

1. Introduction

Sexual delinquency is among the most serious crimes constituting a significant societal problem and raising the most public attention (Hanson & Morton-Bourgon, 2005). They do so in particular when it concerns a re-offence committed by a forensic patient. The prevention of sexual recidivism through treatment and rehabilitation in correctional settings is crucial, given the irrefutable harm that these offences cause victims and the fear they generate in the community (CSOM, 2001). Such offences have grave physical, emotional, psychological and social impact on the victims (Boyd, 2011), which makes them incomparable and exceptional with regard to other criminal offences. The following two quotes by two victims of sexual assaults illustrate clearly the serious consequences for the victims:

“Depression followed, as did lack of any self-care or self-worth. Though I am ashamed to admit this, yes, suicide did enter my mind on many occasions and thankfully I was blessed in my life by daughters because they were my reason for surviving and pressing on even when I could barely stand my existence. I am still frequented by many of these emotions and am now just beginning, through therapy and strong support system, to work through them.” (“Summer” in Easteal & McCormond-Plummer, 2006, pp. 143-144)

“The on-going violence throughout my years of marriage was mental and sexual. My urethra was so battered I became incontinent; my psyche was so battered I became a mental cripple. I finally got out and changed my name and city, and found myself again.” (Unnamed victim in Easteal, 1994, p. 67)

With respect to the grave implications of sexual delinquency, much focus of research and the public is therefore on the issue of assessing the risk of recidivism among the group of sexual offenders. It is however challenging to find strategies that are most likely to achieve the goals of prevention of relapse (Levenson, 2009). Taking into account the significance to provide the community and more importantly victims of sexual offences a life without fear and to protect them from future assaults, rehabilitation systems could draw great benefit from a deeper engagement within the uprising neuroscientific dimension. The rapidly growing field of neurosciences and the technological and medical development offer new opportunities to understand the brain, and the correlation between damaged brain structures and misbehaviour of criminals. Sexual deviance and

violence are increasingly being associated with anomalies in the brain structure of the offenders. A better understanding of a sexual delinquent's brain and the rise of new different neuroscientific techniques provide new prospects for the rehabilitation of these delinquents.

In light of the new insights neuroscience can provide, the question arises how neuroscience could be used for the rehabilitation of sexual offenders in order to reduce the possibility for recidivism. This paper will thus analyse the possible use of neuroscience in treatment of sexual offenders before release and reintegration to community. Therefore, the study intends to provide insight into the deficiencies of contemporary rehabilitation methods. Furthermore, it attempts to propose possible innovative approaches to safe reintegration of sexual offenders by using neuroscience and to examine in how far it would be possible with regards to ethical issues. The overall claim of the paper is that neuroscience could provide complementation to rehabilitation methods aiming at the reduction of recidivism among sexual offenders, though in limitation of the respect of certain rights of the delinquent.

On account of a proper understanding of the concept 'sexual offenders', it is defined in this study as "a highly heterogeneous mixture of individuals who have committed violent sexual assaults of strangers, offenders who have had inappropriate sexual contact with family members, individuals who have molested children, and those who have engaged in a wide range of other inappropriate and criminal sexual behaviours" (CSOM, 2001). Furthermore, 'recidivism' is defined as the relapse into crime by a person, who cannot be cured of criminal tendencies and is therefore a persistent offender (Hornby, 1974). However, it is important to consider that recidivism has different operational definitions. It can be either measured by a re-arrest, by subsequent conviction, or by subsequent incarceration. Moreover, it has to be decided, when measuring recidivism of sexual offenders, whether the commission of any crime is sufficient to be classified as a recidivating act or of only sexual delinquency will be regarded as recidivism. In this study, the focus lies on merely subsequent sexual delinquency as recidivating offence.

The discussion is structured as follows. The first section illustrates the academic relevance of this study by pointing out the deficiencies of existing studies and what it aims to add to the discussion. The following section addresses the problems of contemporary rehabilitation methods. It will do so by reviewing literature and studies on recidivism of sexual offenders and on the problems of current rehabilitation. By drawing general

conclusions from the findings and providing recidivism rates, the section provides the basis for the following discussion. Subsequently, the paper will discuss which insights neuroscience has brought so far on the brain structures of sexual offenders in order to determine the neuroscientific relevance. In the fifth section, the most relevant technologies of neuroscience for this study will be presented. An analysis of their possible use and new approaches for the rehabilitation of sexual offenders will be provided. Following that, the proposed approaches will be examined in the light of ethical concerns. The last section concludes by summarising the findings of this research paper and providing impetus for further research.

2. Academic Relevance

A precise reading of academic studies related to sexual recidivism, the effectiveness of the rehabilitation of sexual offenders and neuroscience enables to determine the academic relevance of this research paper. It revealed that not much has been researched on the intersection of neuroscience and the treatment of sexual delinquents. There are several meta-studies (Hall, 1995; Hanson & Bussière, 1998; Hanson et al., 2003; Lösel & Schmucker, 2005; Hanson, 2005; Hanson et al., 2009) on recidivism of sexual offenders, in particular of paedophiles and child molesters, which provide recidivism rates based on many different studies, which were selected on the basis of established criteria by these researchers. These meta-analyses offer an initial approach to the understanding of effectiveness of treatment. However, it is difficult to draw general conclusions from all of them, as they all use a different methodology, focus on distinct follow-up periods, and are based on different operational definitions of recidivism.

More importantly, so far there has been no literature on a potential improvement of recidivism prevention related to neuroscience. Until now, studies drawing a link between neuroscience and sexual offenders focus rather on their brain structure and the understanding of deviant interests and behaviour of sexual delinquents as a result of mental disorders (McKenna, 1999; Arnow et al., 2002; Joyal et al., 2007; Dreßing et al., 2007; Schiffer et al., 2007; Dreßing et al., 2008; Witzel et al., 2008; Gillespie et al., 2012). Witzel et al. (2008) suggest that neuroimaging, for example, could help in understanding recidivism of sexual offenders. They do not however state that neuroscience could potentially help in reducing future recidivism. The current paper tries to address this deficiency by examining the possible prospect application of neuroscience in the context of rehabilitation of sexual offenders.

With regard to the before mentioned limitations and the fact that no study has so far investigated the potential application of neuroscience, the current research paper attempts to provide an innovative approach to that particular intersection of neuroscience and the criminal justice systems. Moreover this research paper will add to the discussion an analysis of several neuroscientific methods that can address particular brain regions which are considered to be related to sexual deviance and behaviour. It will complement the research made to date by adding insights into the potential impact of these neuroscientific methods on the sexual offender during treatment, and how they could contribute in preventing sexual recidivism.

