1. Introduction

Jan Willems writes in his article on the Rights of the Child that every fifth child suffers from maltreatment, even every third is not securely attached to its parents (2012, p. 5). What *attachment* means has been explained in the Encyclopedia of Child Development as the relationship between parents and their children. Parents need to be attentive and supportive towards their children. Maltreatment and neglect lead to insecure attachment resulting in, according to this article, "problem behaviours and psychopathologies" (Attachment Synthesis, 2012, p. i). Children, especially infants, seem to be particularly vulnerable to such treatment because their brains are still in the process of development. Such a kind of treatment has been explicitly forbidden by Article 19 of the United Nations (UN) Convention on the Rights of the Child (CRC). It demands of states parties to take all appropriate measures guaranteeing an environment in which children can grow up holistically. The Committee on the Rights of the Child, however, indicates that measures taken by states for this purpose are in many cases neither sufficient nor adequate (2011, p. 6). This may be the source of high costs on the criminal justice system as the Committee argues that children growing up in a violent environment are more likely to develop criminal behaviour (p. 7).

Criminal behaviour, in the case of persons below the age of 18 called delinquency, is a concept stemming from the legal field, according to which a person shows "conduct that does not conform to the legal or moral standards of society" (Deliquency, n.d.). The notion of antisocial behaviour in psychopathology features similar characteristics described as "behaviour usually marked by aggression but representing transgressions against societal norms" (Smith & Stern, 1997, p. 383). Chakraborty et al. confirm that criminal behaviour is defined by law, and that it is thus not usable in biology. This leads to the use of the notion of antisocial behaviour instead and the investigation thereof by researchers. They identify three ways of defining antisocial behaviour: the first one would be an equation with criminal behaviour and delinquency, which were explained above. This, however, seems to be problematic because a definition thereof changes over time and from one legal system to another. A second possibility is to investigate Antisocial Personality Disorder (ASPD) because it often involves the commission of criminal acts resulting from neglect of rights of fellow human beings. The third possible way of how to define antisocial behaviour is a focus on characteristics that are at risk for developing criminal behaviour, such as aggressiveness and impulsivity (Chakraborty et al., 2011, pp. 37-38).

I am seeking to find out what is meant by holistic development from a neurobiological perspective and which consequences child maltreatment has on this development. In

particular, I am focussing on criminal behaviour as a possible consequence. Hence, my research question states as follows: In how far does a violation of Article 19 of the UN Convention on the Rights of the Child lead to criminal behaviour?
My paper is structured as follows: First, I am describing the methodology used in my research in order to obtain meaningful and reliable results. A short explanation of the theoretical framework is following, which shall lay down the relation between processes occurring in the brain, its influence on behaviour and environmental impact on these processes. This framework will be used throughout the paper and will be turned back to in the end. Thereafter, insecure attachment will be further elaborated on. The section afterwards deals with the content of Article 19 of the CRC and with problems that experts see in a case of a violation thereof. The consequences of such a violation will then be considered from a neurobiological perspective, which means that the focus will be purely on the effects of maltreatment on the neurobiology of children. This will be followed by an analysis of the neurobiology of criminal personality traits. The findings are discussed afterwards followed by a conclusion consisting of a small summary and some remarks.

2. Methodology

In order to answer my research question, I am analysing articles of experts in the field of neurobiology. As I am not a neurobiological expert, I will have to rely on their descriptions of studies, their results, interpretations and opinions on this issue. However, in order to guarantee reliability, I am analysing several articles on the same issue so that a control mechanism is given. When writing from a human rights perspective, I am using primary literature wherever this is possible rather than repeating what has been said in secondary literature on the respective issue. This guarantees an own approach to the subject and more reliability and objectivity.
I have chosen literature in form of books which deal with the development of the brain during childhood in general and how it may develop under atypical circumstances. Furthermore, I have used the search option in the data bases "BioMedCentral" and "Psychology and Behavioral Sciences Collection" using the words *child maltreatment, consequences*, *criminal behaviour, (early) stress, neglect, aggression* and *neurobiology* in different combinations for rather general and/or explanatory articles, and also more specific notions, such as *norepinephrine, dopamine* and *serotonin* in combination with *violence* or *aggression*.

I am seeking to find an answer to my research question by analysing texts which give me an insight into the neurobiology of maltreated children. Thereby, it must be explained that I do not look at each specific kind of maltreatment which is listed in, for instance, Article 19 of the CRC. My aim is to draw a conclusion on that provision as a whole and not only on one kind of maltreatment in particular, which in itself can, as will be seen below, subdivided into even more categories. Hence, I chose instead to analyse the effects of stress as a result of maltreatment. This is followed by an investigation of the neurobiology of criminal behaviour. For this purpose, criminal behaviour has to be defined. As established in the introduction, this is problematic as the term is defined by legal systems and not according to neuropsychological criteria. Moreover, it differs from one system to another. Thus, the term "antisocial behaviour" is chosen, which is usable in neuropsychology. It can be analysed in three ways, of which I choose the third one. Hence, my analysis of criminal behaviour is based on three points that may be characteristic of criminal behaviour, namely aggression or violence, missing empathy, and immorality. Methodological limitations will be mentioned in the conclusion.

3. Theoretical framework: an integrated model of neuropsychological and transactional paradigms

Technologic advances have helped to explain more and more disorders by pointing to processes occurring in the brain rather than by considering behavioural or environmental influences as the sole explanation possibilities (Teeter Ellison & Semrud-Clikeman, 2007, pp. 1-2). The field of science examining the brain and its relation to a person's behaviour is called neuropsychology. It is founded on the notion that "[a]ll behaviour – including cognitive processes, which are essentially psychological – is mediated by the brain and central nervous system and their integrated and supporting physiological systems" (p. 3). However, neuropsychology does not suffice to explain the relation between different factors, such as environmental influence, behaviour and psychological aspects. Therefore, other theories should be used as well if one wants to have the full picture of the subject matter to be examined (ibid.).

In a transactional model, it is explained how environmental factors influence the child's development. First of all, the development of the central nervous system is dependent on both biogenetic factors and environmental impact, such as complications during birth or pre- and postnatal toxins or insult. The child's intellect, perception and cognitive

capacity are shaped by biological factors only, namely various brain regions, which in turn are affected by cortical and subcortical structures. These various brain regions also have an influence on the academic, behavioural and psychosocial development of the child and may be the source of disorders, just as environmental impacts. Such can be school or family, the latter of which includes the standard of living, but also the way parents treat their children (Teeter Ellison & Semrud-Clikeman, 2007, pp. 6-7). For instance, childhood stress can lead to psychopathologies. In this way, the child's development is shaped by experiences it makes. Thereby, it adapts to the circumstances in which it lives, which enables it to survive under these circumstances, but which are not adequate in a different environment (p. 7). This assumption is also the basis of the alternate developmental pathway approach, which will be dealt with in a later section.

