸ According to Robinson et al. (2010: 173), MACM “overcomes many weaknesses of conventional connectivity analyses and provides a simple, automated alternative to developing accurate and robust models of anatomically-defined human functional connectivity.”

study, emotional control stimuli and pictures of adults are frequently taken from the International Affective Picture System (e.g., Schiffer et al., 2008a; Schiffer et al., 2008b; Walter et al., 2007), and juxtaposed with “erotic” pictures of children (e.g., Habermeyer et al., 2013a: 90; Schiffer et al., 2008a: 25; Schiffer et al., 2008b: 82; Walter et al., 2007: 698), of unspecified origin.

There are three exceptions to the rule of using child stimuli of unreported origin. One case applies to studies in which the stimuli are partly attributed to a source, and the exceptional cases two and three encompass studies in which no pictures of (real) children were used at all. First, the authors of three papers identify their child stimuli as pictures “obtained from different sources such as Internet [sic], mail-order house or art catalogues” (Schiffer et al., 2008a: 25; see also Sartorius et al., 2008: 273; Schiffer et al., 2008b: 82). In other words, pictures of prepubescent models were repurposed to elicit pedophilic sexual arousal. Second, and much less ethically concerning, two studies used computer-generated pictures that look very much like ‘real’ children, but are not based on photographs (Jordan et al., 2014; Poeppel et al., 2011). These pictures were taken from the *Not Real People* stimulus set.⁹

The third exception is a study that used, as quickly mentioned in section IV.1, only erotic and non-sexual emotional pictures of adults for a comparative functional analysis in pedophiles and teleiophiles (Walter et al., 2007). The advantages of an entire absence of child stimuli are that abstinent pedophiles are not stimulated to recidivism and that no children’s pictures are turned into pedophilic erotic material. The disadvantages, however, are obvious. Without erotic stimuli, researchers are only able to identify brain structures related to non-arousal in the pedophiles and compare them to the correlates of sexual arousal in teleiophiles. Pedophilic arousal, thus, could be identified only negatively.

IV.3 Variability and Inconsistencies

It has become clear that neuroscientific studies on pedophilia are considerably diverse regarding the technologies used, the experimental design employed, and the visual stimuli shown, if applicable. This has been criticized in all of the selected review papers and in a considerable number of the original articles as well. Additional critiques, which were not mentioned in section IV.3, pertain to small and variable sample sizes (from single case studies to twenty participants per subject group), lenient statistics, variability in analytical models, conceptual weaknesses of the neuropsychological and -cognitive tests used, unreliable measures of behavioral performance, and a lack of precision in determining the sexual preferences in child offenders as well as in matching them with appropriate controls (e.g., Habermeyer et al., 2013a: 94; Jordan et al., 2014: 143–144; Joyal et al., 2007: 159–160; Mohnke et al., 2014; Poeppel et al., 2015: 2; Poeppel et al., 2013: 679; Schiffer and Vonlaufen, 2011: 1976; Suchy et al., 2009: 248; 255).

The methodological variability may directly relate to the inconsistency in results, which has been exemplified in section IV.1. The following questions, among others, thus remain unsolved: Are pedophiles cognitively and emotionally impaired compared to teleiophilic controls or not? Is pedophilia provoked and/or exacerbated by executive dysfunctions? Do white and/or gray matter volumes generally differ in pedophilic and teleiophilic subjects, and, if so, how, and in what brain regions? Are the variances between different subject groups related to hypersexu-

⁹ For exemplary pictures of the picture set supplied by *Not Real People*, see the Appendix (section IX.5).

ality and offending or to pedophilia itself?—No answer to the latter question will be given in the next section, but it will nonetheless provide a more detailed treatment of the question of how pedophilic and child offender participants are recruited and sub-classified for neuroscientific studies.

V ‘The Pedophile’

Thus far, this paper has identified the definition of pedophilia that underlies the selected publications and it has provided an overview of the etiology of pedophilia, both as evidenced by the sampled neuroscientific articles and by earlier research those publications draw on. An overview of original research papers published in the past decade has been provided, with a focus on the varying methodologies, which may underlie significant inconsistencies between findings. In the following, the focus will be shifted towards the concept of individual pedophiles as they have been recruited for and researched in the studies on which the selected publications are based.