With regard to ethical concerns of neuroscience, Shaw (2012) and Vincent (2012) contribute considerably to this field. Both focus however on direct brain interventions and do not relate it to sexual offenders at all. Nevertheless, they make general conclusions, which are of considerable significance for this study. Other literature (Foster, 2006; Steven & Pascual-Leone, 2006; Ford & Henderson, 2006; Klitzman, 2006) also delivers meaningful insight into ethical problems regarding neuroscience by discussing of other neuroscientific techniques, such as the Transcranial Magnetic Stimulation, neuroimaging, and Deep-Brain Stimulation. Instead discussing merely one or two specific neuroscientific methods, this study will rather attempt to provide a discussion of the ethical concerns regarding the use of several neuroscientific techniques, as presented in section 5 of this paper, for sexual offenders in particular.

3. The Flaws of Contemporary Rehabilitation

Methods

This section addresses the problems of current rehabilitation and treatment of sexual offenders. Terms such as rehabilitation and reintegration are used to refer to the psychological and social processes employed to assist criminals before or often even after their release (Seifert et al., 2003). It is employed as a sanction to protect the community from a relapse of serious sexual offenders. The main target of such a therapeutic treatment of sexual delinquents is to reduce the risk of re-offending sexually (Song & Lieb, 1994). Furthermore, treatment is provided to these criminals “to take responsibility for their behaviours, develop the necessary skills and techniques that will prevent them from engaging in sexually abusive and other harmful behaviours in the future, and

lead productive and prosocial lives” (CSOM, 2006, pp. 3-4). From a cognitive-behavioural perspective, correctional treatments intend to instil into criminals an understanding of the correlation between “thoughts, feelings, and behaviours, their impact on one’s conduct, and then developing more healthy thinking patterns and appropriate ways of managing emotions” (ibid.). Furthermore, contemporary correctional programs are aimed at deviant sexual interests, distorted cognitive perception of offending, deficient social competence, lack of empathy, and impaired way of managing aggression (Song & Lieb, 1994).

In countries such as the Netherlands, Belgium, Germany, England and Canada delinquents with a mental disorder usually face an obligatory hospitalisation in forensic psychiatric clinics. In these states, national legislation arranges a risk assessment for individuals regarded as dangerous in view of recidivism. Moreover, it provides for the possibility of a prison sentence of indeterminate duration, to prolong the sentence or keep a criminal incarcerated as soon as the sentence has been served. Such a sentence is known in England as *life sentence, imprisonment for public protection* and *extended sentence*; in Germany it is called *Sicherheitsverwahrung*; in Canada *dangerous and long-term offender designation*; and in Belgium *terschikkingstelling van de regering*” (Kogel & Nagtegaal, 2006, p. 321).

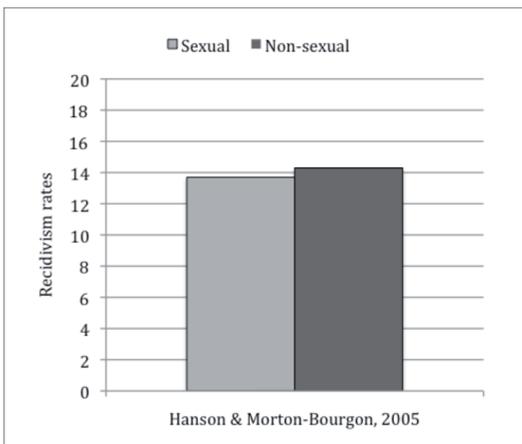
The rehabilitation of sexual offenders employs different treatment approaches – so far, these techniques are cognitive-behavioural, pharmacological, or psychotherapeutic (Motiuk, 2006). The cognitive-behavioural approach is designed to alter thinking schemes and patterns of arousal. Behaviour, beliefs, and attitudes, which are considered to increase the probability of sexual assaults, are addressed. Skills-based training is generally applied in order to strengthen empathy, self-control, and social competences (Seto, 2007; CSOM, 2001). Further, the pharmacological treatment aims at decreasing sexual arousal by means of medication. Lastly, the psychotherapeutic approach targets awareness and sense of responsibility for the offence and better concern for the victim (CSOM, 2001). Often these approaches are connected in practice. Sexual offender treatment also varies by location of the treatment – e.g. in prison, the community or a forensic clinic – and by the levels of intensity of treatment, i.e. the focus and duration (Motiuk, 2006; CSOM, 2001).

Recidivism might be much more likely among higher risk sexual offenders than lower risk ones. As Motiuk (2006) puts it, “although treatment may be more likely to reduce recidivism among higher risk sex offenders than their lower risk counterparts ... their higher risk level suggests that some of them will re-offend – even after treatment” (p. 21). In this paper it is held that every single case of victimization is one instance too much.

Therefore, we have the duty to reduce sexual offences as much as possible to prevent further victimization and hazards to society.

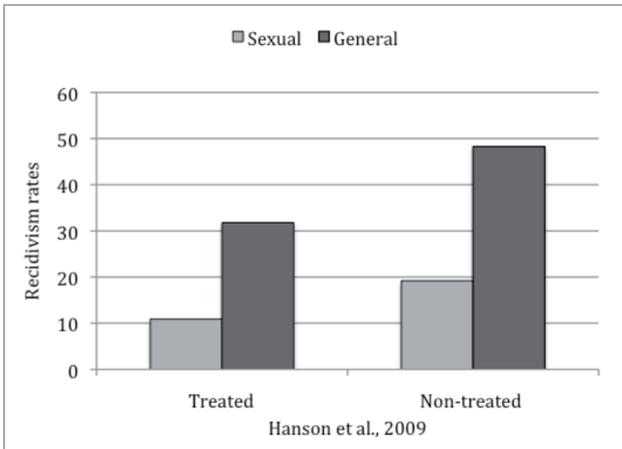
The measurement of the effectiveness of overall contemporary rehabilitation methods is rather difficult due to the different treatment approaches, the different location of treatments, the different levels of seriousness of the offenders' criminal history, and different degrees of self-reflection, i.e. whether it has been the own decision to participate or a forced one. Recidivism rates, however, can alternatively provide an approach to examine whether rehabilitation has been successful in reducing re-offence. Sexual offence recidivism rates can inform us about visible offenders, i.e. offenders who come into contact with the criminal justice systems. Although this seems to be a promising approach, there are crucial limitations. Firstly, recidivism rates "cannot tell us about hidden sexual assault such as intimate partner rape" (Stathopoulos, 2010). As Stathopoulos (2010) explains, "this type of offence, which may be repeated over years, may never come to the attention of police or end up in the justice system". Secondly, only one out of six known sexual assaults are reported, as announced by the Australian Bureau of Statistics in 2006 (ibid.). Consequently, recidivism rates can merely provide for a limited approach to understand the effectiveness of rehabilitation.