4. The sources of insecure attachment

Attachment has been defined in the introduction as parent-child relationship that is important for the child's development in many respects, as for example its personality. Thereby, the provision of security and affection plays an especially important role (Gervai, 2009, p. 1). There are different types of attachment, which can be observed upon the performance of a so-called Strange Situation Procedure (SSP), during which the child is separated from its parent in order to observe its reaction upon reunion. Insecure attachment is shown when the child avoids its parents or when it cannot calm down; disorganised attachment, the most extreme form of insecure attachment, manifests itself in a mixture of attitudes which contradict each other. Insecure attachment is problematic for the further development of the child as it may lead to behavioural disorders (Attachment Synthesis, 2012, p. i). The kind of attachment that applies in a particular case is said to depend mainly on the sensitivity that parents provide their child with (p. ii). This would imply that children who are treated with sensitivity always develop secure attachment to their parents, while those confronted with neglect, abuse or violence are always insecurely attached. However, of those children that are maltreated, there is still a number of up to 30% that are securely attached (Gervai, 2009, p. 2). This leads to the conclusion that there are other factors that play a role as well in the formation of a certain kind of attachment. Indeed, it has been found that "anomalies of caregiver's mental state and behaviour had only low explanatory power in accounting for attachment disorganization" (p. 3). In addition to the environmental factor, there also seems to be a biological component accounting for the type of parent-child relationship (p. 4), namely

the 48 base pair tandem repeat (48 bp VNTR) of the D4 dopamine receptor (DRD4) gene which has been associated with the child's temperament. Indeed, the 7-repeat variant of the 48 bp VNTR polymorphism has been found overrepresented in children insecurely attached to their parents. It thus seems that it has protective effect if the 7-repeat allele is not transmitted facilitating the development of secure attachment (p. 5). There are other genes that modulate the effect of the kind of rearing on the child's development. For instance, the monoamine oxidase A (MAOA) gene has been found to regulate the effect of maltreatment on the development of antisocial behaviour (p. 6). These findings must be kept in mind when the rest of the paper is read: the kind of rearing, which also implies maltreatment, does not seem to have an effect on the behavioural development of the child if its genetic predisposition grants protective effect. Hence, the observations made below are valid only for those children without such protective effect.

5. Article 19 of the UN Convention on the Rights of the Child: a human rights perspective

The purpose of this section is the introduction of Article 19 CRC, which forms the basis of the present paper. The CRC was adopted on 20 November 1989. It is one of several UN Human Rights Conventions that have been adopted on the basis of the provisions of the Universal Declaration of Human Rights making these legally binding. It was negotiated and adopted by the UN Commission on Human Rights. A number of 193 states are a party to it, 140 so far have signed (United Nations Treaty Collection, n.d.; Schmidt, 2010, p. 404). Article 19 (1) of the CRC states as follows:

> States Parties shall take all appropriate legislative, administrative, social and educational measures to protect the child from all forms of physical or mental violence, injury or abuse, neglect or negligent treatment, maltreatment or exploitation, including sexual abuse, while in the care of parent(s), legal guardian(s) or any other person who has the care of the child.

The Committee on the Rights of the Child, established under Article 43 CRC, has made a general comment on this article. Such comments by the treaty bodies serve to interpret and to specify convention provisions (Schmidt, 2010, p. 409). General Comment 13 is used to specify the content of Article 19 CRC and to interpret it in the context of the whole

convention. Therefore, it refers to the different components of subparagraph 1 and defines these further. For instance, neglect implies physical, psychological, and educational neglect and neglect of the child's health. These different forms of neglect are themselves further specified. If a parent does not pay attention to the child's well-being by allowing it to be injured or by denying it basic needs such as clothes or food, this is physical neglect. Neglect of health means that the parents do not provide their child with the necessary medical care. Psychological or emotional neglect refers to a state in which the child does not receive affection and attention from its parents and does thus not feel loved and cared for (Committee on the Rights of the Child, 2011, pp. 8-9). In this way, all the different components of Article 19(1) CRC are subdivided and then further specified. The Committee seems keen on not leaving forgotten any possible form of maltreatment. Therefore, it underlines that "all forms of violence against children, however light, are unacceptable" (p. 8).

A child rights approach shall guarantee all the rights to children that are enshrined in the Convention. Children shall be considered as individual persons, having their own rights with an entitlement to a fulfilment of those. This implies that the child must have the right to express its opinion which shall be heard, laid down in Article 12. Article 3 provides that everything that concerns the child shall happen in its best interest. The best interest principle shall be interpreted in line with the whole Convention, excluding the justification for violence in the child's best interest (Committee on the Rights of the Child, 2011, pp. 23-24). The notion of development in Article 6 CRC shall be understood "as a holistic concept, embracing the child's physical, mental, spiritual, moral, psychological and social development" (p. 24). Only if all the components implied in this term are fulfilled, holistic development is ensured (Willems, 2012, pp. 11-12). Willems refers to holistic, or healthy, child development as the principal aim of the CRC. In his view, *physical* implies mainly "early brain" (2012, p. 11) development. This early brain development is the focus of the next section

6. Article 19 of the UN Convention on the Rights of the Child: from a neurobiological point of view

As indicated before, the duty to guarantee holistic child development includes the development of the child's brain (Willems, 2012, p. 11). Teicher et al. write that consistent stress during childhood greatly affects brain development regarding composition as well

as operation (Teicher et al., 2002, p. 397). In order to understand the impact of early stress on this development, it must first be set out how the brain generally develops during childhood.

6.1. The developing brain

According to the transactional paradigm, both biological and environmental factors shape the brain in its development. This can be confirmed from a neurodevelopmental point of view: the basic composition of the brain is determined by genetic information. It is then further developed by experiences we make, meaning that the neuronal connections in the brain are subject to influences from outside and are affected by those. The first stage in brain development is taken already before birth: approximately 250,000 brain cells are created every minute leading to the fastest growth phase of the brain of the whole development (Ellison & Semrud-Clikeman, 2007, p. 19). Neurons are guided to change position arriving at their final, genetically determined location and forming branches with a view to building connections. What follows is called cell death: this is a process whereby more than half of these neurons disappear because they are not needed (Teicher et al., 2002, p. 398; Ellison & Semrud-Clikeman, 2007, pp. 20-21).