First, it is important to note that ‘the pedophile’ is almost always conceived of as a male adult. Interestingly, neither the DSM nor the ICD-10 specify the sex/gender in which pedophilia is most pervasive, but all of the selected studies used exclusively male pedophiles as research subjects. Only few publications, however, explicitly state that pedophilia occurs primarily in males: Mohnke et al., for instance, reference research from the early 2000s that has shown that a few cases of female pedophiles have been reported, but that the condition is “substantially more frequent in men” (Mohnke et al., 2014: 3). Consequently, it seems confusing that one of the studies used connectivity data from (non-pedophilic) male *and* female subjects as a foundation for their investigations into the brains of pedophiles (Poepl et al., 2015). In all other studies, however, no women functioned as a control group and females were only included in form of visual sexual stimuli, as has been shown in section IV.2.

The following description of pedophiles from Mendez and Shapira contains four of the most important aspects in answering the question of who ‘the pedophile’ is: the link between *pedophilic desire and criminal behavior* (a), and the closely related challenge of distinguishing between *pedophilic and non-pedophilic child molesters* (b), the question of *institutionalized study participants* (c), and the difference between *exclusive and non-exclusive pedophiles* (d).

These patients had pedophilic behavior from brain disease. Their behavior involved stalking, glaring, or inappropriately touching children, or viewing child pornography, and resulted in legal action and several arrests. ... In fact, not all child molesters are pedophiles, those for whom prepubescent children are the primary target of sexual interest, and a small number of the rest could have a brain disorder. (Mendez and Shapira, 2011: 1096)

All of the selected neuroscientific articles draw a connection between *pedophilic desire and criminal behavior* (a), that is, sexual offenses against children. This close link between *pedophilic and non-pedophilic child molesters* (b) is not necessary, as some of the selected papers point out. Mohnke et al., for example, emphasize that the DSM-5 distinguishes between a non-pathological sexual preference for children and a pedophilic disorder. The latter implies that either the pedophile or other individuals—that is, mostly children—suffer from distress or

abuse (Mohnke et al., 2014: 2). In the same vein, Becerra García points to the difference between “[p]ederasty (sexual abuse committed with children) and pedophilia (erotic or sexual attraction that an adult feels toward children or adolescents),” explaining that, confusingly, ‘pedophilia’ is used for both categories in clinical contexts (Becerra García, 2009: 191).

It has been suggested that the occasional mix-up between erotic desire for prepubescents on the one hand and criminal offenses against children on the other hand rests on a pervasive association of the two conducts in public discourse, even though only half of the reported cases of sexual abuse in children are committed by pedophiles, and the other half by non-pedophilic offenders (Mohnke et al., 2014: 3; Ponseti et al., 2012: 187; Wiebking and Northoff, 2013: 351). A potential conflation of pedophilic preferences and sexual child offenses may be one reason for inconsistent results in past pedophilia research, as mentioned in section IV.3. The main difference between the two groups is that ‘real’ pedophiles exhibit “persistent and focused sexual attraction to prepubescent children,” including sexual arousal towards pedophilic stimuli and a strong desire for sexual contacts with children, whereas non-pedophilic offenders of children “are less sexually focused on children,” and their offenses are rather of circumstantial nature in the sense that they may be influenced by substance abuse or a lack of availability of adult sexual partners (Schiffer and Vonlaufen, 2011: 1976). In short, pedophilic child offenders have a particular sexual preference for prepubescents, while non-pedophilic child molesters may have problems with behavioral inhibition. In addition to varying motives, the two groups may also differ in the number of committed offenses and the risk of recidivism, which tends to be higher in pedophilic than in non-pedophilic child molesters (Suchy et al., 2009: 249). Notwithstanding those archetypal features, it is yet unclear if pedophilic and non-pedophilic characteristics lie in a continuum or if they designate two distinct types of offenders (Schiffer and Vonlaufen, 2011: 1976).

Needless to say, a decision of whether an offender does or does not have pedophilic desires is hard to make within a laboratory setting (Mohnke et al., 2014: 3). Nonetheless, researchers have argued that it is crucial to disentangle the neural correlates of diminished behavioral control, which may be related to either hypersexuality and general violent tendencies or pedophilia itself (Mohnke et al., 2014: 19). A review of the neural correlates of sexual deviance, for example, bolsters claims that damage to the frontal and/or temporal lobes is associated with pedophilia is rather thin: morphological patterns that are purportedly characteristic for pedophilia have been inferred from a very heterogeneous sample of sexual offenders. What is needed in order to combat at least some of the inconsistencies mentioned in sections IV.1 and IV.3 are clear delineations between characteristics associated with general tendencies for deviant and criminal behavior as opposed to specifically sexual offenses, in particular sexual offenses against children.