Studies on recidivism differ due to an application of distinct methods and follow-up periods, i.e. the time period until relapse. This research paper makes use of a meta-analysis by Hanson and Morton-Bourgon (2005), which reveals international results on recidivism. The analysis was based on 82 recidivism studies comprising in total 29,450 offenders.



It resulted in recidivism rates that are far lower than usually expected. By an average of 13.7 % (n = 19,267; 73 studies) sexual delinquents re-offend sexually; their violent non-sexual recidivism rate was 14,3 % (n = 6,928; 24 studies). On average, the follow-up time was 5 – 6 years (Hanson & Morton-Bourgon, 2005).

Besides this study, Hanson et al. conducted another meta-analysis in 2009. The meta-analysis was based on merely 22 recidivism outcome studies. It is particularly interesting that the study compared treated and non-treated delinquents. It included therefore 3,121 treated offenders and 3,625 untreated offenders in comparison groups. For the treatment group, the study revealed that the delinquents recidivated with an unweighted mean of 10.9 %, whereas non-treated offenders relapse with an unweighted mean of 19.2 % (Hanson et al., 2009). This illustrates clearly that rehabilitation methods do have a positive impact on sexual offenders and reduce sexual and non-sexual recidivism rates considerably.



Concluding from the foregoing findings by the international meta-analyses, most sexual offenders were not caught for another sexual offence – only 13.7 % were known for relevant recidivism. On average, sexual offenders are more likely to reoffend with a non-sexual offence than a sexual offence. Furthermore, sexual delinquents, who take treatment, are less likely to relapse than their comparison groups. However, it is important to stress that these figures underrate the actual recidivism since not all offences come to light. Nevertheless, we can learn from the recidivism rates over the effectiveness of correctional rehabilitation that not all interventions do effectively reduce recidivism. Given the grave consequences for victims of sexual offences, low recidivism rates are

nonetheless worrisome. Thus, there still remains considerable scope for improvement in sexual offender rehabilitation.

In respect of the effectiveness of rehabilitation for sexual delinquents and their deficiencies, one has to point out a crucial issue: there is never certainty over the outcome of the treatment. Even upon release a psychiatric expert can never make a prognosis over future behaviour and possible recidivism with a probability of 100%. There are always limits to each treatment and a remaining risk can hardly be assessed. Nonetheless, this cannot be a reason for keeping the delinquents arrested or in forensic clinics. In Germany, for example, a risk assessment is obligatory prior to discharge. Seifert et al. (2002) holds that “there is a noticeable trend in Germany towards over-predicting the risk posed by mentally ill offenders in an attempt to create a greater certainty” (pp. 62-63). In this respect, there is a need to improve risk assessment in order to avoid lifelong preventive detentions or clinical stay. It might be that some sexual offenders have to continue their treatment although they would probably not recidivate. Moreover, the effectiveness of risk assessment can be weakened when information fails to be correctly reported, or the experts focus on an irrelevant issue resulting in a biased impression of the offenders’ character and behaviour (Belcher, 2008).

A further deficiency of rehabilitation is that problems may arise with regard to the documentation of post-discharge progress, i.e. in the case of medication compliance (Seifert et al., 2003), which could result in an ultimate ineffective rehabilitation. Moreover, a self-assessment or self-report by the offenders forms a crucial part in rehabilitation treatments in forensic psychiatry (Hanson & Bussière, 1998). Hanson & Bussière (1998) set out that sexual offenders typically “deny recurrent deviant sexual interests or behaviour” (p. 348). Since such self-reports are easily exposed to bias, additional sources of information on the actual state of deviant interest and behaviour are necessary. Another limitation of rehabilitation methods is the fact that it is dubious whether these treatments are able to have an effect on the delinquents’ behaviour even years after they have been released (Fortune et al., 2011).

Furthermore, preventive detention causes considerable costs in the long-term. In Germany, for example, the monthly costs for a single offender amount to 6,000 to 10,000 Euros (Thüringer Allgemeine, 2011). The question remains whether introducing complementary neuroscientific treatment measures at the stage of correctional treatment cannot prevent such costs. Another major weakness is the artificial setting of treatment. Accordingly, one

cannot prove whether improvements shown within this artificial setting will also remain in the real world (Belcher, 2008). In respect of all these deficiencies, the question arises whether neuroscientific methods could provide a solution to reduce even more recidivism rates. Could it be used to improve risk assessment? Or could one make use of it for correctional treatment? These questions are addressed in the following section.

4. Clearing the Stage for Neuroscience?

4.1. A View into Sexual Offenders' Brains

In light of the relevance of neuroscience for the rehabilitation of sexual offenders, we have to understand whether sexual offenders show unusual patterns of brain activity that are critical for sexual behaviour. McKenna (1999) argues that the brain is the 'master organ' responsible for sexual functioning. Sexual functioning involves both the cortical and subcortical structures of the brain – in particular its anterior regions (Joyal et al., 2007). The regulation of sexual drive, initiation, and activation takes place in the frontal and temporal lobes. Subcortical structures, such as the amygdala, the hippocampus, the septal complex and the hypothalamus, are associated with the mental regulation of sexual behaviours and genital reactions (ibid.). Further, neuroimaging data found that the frontal, temporal cingulate and subcortical structures are responsible for the modulation of sexual arousal (Arnou et al., 2002). Joyal et al. (2007) claim moreover that hyper sexuality and paraphilia have been observed to be associated with damage to subcortical structures. Frequent findings of neuropsychological and neuroimaging studies on sexual offenders hypothesise these brain parts to be involved in sexual deviance.

Deviant sexual interest is specific for sexual delinquents, who are usually attracted to sexual acts that are considerably abnormal and unlawful (Hanson & Morton-Bourgon, 2005). Joyal et al. (2007) argue that sexual anomalies represent "signs of an inherited diseased condition of the central nervous system" (p. 156). Additionally, Schiffer et al. (2007) find that the association between frontal and temporal cortex abnormalities and paedophilia support the hypothesis that there is a connection between damaged brain structures and sexual delinquency (also: Witzel et al., 2008). Furthermore, most paedophiles show alterations of the amygdala (Schiltz et al., 2007).

In addition to the foregoing, it is crucial to point out responsible brain structures of the abilities, which are lacking for sexual offenders. Dreßing et al. (2008) set out that “the ability to control impulsivity and to exhibit socially adequate behaviour as well as the ability for moral and ethical judgement seems to be linked to the function of the prefrontal cortex” (p. 8). Further, the occurrence of antisocial personality disorders among sexual delinquents is common. As a functional Magnetic Resonance Imaging (fMRI) study revealed, men with antisocial personality disorder possess at least 11% less prefrontal grey matter compared to the control groups (Raine et al., 2000). This decreased grey matter volume is clearly found in paedophiles, in particular in the orbitofrontal cortex, the ventral striatum and the cerebellum (Schiffer et al., 2007).