New neurons are produced before birth only by the time of which the brain has adult characteristics, although it is still immature (Ellison & Semrud-Clikeman, 2007, p. 20). Afterwards it is only in the hippocampal gyrus that neurons are created. Until the age of fife, the brain becomes bigger, which is for a big part due to myelination of fiber tracts, which is a process whereby exchange of information is accelerated. In the prefrontal cortex (PFC), this process takes place at a later stage (Teicher et al., 2002, p. 398). Myelination happens in the context of development of other capabilities, such as social and cognitive behaviour. This implies that outside events can affect myelination, which again affects the child's learning process. Just as before birth, an overproduction takes place, this time however not of neurons but of synapses. In contrast to the process taking place before birth, the synapses are pruned back without neurons being deleted anew. This process is different from one brain region to the other. The frontal and parietal cortices, for instance, are those gray matter regions with the greatest increase, while the basal ganglia decrease. Other brain areas that increase are the hippocampus, amygdala, and corpus callosum (Teicher et al., 2002, pp. 399-400; Bremner, 2008, pp. 12-13). During the period of overproduction, new information is absorbed in a process which takes a lot of time and energy. At the end of this process, connections not needed are pruned back. It is this process of overproduction and subsequent pruning, which makes children especially vulnerable to stress, such

as maltreatment by their caregivers, because it can have consequences on the brain's development that are not reversible (Teicher et al., 2002, pp. 399-400).
Ellison and Semrud-Clikeman conclude that "[a]lthough genetic factors certainly map the nature and course of neuronal development, environmental factors have a significant influence on the developing nervous system" (2007, p. 22), meaning that genetics lay the foundation for our abilities, but environmental factors influence their maturation (p. 50). To guarantee well-proceeding brain development, stimulation must be appropriate (p. 22). This refers to the way parents interact with their children. Parents should be attentive towards their children and show them that they are cared for to evoke a positive effect in them. In other words: children need to be securely attached to their parents (p. 50). This is in line with the human rights perspective, according to which children only grow up holistically if the parent-child relationship is oriented towards the child's best interest. If children do not live under such circumstances, but for instance are neglected, and are thus insecurely attached to their parents, this affects their development in a negative way (p. 50). This issue is going to be dealt with in detail under the following subtitle.

6.2. Consequences of child maltreatment on the developing brain

It might seem necessary to define child maltreatment before I can go on further in my research. As was made clear in Article 19 of the CRC, child maltreatment can have various facets, and it might seem useful to focus on one in particular in order to have meaningful results in the research. However, researchers in this area have mainly focused on the consequences of stress resulting from maltreatment such as Navalta, Tomoda and Teicher, who claim that "the stress that results from CA [child abuse] has an unfavorable effect on neurodevelopment and, consequently, behavioural development" (2008, p. 50). This focus on stress rather than on one kind of maltreatment also enables me to draw a more general conclusion in the end concerning all kinds of maltreatment listed in Article 19 CRC and not merely one. Therefore, I am first defining stress in order to investigate in the second subsection its effects on brain development. The behavioural aspect will be dealt with in a later section.

6.2.1. Defining child maltreatment as stressor

According to the handbook of stress, "[s]tress can be defined as any challenge to the homeostasis of an individuum that requires an adaptive response of that individuum" (Steckler, 2005, p. 25). It is constituted by three elements, namely by a stressor, the assessment thereof, and a reaction. A stressor is an aversive stimulus that is possibly

harmful to the one experiencing it as an alteration of his environment (ibid.). Two types of stressors can be distinguished: firstly, there are those that intrude in a disagreeable way into the field surrounding the person concerned. Secondly, stressors can manifest themselves as a removal from that familiar field. Both can happen once or several times, shortly or for a long period, or they can happen continuously. The field in which the person finds himself and that is intruded by the stressor can be either external or internal. If the external field is affected, this most probably causes psychological stress, which refers to those stressors that are assessed as being stressful themselves. It is moreover considered "as an asymmetry between the motivational systems of reward and punishment" (p. 26). If, by contrast, the internal field is concerned, this results in physical stress, whereby the stressor itself is mostly not assessed but the stress is rather an automatic reaction to it. Physical and psychological stress can furthermore be distinguished by the brain regions that it activates: the latter has an impact on the higher brain regions, the former on the lower ones. However, the actual distinction between physical and psychological stressors is not always clear, and it can often be argued in both ways (pp. 26-27).

Wallick analysed among others child maltreatment as one type of stressor. She states that the exact definition of what maltreatment means differs from one legal system to another. For the purpose of the present paper, the list of different maltreatment forms laid down in Article 19 CRC serves as definition. However, as the stress resulting from this maltreatment is analysed rather than the different forms themselves, an exact definition is not of importance for the purposes of this paper. It merely needs to be emphasised that all the forms listed in that provision belong to the category of maltreatment and are therefore able to evoke the stress effect that is analysed here. This enables a general conclusion valid for the whole provision. For a confirmation of the categorisation as maltreatment of a certain kind of acts of some parents against their children, one might have a look at the Maltreatment Classification System developed by the University of North Carolina within the framework of their longitudinal studies of child abuse and neglect. Similar to Article 19 CRC, different forms of physical abuse, including violence against the child, sexual abuse, physical neglect, emotional maltreatment, and educational maltreatment are distinguished (English & LONGSCAN Investigators, 1997).

The child's affected environment can be defined as its external environment. Maltreatment would thus be classified as psychological stress, also because of the asymmetry of punishment and reward argument. According to Wallick, maltreated children are "motivated more by the necessity to avoid pain than by pleasurable reward, thus throwing out of balance the normal regulatory function of the pleasure principle" (1990, p. 205). The probably most meaningful criterion in a classification of child maltreatment as stressor

is the brain regions that are affected by it. I am going to deal with this in the second subsection.