The first study employing this distinction compared twenty pedophilic and twenty non-pedophilic offenders as well as the same number of demographically matched non-offenders; the researchers’ explicit intent was not to overcome the “weaknesses” of previous studies due to heterogeneous samples consisting of different types of sexual offenders (Suchy et al., 2009: 248). As mentioned in section IV.1, the researchers found indicators for “potentially different neurobiologic [sic] underpinnings for the two types of child molestation” (Suchy et al., 2009: 254). Another study, however, showed that there are much less specificities in each group of child

offenders. Even though specific “deficit profiles” for different types of executive functioning in pedophilic and non-pedophilic child offenders could be found, several characteristics formerly associated with pedophilia, such as verbal skills, showed to be correlated with criminality and violent offenses, and not specifically with pedophilia (Schiffer and Vonlaufen, 2011).

But even if pedophiles could be reliably distinguished from non-pedophilic child offenders, the problem of disentangling the neural correlates of criminal tendencies and pedophilic desires within each individual would persist. Some studies, for example, included participants who had never been convicted for physical offenses against children but for the possession of child pornography (Habermeyer et al., 2013a; Habermeyer et al., 2013b). In a sample with hands-on offenders, those subjects may lead to a distortion of study results, as Habermeyer et al. explain: the average individual who obtains child pornography through the internet tends to be better employed, higher educated, and more intelligent than the common child offender. Thus, one can expect internet abusers to display significantly better frontal functions than would be found in the allegedly more disinhibited physical offenders.

The problem of *institutionalized study participants* (c) overlaps with the question of how to disentangle criminal predispositions, if those exist, and characteristics specific to pedophilia. Almost all of the subjects used for the selected studies were institutionalized at either penitentiaries or forensic hospitals. Even though the researchers usually excluded individuals with any history of substance abuse, psychiatric disorders, or severe medical illnesses, the bare fact that the subjects were and had been confined for indefinite amounts of time may also skew the data and results. Even though Schiffer’s research group repeatedly could not find a correlation between neural data and the duration of confinement (Schiffer and Vonlaufen, 2011: 1979; Schiffer et al., 2007: 757), other researchers assume an influence of the restrictive environment on their data (Poepl et al., 2013: 683), possibly due to “internment-related stress or general criminality” in the study participants (Poepl et al., 2011: 1662).¹⁰

Be that as it may, recruiting institutionalized subjects has several advantages over recruiting pedophiles from the community. It is, for instance, very convenient for neuroscientists to have court records and forensic files at their disposal. Access to those documents significantly streamlines the process of subject selection and saves considerable resources otherwise needed for screening and diagnosis. Moreover, the researchers do not have to rely on study participants’ self-reports. One German study, however, included both institutionalized and unrestricted self-identified pedophiles for their study. In cooperation with the prevention project *Dunkelfeld / Kein Täter werden* (*Dark Field / Don’t Offend*),¹¹ Ponseti et al. recruited non-convicted, self-identified pedophilic outpatients besides institutionalized pedophilic child offenders for their

¹⁰ Apart from the challenge of clearing the data of any distortions due to the experience of confinement, it would be interesting to inquire into the extent to which, if at all, incarceration policies have contributed to the relatively low prevalence of research on pedophilia in the neurosciences. Out of the eighteen selected original research articles, thirteen stem from German researchers (the groups around Jordan, Poepl, Ponseti, Sartorius, Schiffer, Schiltz, and Walter), two from a laboratory in Switzerland (the group around Habermeyer), and the remaining publications originate from groups in North America, where large numbers of child offenders are sent to prisons and penitentiaries, whereas they are sent to high-security forensic hospitals in Germany. In the latter environment, convicted child offenders can both undergo psychotherapy and be relatively easily available as subjects for neuroscientific studies.