In light of the aforementioned, one can conclude that sexual offenders’ brains display abnormalities in their structures. However, it is very important to stress the heterogeneity of the group of sexual offenders in which paedophiles, for example, have much more significant damages than delinquents in adult rape cases (Joyel et al., 2007; Motiuk, 2006). Nonetheless, we can argue from the foregoing that there is neuroscientific relevance for the treatment of sexual offenders.

4.2. Invasive and Non-invasive Neuroscientific Methods and their Potential Use for Rehabilitation

This section addresses the analysis of whether neuroscience could be used for the rehabilitation of sexual offenders. In respect of the deficiencies of contemporary rehabilitation methods, which were explained in section 3 of this paper, it is assumed that there is a need to search for other criteria for risk assessment and other methods for treatment. Therefore, the following paragraphs will discuss whether neuroscientific techniques could help in this context. Different techniques of neuroscience, from neuroimaging over neurostimulation to chemical castration, will be presented and their possible use will be discussed. In general, the neuroscientific dimension could contribute to rehabilitation by producing more clarity in predicting outcomes of treatment and future risk. Moreover, it could supply forensic institutions with more detailed information on the current state of the sexual offenders’ interests and behaviour.

Neuroscience provides many different techniques, whose use and focus vary significantly. Hanson & Bussière (1998) argue that the strongest predictors of sexual recidivism are factors related to sexual deviance and thus deviant sexual interests. As result of

the introduction of neuroimaging methods, the assessment of sexual interests has substantially developed (Seto, 2007). Of the several neuroimaging techniques, this research paper refers exclusively to functional Magnetic Resonance Imaging (fMRI), Positron Emission Tomography (PET) and Computed Tomography (CT).

To begin with, fMRI is a technique used for the measurement of brain activity. It is based on the fact that brain areas spend more oxygen when they are active and blood flow rises to the active brain region to meet the growing demand of oxygen. fMRI reveals the alteration in blood oxygenation and blood flow resulting from the neural activity. It is a non-invasive technique, which does not expose the patient to radiation (Devlin, 2007). Relating it to sexual deviance, one can state that functional brain imaging of sexual deviance is still at the very beginning and therefore very few studies exist. Stoléru et al. (2003), for example, hold that there is a decrease in inhibition as a result of showing sexual stimuli leading to a reduction of orbitofrontal blood flow in men with normal libido. The case for men with hypoactive sexual desire is distinct, as the same brain area remains active. The maintenance of brain activation hence brings about constant higher levels of inhibition. Does the contrary, i.e. increased blood flow and even lesser inhibition, happen to men with hyper-sexuality? Brooks (2012) states that fMRI reveals an increased cerebral blood flow of hypersexual men when presenting them sexually arousing images. In addition, paedophiles display crucially higher activation in orbitofrontal brain areas and in the right amygdala when presenting them images of children. This has been shown in fMRI studies which contrasted paedophiles with non-paedophilic control subjects, giving them images of men, women, girls and boys in the course of the imaging (Dreßling et al., 2007; Dreßling et al., 2008). A further study on homosexual paedophiles proved significant brain activation around the brain stem, the basal ganglia and the orbitofrontal cortex (Dreßling et al., 2007). One can conclude from the foregoing that the inhibition control of paedophiles is not adequately active after facing images of children (ibid.).

Similarly to the fMRI, the PET is used to display brain activity and its functional processes (Demitri, 2007). It examines trace elements of short-lived radioactive material in the brain. For this purpose special liquid containing radioactive markers, which light the brain activity, are injected. The liquid indicator detects when the radioactive substance decays due to the emission of positrons. High radioactivity in specific cerebral areas is connected with high brain activity (ibid.). Though this technique is invasive, necessitating a small quantity of radioactive substance and therefore having minimal possible side effects, it provides a good resolution of the brain activity due to the positron emission, which

effuses from brain regions that consume the oxygen and burn glucose transported by the blood flow (Gunkelman & Johnstone, 2005).

Relating these findings to the rehabilitation of sexual offenders, one can argue that fMRI and PET have certain potential at this stage of the criminal justice systems. Firstly, it could contribute to the assessments on the sexual offenders' interests, behaviours and personal traits. It could be used to detect the specific sexual interests of the offenders in order to find the most appropriate therapeutic approach. By adopting a treatment, which is not only chosen on a subjective opinion of an expert but also on objective neuroscientific findings, it could result in far more effective rehabilitation.

Furthermore, it could not only be used to find the right treatment, but also to complement the assessment of the sexual offender's state during rehabilitation. Thereby, it could optimize the on-going therapy. Lastly, fMRI and PET results could be used as additional objective criteria in contrast to subjective views of forensic experts in order to reduce possible bias caused by the 'halo-effect'. Concluding from the above, fMRI and PET could particularly mark contribution to (risk) assessment of sexual offenders. Overall, its use could affirm the certainty of choices in treatment by the forensic experts. The fact that it is a non-invasive procedure, it allows for study reproducibility and there are no known risks which makes it a convincing and appealing technology (Illes et al., 2006). Nevertheless, the information gathered through the use of fMRI and PET should be cautiously dealt with as so far it has not been proved and tested sufficiently with sexual offenders. As already mentioned above, functional brain imaging of sexual deviance is still in its infancy.

CT scanning can further picture the brain on grounds of variable absorption of x-rays. CT scans can reveal the gross features of the brain. X-rays are well absorbed by bones and hard tissue, poorly absorbed by air and water, and soft tissue lies somewhere in between. Hence, the grey and white matter in the brain can be displayed. CT scans cannot however provide concrete findings on the brain activity (ibid.). Nevertheless, it is of significance for the underlying discussion since paedophiles feature, for example, an orbitofrontal and striatal reduction of grey matter (Dreßing et al., 2007). CT would offer the possibility of examining the volumetry of grey substance and could thereby provide a complementary check on the right therapy for individual sexual offenders. It could result in a better specification of the type of sexual offender and hence in a better and more appropriate therapeutic approach.

Besides neuroimaging, neurofeedback is a neuroscientific technology that allows for the recondition, training and self-regulation of brain waves (Masterpasqua & Healey, 2003; Hammond, 2008; Gunkelman & Johnstone, 2005). During a conventional neurofeedback session, electrodes are positioned on the scalp and typically also the earlobes. These electrode devices measure the person's brainwaves while watching a computer screen, listening to audio tone and doing specific tasks. The information revealed by the measurement of the brainwaves is read and transmitted to the computer, which translates it into audio-visual feedback (Hammond, 2008; Neurofeedback, n.d.). This technology enables the patient to train the alteration of brainwave patterns and to practice the maintenance of healthier brainwave patterns. As no electrical current enters the brain, this method is non-invasive (ibid.).