6.2.2. Effects on the developing brain

According to Teicher et al., maltreatment during childhood, and the stress resulting from it, has effects on the developing brain because at that time it is not fully developed yet so that brain development can still be easily influenced by outer circumstances (2002, p. 397). In particular, they refer to those processes that have been claimed to be vulnerable to outside events above, namely the formation of neurons, overproduction of synapses, pruning, and myelination leading to different consequences in the various parts of the brain (2003, p. 33). There have been differing hypotheses about the concrete consequences of childhood stress on brain development. Teicher et al. suggest that the "alterations in neurodevelopment represent an adaptive, alternative developmental pathway" (p. 39), allowing the child to adapt to its stressful environment, rendering it however unable to adapt to a friendly environment. Ayoub and Rappolt-Schlichtmann confirm this hypothesis and claim that there seems to be reliable proof for it. They write that the theory of alternative developmental pathways form part of developmental traumatology, which consists of research on trauma, developmental psychology and developmental psychopathology. Thereby, emphasis is set on the effect of the environment, in particular a stressful environment due to maltreatment, on the development of children (2007, p. 306). The developmental pathway approach is founded on the notion that "skills are constructed gradually over the course of development through practice in real activities during interaction with others and independently" (p. 308). Thus, everyone's development is shaped and influenced by experiences one makes and by the spheres in which one moves. Thereby, a variation of abilities evolves which is different for every child dependent on the environment by which it is surrounded. Thus, if the child is maltreated, it develops in a different way than children growing up in a friendly and affective environment. To be more specific, maltreated children separate events and the fears resulting from these to protect themselves from being overwhelmed by those fears. If the events causing their fears continuously occur, such a separation, together with the way of thinking and feeling connected to it, becomes habit. This is then called traumatogenic alternative developmental pathway (p. 309).

As established before, child maltreatment may be considered as stressor through which stress hormones, in particular corticosteroids, are released. Under ordinary circumstances, the brain is protected from a high level of such a release, but certain stressors can lead to a high level of corticosteroid release (Teicher, 2002, p. 402). Corticosteroids have great effect

on brain development, namely glucocorticoids in children are responsible for permanent decrease in brain weight. Moreover, through an "N-methyl-D-aspartate (NMDA) receptor-dependent glutamate excitatory pathway" (ibid.), granule cell mitosis is prevented after birth in the cerebellum and dentate gyrus, which in turn, disturbs myelination. This is enabled by the hormones norepinephrine and vasopressin. Apart from that, neural morphogenesis is changed in some brain regions (p. 401).

Stress not only affects myelination, neural mitosis, and morphogenesis, but it also the stress-response system, which consists of three main components: firstly, the hippocampus together with the hypothalamic-pituitary-adrenal (HPA) axis regulating the feedback of cortisol. Secondly, a response mechanism to norepinephrine and adrenaline, responsible for among others fight or flight reactions, is needed, which is constituted by the amygdala, locus coeruleus (LC), adrenal gland, and sympathetic nervous system. Thirdly, vasopressin and oxytocin activate the release of adrenocorticotropin hormone (ACTH). Through experiences, changes in this stress-response system can be developed. Stress leads to permanent changes. For instance, neglect changes the consistence of gamma-aminobutyric acid (GABA)-benzodiazepine so that less GABA-A receptors are to be found in the amygdala and the LC. Neglect also leads to a higher level of the corticotropin-releasing hormone (CRF) mRNA, while it leads to a lower level of $\alpha 2$ noradrenergic receptors in the LC so that the feedback inhibition of noradrenergic neurons is suppressed. Neglect as well as extended stress reduces the amount of glucocorticoid receptors in the hippocampus. Furthermore, negative feedback inhibition of cortisol is decreased, while the level of vasopressin mRNA in the hypothalamus is increased so that more ACTH and corticosterone are created. To summarise the molecular effects of early stress, it leads to increased levels of norepinephrine, vasopressin and corticosteroid (Teicher, 2002, pp. 400-401).

If one investigates the structural consequences of early stress on the brain, the focus should be on those parts that have a large quantity of glucocorticoid receptors, on those parts whose neural development is not completed on birth, and on those with an extended development after birth. These parts are especially sensitive to cortisol neurotoxicity rendering them vulnerable to continuous stress during childhood. A part of the brain with these characteristics is the hippocampus (Teicher et al., 2003, p. 37). At different steps during development, there is a different amount of synapses in this area. After birth, there is an especially high amount due to overproduction as already explained before. As a result of stress, however, this overproduction does not take place. Pruning nevertheless does take place leading to a lasting state of too low a concentration of synapses (p. 34). Moreover, pyramidal cells can be changed or even destroyed as a result of stress, and the creation of new granule cells is prevented (Teicher et al., 2002, p. 402).

A region with even more glucocorticoid receptors, and also fulfilling the other two criteria for stress-sensitive brain regions, is the cerebellar vermis making it thus especially sensitive to stress (Teicher et al., 2003, p. 36). It is responsible for regulating the level of glucocorticoid through a connection to the hypothalamus. This may be important in controlling the effects of stress and neglect on the brain and behaviour (Teicher et al., 2002, p. 410). For persons who were abused or neglected during childhood, there is less perfusion of the cerebellar vermis so that it is not as active as with people without such a history, which implies that it is functionally affected so that it cannot exercise its controlling function (Teicher et al., 2003, p. 35; Ayoub & Rappolt-Schlichtmann, 2007, p. 315; Teicher et al., 2002, p. 406).

The amygdala is also affected by childhood stress. It is an important region for the occurrence of kindling, which may lead to neuronal excitability through sporadic stimulation possibly resulting in seizures. GABA is responsible for diminishing such excitability. However, as established above, the amount of GABA receptors is reduced as a result of stress. This should mean, argumentum e contrario, that neuronal excitability is not reduced. Apart from that, the serotonin and dopamine innervations are permanently affected with the level of dopamine being increased and the level of serotonin being decreased in the amygdala. Moreover, the size of the left amygdala has been found to decrease. Together with abnormal development of the hippocampus, these findings may result in temporal limbic seizures (Teicher et al., 2002, pp. 403-404).

The corpus callosum is also vulnerable to early stress because glial cell division may be hindered which is needed for myelination (Teicher et al., 2003, p. 35). Moreover, it has been found out that the volume of the corpus callosum becomes smaller in the middle parts, which may lead to less communication between the hemispheres of the cerebrum. This effect has been observed especially with boys that are neglected by their parents and with girls who have been sexually abused. Moreover, child maltreatment leads to a more dominant right hemisphere, which is responsible for emotions, in particular the negative ones (Teicher et al., 2002, p. 405; Teicher et al., 2003, p. 35; Ayoub & Rappolt-Schlichtmann, 2007, pp. 319-320; p. 321).