¹¹ The project was incepted at the Charité in Berlin in 2005. More information is available on the project webpage: <https://www.dont-offend.org/>.

study. Whereas the forensic records were sufficient to assert the diagnosis in the institutionalized subjects, the *Dunkelfeld* outpatients had to undergo phallometric tests in order to confirm their sexual preference (Ponseti et al., 2012).¹² Even though self-identifications may not always be in line with diagnostic manuals and self-reports may be questionable, resources such as *Dunkelfeld* allow for self-referred, unrestricted study participants, who make up a very desirable participant group (Poeppel et al., 2011: 1671; Poeppel et al., 2013: 683). This can be explained by the potentially confounding influences of incarceration on brain characteristics mentioned above.

Even finer sub-classifications within groups of pedophiles have been suggested and led to more refined study results. For instance, it seems fruitful to follow the DSM in differentiating between *exclusive and non-exclusive pedophiles* (d) as defined in section III. This distinction is crucial for studies in which the brain response to both children and adult stimuli is compared in pedophilic and teleiophilic individuals (see section IV.2).

Further studies distinguish between homo-, hetero- and bisexual pedophiles (Habermeier et al., 2013b; Joyal et al., 2007; Ponseti et al., 2012; Poeppel et al., 2011; Poeppel et al., 2013; Schiffer et al., 2009; Schiffer et al., 2008a; Schiffer et al., 2008b; Schiffer et al., 2007; Suchy et al., 2009), which seems important in light of studies that have suggested differences in the processing of visual sexual stimuli with regard to the preferred sex/gender of the participant (e.g., Paul et al., 2008). Moreover, Ponseti et al. found a significantly better distinctiveness of functional brain data when both pedophiles and teleiophilic controls were grouped according to their preferred sex/gender for sexual partners and the groups were analyzed individually (Ponseti et al., 2012). Even though Schiffer et al. report that they could not find a correlation between structural brain characteristics in pedophiles and their target sex/gender (Schiffer et al., 2007), it seems alarming that at least one other group deliberately—although without providing any reasons for it—ran an experiment with an exclusively homosexual group of pedophiles and an exclusively heterosexual group of teleiophilic controls (Sartorius et al., 2008).

In contrast to the overall large number of research groups acknowledging the importance of the preferred sex/gender of their study participants, only very few studies paid attention to the target age of their pedophilic subjects. Some studies mention the age range of children offended by a pedophilic subject (e.g., Suchy et al., 2009; Walter et al., 2007), but only Poeppel et al. performed a correlative analysis, which found that gray matter volume in the orbitofrontal cortex and in subcortical regions is positively correlated with the preferred age of offended children; in other words, the more impaired an offender's brain areas for moral cognition and emotional processing, the younger the victims (Poeppel et al., 2013). Needless to say, knowing the preferred age of pedophiles is also crucial for the selection of appropriate visual stimuli in experiments.

¹² On the controversies around phallometric testing for reasons of occasional inaccuracy and fundamental ethical concerns, see the paper of Ponseti et al. (2012: 188; 193).

VI Conclusion: Ethical Concerns and Future Experiments

Pedophilia, conceptualized as a disorder of sexual preference, has not yet been neuroscientifically understood. This paper has shown that research on the neural correlates of pedophilia is diverse in its methods and inconclusive in its findings. Since this avenue of research has also been growing in the past years, suggestions for future research may be applicable.

First, it is crucial that researchers employ more coherent methods so that results across studies can be compared. For example, this requires consistent classifications of ‘the pedophile’ as a research subject and the identification of suitable control groups (demographically matched non-pedophilic child offenders and/or rapists of adults and/or non-sexual violent individuals and/or non-violent criminals and/or non-criminal teleiophiles). Determining the preferred sex/gender and target age group of pedophilic study participants further helps to determine appropriate visual stimuli in addition to finding appropriate controls. Moreover, study designs, analytical procedures, and statistical tests need to be comparable.

Second, more studies should employ a combination of different tools to get at the various levels of pedophilia as a disorder. Structural and functional findings have to be brought together in order to clearly identify pedophilia-related brain processes. Functional connectivity studies can be helpful in this respect. Furthermore, neurocognitive and neuropsychological task can illuminate an additional dimension of shared characteristics amongst pedophiles.