So far it has been effectively used for, *inter alia*, epilepsy, stroke, alcoholism, drug abuse, post-traumatic stress disorder, depression, obsessive-compulsive disorders, attention-deficits, hyperactivity disorder, autism, schizophrenia, Parkinson's tremor, tinnitus and Tourette Syndrome (Masterpasqua & Healey, 2003; Hammond, 2008). It is commonly argued that neurofeedback can potentially produce relief from any problems influenced by brainwaves. "This would include almost anything controlled by the brain including thinking abilities, motoric responses, behavioural, emotional, and social difficulties" (Neurofeedback, n.d., par. 4).

One tool commonly applied in neurofeedback sessions is real-time fMRI. Renaud et al. (2011) proposed a methodology for neurofeedback with regard to paedophilia. They suggest a neurofeedback technique targeting the activation of the anterior cingulate cortex (ACC). The ACC is associated with impulse control and sexual arousal. If paedophiles train to decrease the cerebral activation in the ACC, their urge to act upon the sexual attraction to children might be reduced (ibid.). The authors suggest a voluntary real-time imaging for paedophiles in which they present images of children on a screen and display the children's movements according to their ACC activation. When ACC activation diminishes, then the child displayed might raise its hands, and the patient would thus recognise that the ACC activity has been effectively reduced. As complementary strategy, the patients should permanently reflect on the severe consequences of acting on their sexual urges (ibid.).

In light of the fact that the frontal lobe is associated with sexual drive, initiation, and activation, Hemoencephalography (HEG) could provide an alternative neurofeedback technique useful for frontal lobe measurement (Neurofeedback, n.d.). One form is the Near

Infrared HEG, which examines the cerebral oxygenation. A headband, which comprises an infrared light source and two optodes, surrounds the head. When the infrared lights begin to blink, the brain oxygenation is measured upon the absorption of these lights and the ratio of this absorption received at the two optodes. The information gathered in the measurement is then transformed in feedback to enable the patient to train the cerebral functions (ibid). Another form of HEG is the Passive Infrared HEG. An infrared lens, which is used as 'brain thermometer', measures the temperature and from it derives cerebral metabolism. It is a technology used for a special neurofeedback to train the enhancement and regulation of cerebral function in the frontal lobe (ibid.).

Having discussed neurofeedback, one can state that there is so far poor experience with treating paedophiles, or sexual offenders in general. Nonetheless, as Renaud et al. (2011) suggest, there might be a potential use of real-time fMRI in the context of neurofeedback to treat this type of offenders in the future. Moreover, in respect of personality and psychological disorders, which are associated with sexual offenders, neurofeedback can provide an alternative to cognitive-behavioural treatment. Gillespie et al. (2012) state that "deficits in emotional regulation are particularly pertinent in sexual offenders" (p. 333). In particular, heightened levels of emotional loneliness, personal distress, and decreased levels of self-esteem have been found among sexual offenders. A person's capacity to keep sexual drives and behaviour under control can be impaired by such emotions states, and thus resulting *inter alia* in abnormal sexual fantasies (Gillespie et al, 2012).

The regions, which are particularly associated with these personality and psychological disorders, are the prefrontal cortex, the amygdala, and the ACC. The orbitofrontal cortex in the prefrontal cortex is a region associated with disorders such as the Post-Traumatic Stress Disorder, Panic Disorder, and Obsessive Compulsive Disorder (ibid.). Explaining the concrete potential of neurofeedback for sexual offenders' brains is difficult. Nevertheless, one can express the speculation that neurofeedback for the activity of these brain regions for rehabilitating sexual offenders might be possible in the future, as the aforementioned disorders are already being treated by neurofeedback. Concluding from the above, neurofeedback for the treatment of sexual offenders is rather at its methodological stage. Nonetheless, neurofeedback in brain regions such as the frontal lobe, which controls emotions, inhibition and impulsivity, could provide some further complementary tool to therapy to rehabilitate sexual offenders in the future.

It is however important to point out that neurofeedback, as it stands now, would provide a complementary tool to therapy rather than being a therapeutic method by its own. Prof Dr R. Goebel (personal communication, April 23, 2013) argues that neurofeedback for sexual offenders would have merely indirect effects on subcortical functions. The more subcortical the deviance is, he says, the more difficult it is to correct. Nevertheless, as stated before, sexual arousal and sexual offenders' behaviour are often related to the cortical structures of the brain that would accordingly be addressed by neurofeedback. Neurofeedback is however limited to a certain compliance by the offender. The offender must have active thoughts and must focus on the treatment. Otherwise it is rather difficult to have a positive impact on the offender (ibid.). As a consequence, neurofeedback would have a rather uncertain effectiveness when used as single treatment technique.

Another advance in neuroscience, which has so far no use for the treatment of sexual deviance or delinquency, but could potentially be a complementary method for rehabilitation in the future, is neurostimulation. One neurostimulation tool is the Transcranial Magnetic Stimulation (TMS). It is a non-intrusive technology for the electrical stimulation of neural tissue and thus it has a moderate risk of serious consequences. Minimal side effects are, for example, migraines and minor skin injuries in the treatment area (López-Ibor et al., 2008). This technique "induces an electric current in the brain via application of a localized magnetic field pulse. The pulse penetrates the scalp and skull non-invasively and, depending on the parameters of stimulation, facilitates or depresses the local neuronal response with effects that can be long-lasting" (Steven & Pascual-Leone, 2006, p. 201). TMS finds applications in the study and treatment of movement disorders, epilepsy, depression, anxiety disorders, stuttering, Post-Traumatic Stress Disorder and schizophrenia (Walsh & Cowey, 2000; Kobayashi & Pascual-Leone, 2003; López-Ibor et al., 2008). The stimulation of neurons belonging to certain brain regions takes place through the supply of a current that builds a magnetic field (Walsh & Cowey, 2000). With regard to sexual offenders, the method could benefit rehabilitation by improving the correctional treatment as a therapy itself.

It is a method that activates cortical and subcortical structures in a safe, non-intrusive and relatively painless way, with minimal side effects reported (Kobayashi & Pascual-Leone, 2003; López-Ibor et al., 2008). Kobayashi and Pascual-Leone (2003) state that repetitive TMS can alter activity in the cortex with long term "behavioural effects, including visual, prefrontal, parietal cortex, as well as the cerebellum" (p.153). This offers a possibility to treatments applying repetitive TMS to regulate decreased or increased levels of cortical activity, by decreasing blood flow in the brain area stimulated which ultimately results

in a reduction of behavioural performance of tasks related to that region (ibid.; Walsh & Conway, 2000). Relating it to sexual offenders, who have an increased cerebral blood flow, TMS could decrease blood flow in cortical and subcortical brain areas related to sexual arousal. As a consequence, the behavioural performance of sexual interests and urges might be diminished.