The cerebral cortex, in particular the PFC, also has many glucocorticoid receptors rendering it vulnerable to glucocorticoid toxicity resulting from stress (Teicher et al., 2003, p. 36). Arnsten confirms this and states that "even mild uncontrollable stress can rapidly impair PFC functions" (2009, p. 410). The cerebral cortex is a brain region developing slowly, especially the PFC with myelination extending until the mid-twenties (Teicher et al., 2003, p. 36). The ventromedial PFC (VMPFC) is connected to subcortical brain regions which are responsible for emotions and which its task is to control. The dorsolateral PFC (DLPFC),

in contrast, is connected to sensory and motor cortices so that its responsibility is the control of thought, action, and attention. Inappropriate behaviour shall be prevented by the right inferior PFC (rIPFC). If stress does not disturb the functioning of the PFC, these different parts work together to "orchestrate the brain's activity for intelligent regulation of behaviour, thought and emotion" (Arnsten, 2009, p. 411). The PFC is responsible for functioning as inhibitor to the stress response of subcortical areas as well of the HPA axis (Teicher et al., 2003, p. 36). Stress leads to a release of dopamine and norepinephrine by the amygdala to the PFC. The stress regulation by the PFC is consequently affected, while the amygdala is strengthened in its activity so that behaviour regulation as done by the amygdala instead of by the PFC meaning that it is directed by emotions and reflexes rather than by deliberation. If this happens chronically, the result is thus a weakened stress response by the PFC and instead promotion of the stress response by the amygdala (Ayoub & Rappolt-Schlichtmann, 2007, p. 320; Arnsten, 2009, p. 411; p. 418). Stress has a great impact on the structure of the PFC: it requires only one week of stress for the dendrites of the PFC to alter. Sometimes, even a one-time impact of stress is sufficient to affect the PFC (Arnsten, 2009, p. 418). Hence, adults who were maltreated while they were been children, showed a smaller volume of the left DLPFC and of the right medial PFC (McCrory et al., 2010, p. 1085). Ayoub and Rappolt-Schlichtmann state that a further effect of early stress on the PFC is retarded development thereof (2007, p. 320).
Teicher et al. conclude that the brain shapes according to experiences one makes. Thus, also the brains of children who are under continuous and severe stress shapes according to this negative experience. This creation of an alternate developmental pathway allows those children to cope with the stress of abuse or neglect they have to live with (Teicher et al., 2002, p. 414).

7. Neurobiology of criminal personality traits

As the antisocial – rather than the criminal – person's behaviour has been investigated in the field of psychology, I use these sources for my research on the neurobiology of the criminal person, focussing thereby on the character traits and behaviour that are typical for criminal persons as defined before, such as immoral behaviour, lack of empathy, and impulsive aggression, "which often culminates in physical violence" (Davidson et al., 2000, p. 591). First, it will be described which regions of the brain are responsible for moral, empathetic and non-violent behaviour in order to, as a second step, examine what may be different for people showing the negation of all these characteristics, which may be a sign for criminal behaviour as it is defined as such a negation.

7.1. Brain regions responsible for moral, empathetic and non-violent behaviour

The question is if morality, which is defined as "that code of values and customs which informs social conduct" (Marazziti et al., 2013, p. 3), really is regulated by processes in the brain or if it is rather a social construct that our brain has no influence on. The famous case of Phineas Gage, who had his frontal lobe smashed by a metal bar and whose behaviour completely changed afterwards into immoral and antisocial attitudes, leads Marazziti et al. to the conclusion that ethical and social behaviour is determined by processes that occur in the brain. Brain damage can lead to a reversal of such personality traits (2013, p. 2). The brain regions involved in morality are three parts of the frontal cortex: the VMPFC, the DLPFC, and the orbitofrontal and the ventrolateral cortex (OFC/VL) as one region. More specifically, the VMPFC is involved in the innate moral sense, which refers to the moral sense that is active if we have to take a decision in a moral problem involving ourselves and the possibility that someone else might be harmed. The DLPFC is responsible for moral problems of a more general nature, but it is also active in situations in which the innate moral sense is needed. The OFC/VL area regulates aversive reactions, it alters reactions depending on how another person reacted, and it controls impulsiveness created by the amygdala (Marazziti et al., 2013, p. 4), which will be explained below.

The VMPFC and the OFC/VL are also involved in the creation and activation of the second characteristic that is investigated here, namely empathy: the VMPFC is responsible for the ability to understand someone else's perspective on a certain issue, the OFC/VL for the emotional kind of empathy, which refers to the ability to feel with someone else and to share this person's feelings (Marazziti et al., 2013, p. 5; Rodrigo et al., 2010, p. 2). There are more areas in the brain, which are active in the creation and expression of emotions, such as empathy. Especially in the case of negative emotions, the insula is activated. The same process occurs when such emotions of fellow human beings are observed, in particular those that are dear to us. The relation between the insula and another part of the cerebral cortex, the anterior cingulated cortex (ACC), is significant as well for the experience of emotions and the ability to feel with others. The ACC relates to the autonomic nervous system, which is responsible for automatic reactions in situations when they are needed, and it also reacts in situations when something does not seems to be right (Rodrigo et al., 2010, p. 2). Thus, the ACC is not only important for empathy, but also for morality. Together with the OFC/VL, it belongs to the limbic system, which is said to be important for empathy. A further part of it is constituted by the amygdala. It is equally involved in learning and experiencing emotions, and it is responsible for reactions to the fear of others

(ibid.; Marazziti et al., 2013, p. 4). How empathy is created may be explained with the aid of so-called mirror neurons, which are active when someone pursues an action himself and also when he observes someone else pursuing this action. Marazziti et al. explain that the "neurons of the observer 'mirror' what is taking place in the mind of the observed subject, as if it were the observer that was carrying out the action" (2013, p. 5; Rodrigo et al., 2010, p. 2). Thereby, other brain areas become active, namely the inferior area of the anterior central gyrus, the posterior area of the inferior central gyrus, and the anterior rostral part of the inferior parietal lobe. Marazziti et al. emphasise, however, that it is only a hypothesis that mirror neurons are the involved in the creation of empathy (2013, p. 5).

Emotions also play a role in violence and aggression, more specifically negative emotions, such as impulsive aggression, negative affect and anger, and the inability to control them. This leads to the conclusion that non-violent people are able to control such negative emotions (Davidson et al., 2000, p. 593; p. 591). This is normally done via a mechanism, whereby an area in the PFC, which probably is the OFC, works as an inhibitor to the amygdala (p. 592). The amygdala responds to signs of threat, such as a fearful face, whereby it is important to note that the response to a fearful face is stronger than to other facial expressions, as for example an angry face. Anger is rather associated with a more active OFC and ACC, which is a mechanism that shall regulate the strength of the anger expressed (p. 591). The OFC is involved in the process of reversal learning which means that someone having reacted negatively in one case learns from this in another and restrains this negative feeling (p. 592). Based on the knowledge gained from this subsection, the next one lays down what happens in the respective brain regions if one's behaviour is immoral, unsympathetic and violent.