Third, future studies should be more receptive to ethical challenges pertaining to experimental stimuli, the potential uses of their research, and their engagement with pedophiles. As illustrated in section IV.2, some of the selected studies used visual child stimuli from unidentified or questionable studies. This practice is unacceptable. Neither should ethical commissions allow the repurposing of fashion pictures for pedophilic arousal nor should researchers assemble online pictures of nude prepubescents while they abstain from the use of video material “for legal, moral, and ethical reasons” (Schiffer et al., 2008a: 31; see also Poeppel et al., 2011: 1662–1663). The lines between pornographic online videos and online pictures of naked children may not be as clearly drawn as the researchers wish.

While the use of computer-generated visuals such as the *Not Real People* stimulus set protects ‘real’ children, these pictures look authentic enough to refresh the memory of potentially abstinent pedophilic study participants and at least virtually perpetuate child abuse. The researchers are aware of the fact that visual child stimuli elicit an “appetitive response” in pedophilic subjects (Sartorius et al., 2008: 275). That is, researchers deliberately use pictures of children, regardless of their origin, to stimulate pedophilic sexual arousal, which may increase the risk of recidivism in study participants. Future studies could experiment with non-visual stimuli, such as textual stories, for example. This would protect the children from being instrumentalized, but most likely, and unfortunately, not the pedophilic subjects from being thrown back into desires that they are trying to overcome.

Regardless of whether or not study participants get to view visual sexual stimuli, it is crucial that they can be sure that the research they volunteered to be part of will not be used to their disadvantage. This is a tough appeal since pedophilia research does not innocently aim at understanding pedophilia or finding successful treatments for it; dominant motivations are to predict the risks of recidivism in convicted child offenders and to ‘diagnose’ pedophilia in sus-

pect individuals. Whereas it is clear, as the introductory quote to this paper states, that pedophiles need to accept the consequences of their behavior, it would not be justifiable to confine individuals because their brain activation patterns look 'pedophilic' or to use any forms of pedophilia 'diagnosis' as evidence in court, for example. The predictive power of those tests is far from 100 % in laboratory settings, and real-life uses may be even more unreliable.

Dealing with pedophiles and available technologies in a way that benefits both the pedophile as well as society writ large, including offended or potentially targeted children, should be seen as one of the core tasks of neuroscientific research on pedophilia. Not only for neat study results, but also out of respect for the study participants, it is important to distinguish between individuals' brains, their desires, and their behavior. It would be a demoralizing signal to abstinent pedophiles, for instance, if pedophilia research equaled studies on child sex offenders. As far as current neuroscientific knowledge on pedophilia suggests, associated brain structures, activity patterns, or dysfunctions alone do not necessarily lead to pedophilia, let alone to sexually violent behavior. Project *Dunkelfeld*, mentioned in section V, illustrates this very well.

Interestingly, even though pedophilia is compared to or contrasted with other forms of desire, urges, and arousal in the selected studies, 'pleasure' or 'reward' are concepts rarely used in the surveyed literature. The only selected research paper mentioning 'wanting' and 'reward' calls for neuroimaging analyses of the "reward deficiency system in impulsive, addictive and (sexually) compulsive behaviors" (Schiffer et al., 2007: 760). It looks as if, in the eight years since its publication, not even the authors themselves have followed up on this idea. Future research can fill this void of research on pleasure and reward in pedophilic individuals. In particular the distinction between 'liking' and 'wanting' may eventually provide a fruitful framework for pedophilia *versus* sexual offenses towards children. This may also contribute to a stabilization of the concept of pedophilia as a multi-factorial disorder, which is not in any way directly caused by a non-existing entity that may be termed 'the pedophilic brain'.

VII Appendix

IX.1 Pedophilia (ICD-10)

F65.4 Paedophilia

- A. The general criteria for F65 Disorders of sexual preference must be met.
- B. A persistent or a predominant preference for sexual activity with a prepubescent child or children.
- C. The person is at least 16 years old and at least five years older than the child or children in B. (World Health Organization, 1993: 166–167)

F65 Disorders of Sexual Preference

- G1. Recurrent intense sexual urges and fantasies involving unusual objects or activities.
- G2. Acts on the urges or is markedly distressed by them.
- G3. The preference has been present for at least six months. (World Health Organization, 1993: 165)

IX.2 Pedophilia (DSM-IV)

■ Diagnostic criteria for 302.2 Pedophilia

- A. Over a period of at least 6 months, recurrent, intense sexually arousing fantasies, sexual urges, or behaviors involving sexual activity with a prepubescent child or children (generally age 13 years or younger).
- B. The fantasies, sexual urges, or behaviors cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.
- C. The person is at least age 16 years and at least 5 years older than the child or children in Criterion A.