Lastly, this paper discusses chemical castration as neuroscientific method with potential use for the rehabilitation of sexual offenders. This form of treatment already takes place in several countries – in the United States, for example, it is used for relapsed paedophiles and rapists. Chemical castration is the use of medication, namely anti-androgenic drugs, to reduce male testosterone to pre-pubertal levels (Kutcher, 2010). With the aim of constraining the impact of male sexual hormones, anti-androgens block the receptors in the brain (Barret, 2008). The predominant anti-androgenic drugs used are cyproterone acetate, medroxyprogesterone, and gonadotrophin that secrete hormone agonists such as leuprolide, goserelin and triptorelin (Grubin & Beech, 2010). The consequence of taking these drugs is the reduction of sexual drives, interest and performance. Logically it seems that such drugs might be an effective method to reduce the likelihood of sexual reoffending (ibid.). An offender with a decreased sexual interest and urges is considerably less likely to re-offence sexually (Sifferd, 2013). As most sexual offences follow from incapacity to control the sexual drives, chemical castration can be considered as a potentially effective method for rehabilitation. Grubin and Beech (2010) point out that such an intervention affecting the hormones is much more effective in decreasing recidivism rates than any other treatment approach.

The participation of offenders in psychological treatment, which might not have been previously possible or successful due to high testosterone levels, becomes possible with the taking of anti-androgenic drugs (Grubin & Beech, 2010). Consequently, these drugs enable to address the psychological qualities of sexual interest besides its hormonal part. The lowered testosterone levels not only reduce sex drive, but also sexual imagery, hence producing relief from obsessive fantasies (Berlin, 1997). Chemical castration however cannot address the psychological roots of offenders, who are not motivated by sexual drive and act as a result of personality disorders. Therefore, it is suggested that chemical castration should be used as complementary approach for rehabilitation besides cognitive-behavioural treatment or other neuroscientific methods. As it is not possible to monitor the compliance with oral drugs, they are mainly injected once a week (Berlin, 1997).

This method of dealing with the sexual interests and drives of offenders has the advantage of allowing for conditional release and enables a safe reintegration into society, provided the injection occurs in a regular and monitored manner. It offers the sexual offender the possibility to choose between longer arrest and an effective therapy for a faster release from prison and forensic psychiatry. Besides all these benefits, there are certain side effects resulting from chemical castration, for example osteoporosis, metabolic abnormalities, cardiovascular disease, and gynaecomastia (Grubin & Beech, 2010).

After having discussed the potential use of several neuroscientific methods, we must not disregard their limitations. These are addressed in the subsequent section.

4.3. Practical Limitations to Use of Neuroscience for Rehabilitation

Although neuroscientific methods seem to be promising for the rehabilitation of sexual offenders, one has to keep in mind that there are significant limitations to their application. Firstly, it has to be pointed out that early attempts to alter sexual interests have not been effective (Gordon, 2013). Moreover, there is an overall lack of knowledge of how the brain works and how to use neuroscience accordingly. Hence it seems that neuroscience has still a long way to go before being able to reveal much more information on the brain (Morse, 2011). Nonetheless, it has to be recognised that it could provide new approaches in the future if further investigation and the rise of innovative techniques provide a breeding ground for it.

Secondly, there is no proper understanding of the neurobiology of sexual interests and urges in general. Consequently, there is a need for further experiments and investigation in this field (*ibid.*). Thirdly, there are concerns regarding the validity of measures such as neurofeedback, as sexual offenders would not be exposed to a real life circumstances (*ibid.*; Morse, 2011). The situation of a sexual offender being connected to machinery and staring at a computer screen, on which images of children are shown, is certainly different from a real-life encounter with a child. Consequently, we cannot be certain about how exactly sexual offenders would behave in the real world, and whether neuroscientific advances could actually contribute to effective rehabilitation in real life, in spite of the positive results in laboratories.

Furthermore, there is a concern about the accuracy of predictions of sexual recidivism. The accuracy of neuroscientific methods in predicting recidivism is essential for rehabilitation in order to prevent any future harm caused to society (Greely, 2006). Greely (2006) further argues that

“one crucial question would become just how much accuracy, and of what kind, should be required before relying on such predictive tests. In addition, how to calculate these accuracy rates will raise their own difficult problems: we would not want to test the accuracy of tests for predicting pedophilia by releasing tested suspects to see how often they molest children” (ibid.).

As a consequence, it is necessary to find an appropriate way of foreseeing assuredly whether a sexual delinquent will reintegrate properly in society and act lawfully after release or not (Canli, 2006). A further crucial limitation is that neuroscientific methods are connected with enormous costs. These costs do not only result from the acquisition of the equipment, but also from the employment of experts who operate and maintain the neuroscientific techniques (Illes et al., 2006). Nevertheless, these costs have to be balanced with the expenses of actual incarceration, rehabilitation, re-arrest in case of re-offence, and more importantly the costs of new victimization and the therapeutic measures needed after a re-offence. Lastly and more generally, current neuroscience studies on humans take place only with a very little number of subjects. This complicates the setting up of approved methods at present (Morse, 2011). In the end, it is to stress that neuroscience as it stands now is largely in its infancy and still needs lots of development to play a significant role in the rehabilitation of sexual offenders.

All in all, one can conclude from the foregoing discussion that neuroscience could potentially contribute to the rehabilitation of sexual offenders in the future besides the practical limitations. It could provide devices that allow a better prediction of potential recidivism, and to adjust the treatment itself through better risk assessment. As additional data will be independently assessed on the basis of neuroscience, subjective mistakes by forensic experts could be avoided and there would be overall more clarity in predicting risk. In addition to that, experts would be able to develop individually adjusted treatments so that a ‘one-size-fits-all’ approach to rehabilitation would be avoided. Thereby, treatment could address the specific individual needs of each offender and thus improve the reduction of recidivism rates.

Further, the new strategies for rehabilitation in terms of neurofeedback, for example, allow an individual to have a better control of his behaviour after release. Besides this, the use of neuroscience in the context of rehabilitation and also of incarceration could not only be significant for the prediction of re-offence, but also for avoiding over-prediction, i.e. keeping sexual offenders incarcerated or in forensic clinics although they would not recidivate after release. Thus, an unjust confinement of successfully treated offenders would be prevented. In light of lifetime surveillance after release, as in the case of the German sexual offender Karl D.¹, a neuroscientific approach in terms of chemical castration or TMS for example could provide an alternative solution to such a situation. Lifetime surveillance is associated with immense costs. By conducting a cost-benefit analysis, one could decide whether a neuroscientific approach would not be the more desirable solution. A cost-benefit analysis would be similarly adequate for the decision to safe-keep an offender in preventive custody. Instead of investing in further preventive detention institutions, money could be put into neuroscientific investigations and techniques in order to enhance its future use in the field of sexual offender rehabilitation.