7.2. Neurobiology of immoral, unsympathetic and violent behaviour

Marazziti et al. indicate that studies looking at the neurobiology of criminals are restricted, but that "some criminals often display unspecific alterations at temporal level, or disturbance of other brain areas" (2013, p. 5). For instance, people behaving in an indifferent and unemotional way often show abnormal functioning of the VMPFC, the OFC/VL and the amygdala and those who are violent often have defective frontal lobes (Rodrigo et al., 2010, p. 3; Silver et al., 2003, p. 757). Teicher et al. add that irritability of the amygdala can be the reason impulsive violence and for loss of self-control (Teicher et al., 2002, p. 408).

Davidson et al. claim that persons with a defective OFC and those vulnerable to impulsive aggression are deficient at reversal learning, meaning that they are not able to suppress

their negative emotions (2000, p. 592). This is because if the OFC is defect, it cannot inhibit the reaction to aversive stimuli which is regulated by the amygdala (ibid.). This leads to an overreaction that would normally be regulated by the frontal cortex. More specifically, stimuli that would normally have no great effect now lead to exaggeratedly angry and/or aggressive reactions. Hence, if the neocortex, especially the OFC, is defective, the consequence can be anger that is not inhibited and needs not a lot of provocation so that the respective person has no regard for the effect on others that his or her anger has and the behaviour related to it. Equally, a defective amygdala can lead to violent behaviour (Silver et al., 2003, p. 757). Moreover, aggressiveness results from kindling in the amygdala (p. 758; Davidson et al., 2000, p. 593). Marazziti et al. add that early abnormal, or reduced, development of the amygdala may result in abnormal development of the VMPFC and the OFC/VL. They specify that this "would lead to an erroneous association between actions that are harmful to others and negative reinforcement of the discomfort of the victim" (2013, p. 6). Abnormal functioning of the ACC and insula, however, is rather associated with psychopathic behaviour. If the limbic and paralimbic circuitry are less active, this makes it more difficult to be empathetic, especially with the fear of someone else. It is also associated with egoistic and antisocial behaviour, such as the refusal to help, and it hinders a person from recognising when his actions render others uncomfortable. Moreover, mirror neurons, which are involved in the activation of empathy, are suggested to be abnormal in callous persons (Rodrigo et al., 2010, pp. 2-3).

More observations that were made in the brains of criminals are put forward by several authors, such as abnormalities of the temporal lobe. For instance, the so-called "dyscontrol syndrome" (Silver et al., 2003, p. 757) results from epilepsy of the temporal lobe, for which suspiciousness and no control over impulsiveness are characteristic (ibid.). Such seizures of the temporal lobe can moreover be responsible for aggressive behaviour (Teicher et al., 2002, p. 408). The hypothalamus is responsible for "fight or flight" responses linked to the autonomic reaction mechanism. If it is impaired, this may result in aggressiveness, even without being provoked (Silver et al., 2003, p. 757). A smaller volume of gray matter in the prefrontal cortex may be connected to a decreasing ability to automatically respond in a given situation, which might have been responsible for violent criminal acts in the past. Marazziti et al. add that the smaller the prefrontal cortex, the greater is the risk for antisocial behaviour. They claim that the cerebral cortex of children showing no affection seems to mature later than for other children. Davidson et al. affirm this with a finding of "hypoactivation in prefrontal territories including lateral and medial zones of the PFC" in a study of 41 murderers (2000, p. 593; Marazziti et al., 2013, p. 6). Violence is not only characterised by neurofunctional but also by also by neurochemical processes.

Norepinephrine, for instance, may be responsible for aggressive behaviour, such as sham rage, affective aggression or fighting as a result of shock (Silver et al., 2003, pp. 757). Release of norepinephrine can be the consequence of amygdaloid stimulation. However, it is not entirely clear to which extent there really is such a correlation as studies are pointing into different directions. As Siegel states, "[t]he most likely possibility is that various noradrenergic receptor subtypes mediate different effects on aggressive processes" (2005, p. 170). Serotonin, in contrast, has been studied more in this context. Less activity of serotonin, in particular if that is the case in the PFC, has been found out in various studies to lead to aggressiveness, in particular impulsive aggressiveness because serotonin is an inhibitor of such a kind of aggressiveness. In part, this low activity of serotonin can be made responsible for hyporesponsive cortisol secretion which, together with a low basal cortisol level, may permanently alter cortical and subcortical connections. Such a phenomenon has been found with people behaving aggressively (Silver et al, 2003, pp. 757-758; Davidson et al., 2000, pp. 592-593; Rodrigo et al., 2010, p. 3). By contrast, the level of dopamine has to be raised to effect aggressive behaviour (Silver et al., 2003, p. 757; Siegel, 2005, p. 175). GABA increase, in turn, is associated with less aggressiveness (Silver et al., 2003, p. 758).

These findings are compared to the neurobiology of maltreated children in the next section, which elaborates on the behavioural consequences of maltreatment, having regard especially to those characteristics that are at risk for developing criminal behaviour.

8. Discussion of findings

According to the transactional model, neurobiology is impacted by environmental occurrences. Or, to say it differently – in terms of the alternate developmental pathway approach – neurobiology adapts to the environment and the experiences that we make therein. This was observed in section 6.2 of the present paper. The child that is permanently subject to maltreatment by its parents adapts to these circumstances: the brain develops in a way that is different from that of children raised in an affective environment and that allows the child concerned to survive under the negative impact that it has to experience. Neuropsychology and the transaction model both concede furthermore an influence of neurobiology on the behaviour of the respective person. Teicher et al. state that this alternate developmental pathway leads to, among others, a hostile attitude (2002, p. 415). At another point, they speak of an alteration in social behaviour, which they explain by the release of glucocorticoids as a result of stress (p. 401). In this way, behavioural

consequences can be found for the development of each of the brain regions described in section 6.2. The hippocampus is supposed to be an important inhibitor of environmentally inappropriate actions (Teicher et al., 2003, p. 37) which leads to the conclusion that an affected hippocampus cannot exercise its inhibiting function. Hence, there seems to be a likelihood that a person with an affected hippocampus may behave inappropriately to his surroundings (Ayoub & Rappolt-Schlichtmann, 2007, p. 311). This might be an indicator of antisocial behaviour, but it does not necessarily have to lead to criminality.