Note: Do not include an individual in late adolescence involved in an ongoing sexual relationship with a 12- or 13-year-old.

Specify if:

- Sexually Attracted to Males**
- Sexually Attracted to Females**
- Sexually Attracted to Both**

Specify if:

- Limited to Incest**

Specify type:

- Exclusive Type** (attracted only to children)
- Nonexclusive Type**

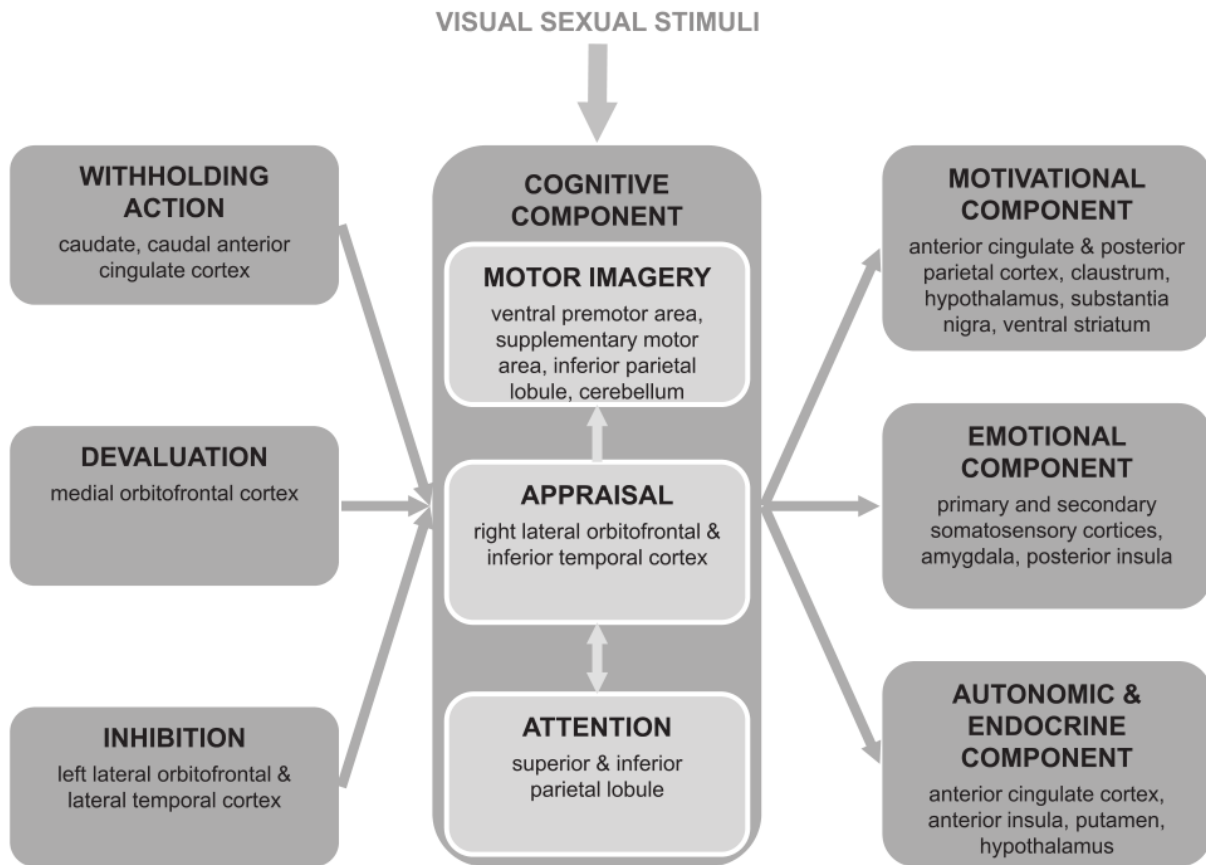
Pedophilia (American Psychiatric Association, 1994: 328)

IX.3 Pedophilic Disorder (DSM-5)