Moreover, neuroscientific technologies such as TMS could provide new future treatment approaches, which alter the sexual deviances, desires and associated disorders. Thus, there is certainly a potential for neuroscience in the context of the rehabilitation of sexual offenders. It has just to find its way through greater commitment to experiments, further investigation and addressing the practical limitations discussed above. Nonetheless, there are not only practical limitations to the use of neuroscientific methods. Just as crucial are the ethical concerns to their use. As these issues can hardly be reduced in the future and thus constitute a permanent limitation to the use of neuroscience, they deserve their own section in this research paper. The following section thus discusses these concerns and proposes a possible approach in handling them.

1 In the 1980s Karl D. brutally raped three girls. He was arrested until 2009 and was released although he was considered as highly risky, *inter alia* because he does not accept the most brutal rape as his own. Karl D. moved to the German town Heinsberg-Randerath nearby Aachen, where he was under permanent surveillance – 24 hours a day, 7 days a week. After his move to the city Gelsenkirchen, he still stands under lifetime surveillance.

5. Neuroscience and Rehabilitation of Sexual Offenders – an Ethical Perspective

Neuroethics is a field dealing with the benefits and dangers that neuroscientific advances on the brain provide, and debating the ethical, social and legal consequences of treating or manipulating the brain (CCLE, 2003). This section addresses the discussion of the ethical and legal challenges of neuroscience with regard to the rehabilitation of sexual offenders. The discussion revolves around concepts such as privacy, autonomy, choice, consent, personal identity and proportionality.

First of all, it is necessary to understand that sexual offenders are not merely 'sexual offenders'. They are individuals, who have offended sexually and who have nonetheless specific fundamental rights, like any other criminal. One can therefore not simply disregard their rights when applying neuroscientific methods in a rehabilitation context. These rights are at the core of what it means to be a free person. As neuroscience advances and is increasingly used for the observation, enhancement and manipulation of brains, it is of utmost importance to ensure that those rights are recognised and safeguarded.

To begin with, the Centre for Cognitive Liberty and Ethics (CCLE) (2003) emphasizes the importance of cognitive liberty. It defines cognitive liberty as "the right of each individual to think independently and autonomously, to use the full spectrum of his or her mind, and to engage in multiple modes of thought" (ibid.). Accordingly, cognitive privacy and autonomy have to be protected when applying methods that enable the control and alteration of cognition. Gordijn and Buys (2010) consider privacy to be "the power of a person or group to control information about themselves. Consequently, it involves the ability to prevent data becoming known to others than those whom one chooses to be informed" (pp. 295-296). As neuroscience is able to uncover intimate, private thoughts and mental attitudes of individuals, there are many concerns that these may jeopardize privacy (Fuchs, 2006, p. 601-602).

An approach, which would enable to overcome these concerns, is to ask for an informed consent of the offender at issue, to prohibit forced applications of neuroscience, and to provide proportional treatment (Greely, 2004). It is necessary to take account of the proportionality of the trade-offs between privacy and the use of neuroscientific methods. The use of neuroscience is justified with regard to the benefits they could provide for

offenders (Gordijn & Buys, 2010). To illustrate this conflicting issue, we can have a look at neuroimaging techniques. As has been argued before, neuroimaging techniques can provide many opportunities to ameliorate risk assessment of sexual offenders by observing their brain structures. However, as neuroimaging then uncover the offenders' psychological and mental states – thoughts, desires, and attitudes – it is clear then these cause concerns over privacy (Buller, 2006).

Another crucial point in this discussion is the impact of neuroscience on the personal identity and character. Vincent (2012), for example, argues that direct brain interventions severely impact on individual's character, personality and identity. Furthermore, Spalding (1998) states that also behavioural drugs profoundly interfere with the personality and character of a person. In this respect, Shaw (2012) sets out that interventions should not alter values, which lie at the core of an individual's personality. Neuroscience should rather enhance capacities of individuals, i.e. the capacity to better control the sexual urges in the case of sexual offenders. Even more worrying is the modification of features that are fundamental to who the person is (ibid.).

Similarly, Vincent (2012) is afraid that changing an offender's character and central values might challenge his authenticity, or might even alter his personality in so far as he would be transformed into a different 'self'. In addition, Gordijn and Buys (2010) emphasize this loss of authenticity. They set out that a person "must be 'true to herself' and feel that her experience and feelings are 'her own'" in order to be authentic (p. 294). In addition, they argue that a person distances him or herself from his or her own emotions and experiences (ibid.). Such a change of a person's character traits and personality is considered to be an inexcusable violation of his or her autonomy rights (Sifferd, 2013). One would have to ensure that a person remains herself and authentic. In the case of sexual offenders, this is however rather difficult as the change or control of sexual interests and urges automatically alter attributes which are part of their identity. Sexual offenders would be alienated from their original feelings and experiences, and would thus not be the same person as before. This is therefore a striking concern regarding the use of neuroscience for rehabilitation.

A further right linked to cognitive liberty is the right to autonomy. It is the power of independence and self-rule over one's own cognition, as the CCLE defines it (2003). It remains an individual's decision whether or how to change his or her mental processes (ibid.). With regard to the discussed neuroscientific methods, it is to say that they are

compatible with the right to autonomy as long as they are reversible. This would be *inter alia* the case for chemical castration. The right to autonomy is further connected to the concept of choice, which implies that individuals have the freedom to choose. With regard to neuroscience, this means consequently that individuals should have the right to choose whether neuroscientific methods are applied or not, and to what exact extent (Sententia, 2004). Relating it to chemical castration, for example, sexual offenders should have the right to choose a treatment with anti-androgenic drugs, if they wish to voluntarily control their sexual urges (Berlin, 1997). As Berlin (1997) puts it, “a liberalized society calls for individuals to be able to make independent choices regarding their own lives, free of government interference” (p.195). The concept of choice should not merely be limited to the question whether and to what extent neuroscience is used, but also comprise the choice of the actual treatment method.

The idea of informed choice relates to the concept of informed consent. The voluntary use of neuroscientific tools for the rehabilitation of sexual offenders with an informed consent of the sexual offender would minder the legal and ethical concerns. What is necessary for consent to be informed? Bosmann-Larsen (2011, in Shaw, 2012) argues that the offer of treatment must be suitable in order for the consent to be well founded. Therefore, it needs firstly to be a genuine offer of treatment, without any threat. Secondly, the treatment must be restrictedly directed at the behaviour for which the delinquent was condemned (Ford & Henderson, 2006).