The PFC is said to be responsible for making us "rational, intellectual, and moral entities" (Mobbs et al., 2007, p. 693). This function, however, is impacted by chronic stress which leads to an emotional and impulsive reaction instead of a deliberative one, which would normally be regulated by the VMPFC together with the DLPFC and the rIPFC. Instead, response to stress is controlled by the amygdala. It seems thus that the inhibitor function of the amygdala by the PFC is affected so that stressful situations lead to anger that is not inhibited leading to impulsive and aggressive reactions. Moreover, the volume of the left DLPFC becomes smaller, which might impair the function it has in the context of morality. The volume of the right medial PFC also becomes smaller as a result of stress. As said before, a smaller volume of grey matter in the PFC may have been the source of criminal acts in the past, and less activity in the PFC has been found in a study involving murderers. The VMPFC is responsible for remembering experiences and for modulating emotions and behaviour according to these memories. It has moreover the task to inhibit behaviour that is not appropriate to one's environment (Arnsten, 2009, pp. 410-411). It also directs the innate moral sense and the ability to understand the point of view of someone else. The OFC has the task of controlling impulsiveness and the emotional kind of empathy. These functions do not seem to be directly affected by stress, but indirectly they might as the PFC matures later as a result of stress. Such a late development has been found in children that do not show affection. It might also account for acts of delinquency if the regions responsible for empathy and morality develop later than normally.

As stated above, the right hemisphere of the corpus callosum is supposed to be responsible for negative emotions. If it is more dominant than the left one, this may hence lead to a prevalence of negative emotions. In an experiment, Ayoub and Rappolt-Schlichtmann observed that maltreated infants had problems telling positive stories dealing with an interaction of themselves and another person. Instead they preferred to tell negative ones, whereby they even turned positive stories into negative ones. Negative stories are also told in a more complex and active way than positive stories; they are often violent or aggressive. These infants see themselves as the bad protagonist, while non-maltreated infants consider themselves to be good (2007, pp. 321-322). This, together with the findings

of a smaller corpus callosum and reduced communication between the hemispheres, may have the consequence that the person with such a brain development becomes angry and aggressive if confronted with situations of danger or loss (Teicher et al., 2002, p. 414).
Changes in the amygdala and the limbic system can be responsible for a fight-flight response and aggressive reactions as well as impulsive violence (Teicher et al., 2002, p. 414; Teicher et al., 2003, p. 37). More concretely, irritability has been associated with the reduced size of the left amygdala side (Teicher et al., 2002, p. 404). As has been explained above, the reduction of GABA leads to kindling. At another point, it has been explained that irritability of the amygdala may be the source of violence, aggressiveness, and missing self-control. The effects on the amygdala and the hippocampus have also been found to lead to seizures of the temporal lobe, which has later been called "dyscontrol syndrome", which was said to be responsible for suspiciousness, impulsiveness and aggressiveness. Moreover, stress-induced changes in the amygdala, but also in the cerebellar vermis, may lead to violent behaviour. In this regard, Ayoub and Rappolt-Schlichtmann state that severe maltreatment may have the effect of "frequent impulsive violence, increased fear and negativity" (2007, p. 316). Apart from that, a reduced development of the cerebellar vermis plays a significant role in maintaining the stress effects flowing from the corpus callosum and the hemispheres described above (Teicher et al., 2002, p. 415).
Comparisons can also be made between the neurochemistry of stress and that of criminal characteristics: an increase of GABA has been stated to be negatively correlated with aggressiveness, meaning that a reduced level of GABA resulting from stress may result in more aggressiveness. Stress raises the level of norepinephrine. Although findings have pointed into different directions, it may be a source of different forms of aggressive behaviour. The level of dopamine has been found to increase, while that of serotonin decreases. These processes correspond exactly to what has been said about what has to occur to these neurotransmitters in order to lead to aggressiveness, in particular impulsive aggressiveness in the case of serotonin.
The cerebellar vermis is particularly vulnerable to stress because of its high density of glucocorticoid receptors. This factor renders the hippocampus and cerebral cortex vulnerable areas as well. The effect of stress on the cerebellar vermis may be violent behaviour, and the maintenance of angry and aggressive reactions resulting from stress effects on the corpus callosum and the hemispheres. Anger, aggressiveness, and impulsiveness are also consequences of stress and the effect it has on the amygdala and the PFC and the changes of dopamine, serotonin, norepinephrine and GABA levels. A striking fact is that a smaller volume and hypoactivity of the PFC have been found in criminals, in particular murderers. The PFC's responsibility in morality and empathy

may also account for these findings. Violence, aggressiveness and impulsiveness are characteristics that have been named in the beginning to define criminal behaviour. There seems thus to be a link between maltreatment of children and criminality: maltreatment is a stressor evoking changes in the brain bearing the risk to develop criminal behaviour. Maltreatment can be considered to be a psychological stressor because in addition to the external environment and reward/punishment arguments the affected brain regions seem to confirm this hypothesis. The child adapts to its malevolent environment. Not only neurostructural and neurochemical changes occur, but these changes also have an impact on the child's behaviour: it reacts more aggressively which enables it to survive in its malevolent surroundings. It makes it, however, difficult to adapt its behaviour to a friendly environment. Hence, the brain changes lead to that behaviour established before: violence, impulsiveness and aggressiveness. These factors do not necessarily lead to criminality, but they represent at least a risk for such behaviour.

Hence, the thesis may be confirmed that a violation of Article 19 CRC, which prohibits child maltreatment, has social costs in the form of high criminality rates. From a human rights perspective, it was argued that a parent-child relationship should be based on the child's best interest and its holistic development, which included, among others, brain development. If the relationship is in fact formed according to the child's best interest, this means that maltreatment does not occur. The child's opinion and its healthy development are of major interest to the parents. Moreover, the parents treat their child with affection, which in a different part of the paper has been stated to be the basis for a normal, thus holistic, brain development. This implies that there would be no reason for the brain to develop according to the alternate developmental pathway approach. There would be no reason to develop aggressive behaviour. The compliance with Article 19 CRC is thus of utmost importance not only for the protection of the child and its holistic development but also for society as a whole. The compliance with Article 19 CRC might reduce the amount of people behaving impulsively, aggressively and violently. The consequence may be a reduction of criminal acts.

9. Conclusion

The present paper sought to answer the question of in how far a violation of Article 19 of the CRC leads to criminal behaviour. Through an analysis of the impact of early stress on the brain and the neurobiology of people exhibiting character traits that might be at risk for developing criminal attitudes I arrived at the conclusion that there is a connection between the neurobiology of maltreated children and people showing impulsive, violent and aggressive behaviour. There is a connection in so far as the child's brain develops according to the alternate developmental pathway approach in such a way that the brain adapts to the unfriendly surroundings of the child. These alterations, however, continue to exist in a friendly environment and are alterations of a kind that is often found in people exhibiting criminal behaviour.