Diagnostic Criteria	302.2 (F65.4)
<p>A. Over a period of at least 6 months, recurrent, intense sexually arousing fantasies, sexual urges, or behaviors involving sexual activity with a prepubescent child or children (generally age 13 years or younger).</p>	
<p>B. The individual has acted on these sexual urges, or the sexual urges or fantasies cause marked distress or interpersonal difficulty.</p>	
<p>C. The individual is at least age 16 years and at least 5 years older than the child or children in Criterion A.</p>	
<p>Note: Do not include an individual in late adolescence involved in an ongoing sexual relationship with a 12- or 13-year-old.</p>	
<p><i>Specify whether:</i></p>	
<p>Exclusive type (attracted only to children)</p>	
<p>Nonexclusive type</p>	
<p><i>Specify if:</i></p>	
<p>Sexually attracted to males</p>	
<p>Sexually attracted to females</p>	
<p>Sexually attracted to both</p>	
<p><i>Specify if:</i></p>	
<p>Limited to incest</p>	

Pedophilic disorder (American Psychiatric Association, 2013)

IX.4 Sexual Arousal in the Brain



The neurophenomenological model of sexual arousal (Mohnke et al., 2014: 5)

IX.5 Not-Real-Person Stimuli



Stimuli as used by Jordan et al. (2014) and Poeppel et al. (2011) (Pacific Behavioral Assessment)

VIII References

- American Psychiatric Association (ed.) (1994) *Diagnostic and Statistical Manual of Mental Disorders: Fourth Edition*. Washington, D.C.: American Psychiatric Association.
- American Psychiatric Association (2013) *Paraphilic Disorders*. In: American Psychiatric Association (ed.) *Diagnostic and Statistical Manual of Mental Disorders: Fifth Edition*: American Psychiatric Association.
- Becerra García, JA (2009) Etiology of Pedophilia from a Neurodevelopmental Perspective: Markers and Brain Alterations. *Revista de psiquiatría y salud mental* 2(4): 190–196.
- Georgiadis JR and Kortekaas R (2009) The Sweetest Taboo: Functional Neurobiology of Human Sexuality in Relation to Pleasure. In: Kringelbach ML and Berridge KC (eds) *Pleasures of the Brain*. New York: Oxford University Press, 178–201.
- Habermeyer B, Esposito F, Händel N, Lemoine P, Klarhöfer M, Mager R, et al. (2013a) Immediate Processing of Erotic Stimuli in Paedophilia and Controls: A Case Control Study. *BMC Psychiatry* 13: 88–96.
- Habermeyer B, Esposito F, Händel N, Lemoine P, Kuhl HC, Klarhöfer M, et al. (2013b) Response Inhibition in Pedophilia: An fMRI Pilot Study. *Neuropsychobiology* 68(4): 228–237.
- Jordan K, Fromberger P, Laubinger H, Dechent P and Müller JL (2014) Changed Processing of Visual Sexual Stimuli under GnRH-Therapy: A Single Case Study in Pedophilia Using Eye Tracking and fMRI. *BMC Psychiatry* 14: 142–154.
- Joyal CC, Black DN and Dassylva B (2007) The Neuropsychology and Neurology of Sexual Deviance: A Review and Pilot Study. *Sexual Abuse* 19(2): 155–173.
- Kaiser A, Haller S, Schmitz S and Nitsch C (2009) On Sex/Gender Related Similarities and Differences in fMRI Language Research. *Brain Research Reviews* 61(2): 49–59.
- Mendez M and Shapira JS (2011) Pedophilic Behavior from Brain Disease. *The Journal of Sexual Medicine* 8(4): 1092–1100.
- Mohnke S, Müller S, Amelung T, Krüger, Tillmann H C, Ponseti J, Schiffer B, et al. (2014) Brain Alterations in Paedophilia: A Critical Review. *Progress in Neurobiology* 122: 1–23.
- Mokros A, Osterheider M and Nitschke J (2012) Pädophilie. Prävalenz, Ätiologie und Diagnostik. *Der Nervenarzt* 83(3): 355–358.
- Pacific Behavioral Assessment NRP (Not Real People) Visual Stimulus Set. Available at: <http://www.pacific-assmt.com/products/nrp-not-real-people-visual-stimulus-set/>.
- Paul T, Schiffer B, Zwarg T, Krüger, Tillmann H C, Karama S, Schedlowski M, et al. (2008) Brain Response to Visual Sexual Stimuli in Heterosexual and Homosexual Males. *Human Brain Mapping* 29(6): 726–735.
- Phenix A and Sreenivasan S (2009) A Practical Guide for the Evaluation of Sexual Recidivism Risk in Mentally Retarded Sex Offenders. *The journal of the American Academy of Psychiatry and the Law* 37(4): 509–524.