Furthermore, the offenders must be confident of the forensic expert and understand the possible risks and side effects of the treatment (ibid.). It might be difficult for the delinquents to assess the potential of a change in their personalities, or any other complication of intervention, it is crucial to provide as much information to the offender as possible. Thus, it is less difficult for them to reach a decision on the application of neuroscience. Additionally, informed consent involves the offender’s realising and accord to advance the particular treatment. As it does not simply comprise an initial authorisation of the treatment, informed consent implies the voluntary wish and constant accord to continue the treatment. In order to encourage the offenders to make informed decisions, clear limits to the use of neuroscience should be set and they should be assisted to become aware of the possible consequences. For this purpose a safe, acceptable environment, in which the delinquents can simply recognise that more can be gained than lost from the use of the particular neuroscientific method, must be created.

Furthermore, informed consent involves the *voluntary* intent to participate in a neuroscientific treatment. Hence, the use of such technologies or drugs should not be forced (Spalding, 1998). Sententia (2004) puts it somewhat differently by stating that individuals should not be coerced to use technologies or to take drugs, which have an impact on their brain, as long as their future behaviour does not cause danger to others. Relating Sententia's idea to sexual offenders, he would argue that sexual offenders might be compelled to take anti-androgenic drugs or to participate in correctional treatment based on neuroscientific advances, as they constitute a danger for the society upon their release if not effectively rehabilitated. Limiting the offender's options can thus be justified by the need to protect society and by the value of rehabilitating the offender and restoring him to the community. In the context of sexual delinquency, it is overall difficult to say whether it is possible to make an informed decision as a sexual offender as there is always some external control and pressure, given the particular legal status of the offender. Nonetheless, Bosmann-Larsen (2011, in Shaw, 2012) states that "despite the coercive circumstances, an offender can sometimes give a valid consent to behaviour treatment when this is offered as a condition of early release from prison".

As a consequence from the foregoing, it is arguable that there is a need to follow the main purpose of using neuroscience for the rehabilitation of sexual offenders, namely the prevention of further harm to society. The different interests, i.e. the sexual offenders' rights and the society's protection, have to be balanced. It is necessary to determine in each context whether the traditional treatment is the safer option – as Shaw puts it: "what is safer for the offender may not be safer for the public" (2012). Sexual offenders do not only have rights, which have to be protected to a minimum, but also obligations to others in society, resulting from their harm committed to their victims and the community. As they have forfeited their rights as a result of their offence (Scott & Holmberg, 2003), it could be justified to use neuroscience in a non-excessive manner in order to help the sexual offender in improving his or her sexual deviance and behaviour. The question is then, to what extent it is permissible to constrain sexual delinquents' rights for the greater good of society.

Besides the discussion of constraining certain rights of sexual offenders, it is nonetheless crucial to point out the chance of greater exercise of the right to liberty. The exercise of this right could be possible through a treatment based on neuroscience that allows for parole or probation. Therefore, it is arguable that it would be a mutual give and take between society and offender in this context. Levenson and D'Amora (2005) state that the sexual

delinquent's treatment does not only benefit society, but is also a patient's best interest by reducing his or her suffering. "Community safety and alleviation of client distress are goals that can be mutually rewarding for patients and society" (ibid, p.146).

Overall, one can conclude by stating that the use of neuroscience for the rehabilitation of sexual offenders must be proportional, i.e. the benefits of treatment through neuroscientific technology or anti-androgenic drugs must exceed their risks and ethical concerns. Moreover, transparency should be increased, thus allowing the sexual offender to take an informed decision on whether to participate in neuroscientific treatment methods. Finally, an explicit scheme of continuous informed consent should be adopted to milder the effects of neuroscience on the sexual offenders' rights relating to privacy, autonomy and his personality. Nevertheless, it must not be disregarded that the delinquent has forfeited his rights by acting criminally. Thus an application of neuroscience, which constrains the sexual offenders' rights in a non-excessive way, could be permissible to some extent, however merely as last resort when there is no chance for any improvement in the foreseeable future.

6. Conclusion

Recidivism rates of sexual offenders and several problems of current rehabilitation systems, which weaken the overall effectiveness of rehabilitation, show that there is a need for improvement in order to prevent further sexual relapses. Neuroscience provides more and more insight on how damaged brain structures are connected with misbehaviour of criminals, and more specifically how unusual patterns of brain activity are related to sexual deviance. This research paper set out to examine how neuroscience could be used for rehabilitating sexual delinquents in order to reduce future sexual relapse. Therefore, it analysed the possible use of neuroscientific methods from neuroimaging, over neurostimulation and neurofeedback, to chemical castration. It is beyond me to explain the concrete possible use of neuroscience from a medical perspective. However, this paper aimed to provide a preliminary approach to this topic and to raise further discussion with the aim of raising the neuroscientific awareness in this specific context.

This study concludes that there is in fact a potential for neuroscientific methods to be used as complementary tools to therapy in the future. It could contribute in allowing for a better prediction of sexual recidivism and assessment – assessment of the progress made by the sexual offender, and assessment of the remaining risk. Further, it could provide more

objective data in order to avoid subjective mistakes by the forensic experts. Thereby, it would provide for more clarity and certainty regarding the choices made by the experts on the type of therapy and treatment, and also on risk assessment. In addition, neuroscience could help in making better and more effective adjustments of treatments according to the specific deviances and need of the delinquents. Neuroscientific technologies as tools to therapy could be moreover an alternative to preventive detention and lifetime surveillance, which would lastly result in avoiding an over-prediction of risk of sexual delinquents.

Besides these benefits, which rehabilitation systems could draw from neuroscience in the future, we have also seen that there are certain practical limitations to the application of neuroscience. These have to be addressed in the near future in order for neuroscience to be effectively applied. Moreover, ethical concerns are raised in this particular context, surrounding *inter alia* the concepts of privacy, autonomy and personality. As these rights must not be disregarded during the use of neuroscience, it is hence proposed to follow a scheme of informed consent to minder the constraints on the sexual offenders' rights as much as possible. At the same time, the interests of community must be safeguarded when applying neuroscience for the greater good of society. This different interest balancing will however lead to much discussion in the future.

Due to practical limitations, this paper did not analyse the psychological rehabilitative treatment in comparison with the neuroscientific approach. Therefore, it encourages to do so in future research. Furthermore, this study did not distinguish between different types of sexual offenders. It would be interesting and relevant to the underlying discussion if future research provides more insights into the heterogeneous group of sexual offenders. Additionally, it would be fruitful to conduct further research on more neuroscientific methods, in particular direct brain interventions.

Future debate on the underlying discussion might advance in several ways. Firstly, the debate could go into the question of whether neuroscience could be already applied to individuals who have not yet offended, but who have certain sexual deviances. However, the use of neuroscientific methods before any criminal activity entails a kind of self-incrimination. Secondly, a debate might ensue regarding the medical significance of sexual offences. If it were found that sexual offences are intrinsically tied to damaged brain structures or unusual brain activity, then these would constitute rather medical than legal problems. Would this then lead to a shift in the area of law? This question remains open for future discussion.

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