This paper focused on maltreatment as a possible source of criminality. Of course, there may be many different factors that may be a reason for becoming criminal. It shall also not be read as a generalisation. The paper is not supposed to accuse people with a history of maltreatment of becoming automatically criminal. It rather states that there might be higher risk that people with such a negative background behave aggressively and impulsively, which may in the end be the reason for criminal acts. My findings are moreover restricted by the fact that genetic predisposition may award protective effect meaning that maltreatment has no influence on the behavioural development of the person concerned.

A limitation of this paper may be that it analysed maltreatment as stressor and the effects of stressors in general on the brain. However, it could be seen that different kinds of maltreatment may have different consequences as well, also depending of the sex of the person concerned. Hence, it would be interesting to investigate in detail which kind of maltreatment listed in the CRC accounts for which kind of changes in the different brain areas. Moreover, it could be further researched how either maltreatment or its effect can be prevented by neuroscience and in how far such prevention mechanisms were ethically justifiable or in how far they would be compatible with the principles of the CRC or the UN human rights Conventions in general.

Bibliography

Arnsten, A. F. T. (2009). Stress signalling pathways that impair prefrontal cortex structure and function. *Nature Reviews Neuroscience, 10,* 410-422.

Attachment Synthesis (2012). In *Encyclopedia on Early Child Development*. Retrieved from: *http://www.child-encyclopedia.com/pages/PDF/synthesis-attachment.pdf*

Ayoub, C.C. & Rappolt-Schlichtmann, G. (2007). Child Maltreatment and the Development of Alternative Pathways in Biology and Behaviour. In D. Coch, G. Dawson & K. W. Fischer (Eds.), *Human Behaviour, Learning, and the Developing Brain* (pp. 305- 330). New York: The Guilford Press.

Bremner, D. (2008). The Neurobiology of Trauma and Memory in Children. In M. L. Howe, G. S. Goodman, & D. Cicchetti (Eds.), *Stress, Trauma, and Children's Memory Development* (pp. 11-49). Oxford: Oxford University Press.

Chakraborty, Dr., N. K., Upreti, P. N., & Mishra, A. (2011). Genetic and Environmental Influences on Criminal Behaviour. *Calcutta Law Times, 1,* 36-48.

Committee on the Rights of the Child (2011). *General comment No. 13 – The right of the child to freedom from all forms of violence*. New York: United Nations.

Davidson, R. J., Putnam, K. M., & Larson, C. L. (2000). Dysfunction in the Neural Circuitry of Emotion Regulation – A Possible Prelude to Violence. *Science 289,* pp. 591-594.

Delinquency (n.d.). In *Encyclopaedia Britannica*. Retrieved from: *http://www.britannica.com/EBchecked/topic/156597/delinquency*

English, D. J. & the LONGSCAN Investigators (1997). Modified Classification System (MMCS). Retrieved from: *http://www.iprc.unc.edu/longscan/pages/maltx/index.htm*

Gervai, J. (2009). Environmental and genetic influences on early attachment. *Child and Adolescent Psychiatry and Mental Health, 3.*

Marazziti, D., Baroni, S., Landi, P., Ceresoli, D., & Dell'Osso, L. (2013). The neurobiology of moral sense: facts or hypotheses? *Annals of General Psychiatry 12*.

McCrory, E., De Brito, S. A., & Viding, E. (2010). Research Review: The neurobiology and genetics of maltreatment and adversity. *Journal of Child Psychology and Psychiatry, 51,* 1079-1095.

Mobbs, D., Lau, H. C., Jones, L. O., & Frith, C. D. (2007). *Law, Responsibility, and the Brain*. Retrieved from: *http://papers.ssrn.com/sol3/papers.cfm?abstract_id=982487*

Navalta, C. P., Tomoda, A., & Teicher, M. H. (2008). Trajectories of Neurobehavioral Development. In M. L. Howe, G. S. Goodman, & D. Cicchetti (Eds.), *Stress, Trauma, and Children's Memory Development* (pp. 11-49). Oxford: Oxford University Press.

Rodrigo, C., Rajapakse, S. & Jayanada, G. (2010). The "antisocial" person: an insight in to biology, classification and current evidence on treatment. *Annals of General Psychiatry, 9*.

Schmidt, M. (2010). United Nations. In Daniel Moeckli (Ed.), *International Human Rights Law* (pp. 391-431). Oxford: Oxford University Press.

Siegel, A. (2005). *The Neurobiology of Aggression and Rage*. Boca Raton: CRC Press.

Silver, J. M., Anderson, K. E., & Yudorfsky, S. C. (2003). Violence and the Brain. In E. Todd & Farah, M. J. (Eds.), *Behavioural Neurology & Neuropsychiology* (pp. 755-762). New York: McGraw-Hill.

Smith, C. A. & Stern, S. B. (1997). Deliquency and Antisocial Behaviour: A Review of Family Processes and Intervention Research. *Chicago Journals, 71,* 382-420.

Steckler, T. (2005). The Neuropsychology of Stress. In T. Steckle, N. H. Kalin, & J. M. H. M. Reul (Eds.), *Handbook of Stress and the Brain* (pp. 25-42). Amsterdam: Elsevier.

Teeter Ellison, P. A. & Semrud-Clikeman, M. (2007). *Child Neuropsychology – Assessment and Interventions for Neurodevelopmental Disorders.* New York: Springer Science + Business Media.

Teicher, M. H., Andersen, S. L., Polcari, A., Anderson, C. M., Navalta, C. P., Kim, D. M. (2002). Developmental neurobiology of childhood stress and trauma. *Psychiatric Clinics of North America, 25*, 397-426.

Teicher, M. H., Andersen, S. L., Polcari, A., Anderson, C. M., Navalta, C. P., Kim, D. M. (2003). The neurobiological consequences of early stress and childhood maltreatment. *Neuroscience and Behavioural Reviews, 27*, 33-44.

United Nations (1989). *Convention on the Rights of the Child.* New York: United Nations.

United Nations Treaty Collection (n.d.). Retrieved from: *http://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=IV-11&chapter=4&lang=en*

Wallick, M. M. (1990). Developmental Sources of Stress. In J. D. Noshpitz & R. D. Coddington (Eds.), *Stressors and the Adjustment Disorders* (pp. 189-216). New York: Wiley & Sons.

Willems, J. (2012). It takes a SMECC to raise a child - Meeting Basic Developmental Needs of Newborn Persons. Retrieved from: *http://arno.unimaas.nl/show.cgi?fid=25622*