- Poeppel TB, Eickhoff SB, Fox PT, Laird AR, Rupperecht R, Langguth B, et al. (2015) Connectivity and Functional Profiling of Abnormal Brain Structures in Pedophilia. *Human Brain Mapping*: 1–13.
- Poeppel TB, Nitschke J, Dombert B, Santtila P, Greenlee MW, Osterheider M, et al. (2011) Functional Cortical and Subcortical Abnormalities in Pedophilia: A Combined Study Using a Choice Reaction Time Task and fMRI. *The Journal of Sexual Medicine* 8(6): 1660–1674.
- Poeppel TB, Nitschke J, Santtila P, Schecklmann M, Langguth B, Greenlee MW, et al. (2013) Association between Brain Structure and Phenotypic Characteristics in Pedophilia. *Journal of Psychiatric Research* 47(5): 678–685.
- Ponseti J, Granert O, Jansen O, Wolff S, Beier K, Neutze J, et al. (2012) Assessment of Pedophilia Using Hemodynamic Brain Response to Sexual Stimuli. *Archives of General Psychiatry* 69(2): 187–194.
- Robinson JL, Laird AR, Glahn DC, Lohvallo WR and Fox PT (2010) Metaanalytic Connectivity Modeling: Delineating the Functional Connectivity of the Human Amygdala. *Human Brain Mapping* 31(2): 173–184.
- Sartorius A, Ruf M, Kief C, Demirakca T, Bailer J, Ende G, et al. (2008) Abnormal Amygdala Activation Profile in Pedophilia. *European Archives of Psychiatry and Clinical Neuroscience* 258(5): 271–277.
- Schiffer B, Gizewski E and Kruger T (2009) Reduced Neuronal Responsiveness to Visual Sexual Stimuli in a Pedophile Treated with a Long-Acting LH-RH Agonist. *The Journal of Sexual Medicine* 6(3): 892–894.
- Schiffer B, Krueger T, Paul T, Greiff Ad, Forsting M, Leygraf N, et al. (2008a) Brain Response to Visual Sexual Stimuli in Homosexual Pedophiles. *Journal of Psychiatry and Neuroscience* 33(1): 23–33.
- Schiffer B, Paul T, Gizewski E, Forsting M, Leygraf N, Schedlowski M, et al. (2008b) Functional Brain Correlates of Heterosexual Paedophilia. *NeuroImage* 41(1): 80–91.
- Schiffer B, Peschel T, Paul T, Gizewski E, Forsting M, Leygraf N, et al. (2007) Structural Brain Abnormalities in the Fronto-striatal System and Cerebellum in Pedophilia. *Journal of Psychiatric Research* 41(9): 753–762.
- Schiffer B and Vonlaufen C (2011) Executive Dysfunctions in Pedophilic and Nonpedophilic Child Molesters. *The journal of Sexual Medicine* 8(7): 1975–1984.
- Schiltz K, Witzel J, Northoff G, Zierhut K, Gubka U, Fellmann H, et al. (2007) Brain Pathology in Pedophilic Offenders: Evidence of Volume Reduction in the Right Amygdala and Related Diencephalic Structures. *Archives of General Psychiatry* 64(6): 737–746.
- Suchy Y, Whittaker JW, Strassberg DS and Eastvold A (2009) Neurocognitive Differences between Pedophilic and Nonpedophilic Child Molesters. *Journal of the International Neuropsychological Society* 15(2): 248–257.

Walter M, Witzel J, Wiebking C, Gubka U, Rotte M, Schiltz K, et al. (2007) Pedophilia Is Linked to Reduced Activation in Hypothalamus and Lateral Prefrontal Cortex during Visual Erotic Stimulation. *Biological Psychiatry* 62(6): 698–701.

Wiebking C and Northoff G (2013) Neuroimaging in Pedophilia. *Current Psychiatry Reports* 15(4): 351–359.

World Health Organization (ed.) (1993) *The ICD-10 Classification of Mental and Behavioural Disorders: Diagnostic Criteria for Research*. Geneva: World Health Organization.