

Saša Poljak Lukek

ORCID: <https://orcid.org/0000-0001-9833-0339>

University of Ljubljana, Slovenia

Tanja Valenta

ORCID: <https://orcid.org/0000-0003-3924-9607>

Franciscan Family Institute, Ljubljana, Slovenia

Neurobiological and Relational Bases for Understanding Aggressiveness*

Abstract

Aggression is a deliberate, proactive or impulsive, defensive or active act, expressed through the use of physical power or psychological pressure. As such, it is a significant element of violent behaviour. According to developmental stages, aggression is expressed in various forms and is associated with the specific ways of regulating the feelings of shame and anger. We assume that excessive exposure and interrupted contact in development can lead to a specific regulation of the affects of shame and anger in a person who, because he feels threatened, can transform these feelings into aggressive behaviour. In addition, the dysregulated affects can lead to the dissociation of emotional experience, and thus to the inability to feel empathy, which allows for deliberate or proactive aggressiveness. Furthermore, the text presents the basic conclusions of research in the neurobiological understanding of aggression. The aggressive action is characterized by the specific functioning of the prefrontal cortex, the amygdala, and the sympathetic and parasympathetic nervous system. Abuse in childhood and relational trauma are presented as a starting point for the specific functioning of the brain and specific affect regulation, which can also be associated with aggressive behaviour in adulthood.

* The authors acknowledge partial financial support from the Slovenian Research Agency (project No. J5-9349).

Keywords

Aggression, neurobiology, relational paradigm, emotional regulation.

1. The definition of aggression

Violence, which is expressed through aggressive behaviour, is a widespread and complex phenomenon that is classified in many ways, depending on who the victim of violence/aggression is (whether it is a violent act against oneself or against another person), on the way in which violence/aggression is carried out (verbally, mentally, directly, indirectly) and on the cause of violent/aggressive behaviour (e.g. a medical cause).¹

One of the definitions is that by the World Health Organization², which defines violence as „the deliberate use of physical force or power, either as a threat or actually, against oneself, another person or against a group or community, that results in or has a high likelihood to cause bodily injury, death, psychological damage, a setback in growth (development) or the deprivation of things necessary for development.” Violence occurs at various levels, and it is especially painful in the form of relational trauma, which means that it is carried out by a person close to the victim, e.g. a family member.

We speak of two main types of aggression:

1. Affective, active, impulsive, reactive or defensive aggression, uncontrolled due to uncontrolled impulses and affects – this includes a hypothalamic sympathetic ventromedial nucleus.³ It is accompanied by anger, rage and hostility and occurs as a response to frustration or provocation, initially because of the need to stop an intense unpleasant affect which causes stress.⁴

2. A thought-out, proactive form of aggression, a planned, targeted form of violence – this includes the parasympathetic lateral hypothalamus, which is also activated in the so-called tonic immobility and dissociation.⁵ In this

¹ L. J. Siever, *Neurobiology of aggression and violence*, “American Journal of Psychiatry” 165 (2008) 4, pp. 429–442.

² World Health Organization, *World report on violence and health*, Geneva 2002, WHO.

³ C. Gostečnik, *Relacijska paradigma in travma*, Ljubljana 2008, Brat Frančišek.

⁴ D. R. Rosell, L. J. Siever, *The neurobiology of aggression and violence*, “CNS Spectrums” 20 (2015), pp. 254–279.

⁵ C. Gostečnik, *Relacijska paradigma in travma*, Ljubljana 2008, Brat Frančišek; A. N. Schore, *Affect regulation and the repair of the self*, New York 2003, W. W. Norton&Company.

case, thenegative affect of anger or rage is not necessarily present. Usually it is the perpetrator who begins a violent act, often without provocation, and he is particularly motivated by the expectation of obtaining something important, such as things, a reward, power, social dominance.⁶

This distinction is important because it refers to two very different organic systems that are strongly linked and dependent on the impact of different attachment styles.⁷ Reactive and proactive aggression often coexist and are interconnected. These two types of aggression are characteristic of borderline personality disorder and antisocial personality disorder in adults.⁸

The differences between these two aggressive responses are also the result of brain development in these individuals; reactive aggression is associated with the past experience of abuse, negative emotions and impulsiveness. Proactive aggression, on the other hand, is associated with past psychopathology, physical aggression and violent criminal acts.⁹

The WHO¹⁰ reports that there are approximately 1.43 million persons who die annually due to the consequences of aggressive behaviour, either as violence against themselves or as the victims of violent acts committed by others (the victims of war are not included in this number). The number of victims who survive aggression is even much higher.

According to research, there is a crucial link between genetic and social factors in the case of aggressive and anti-social behaviour in childhood, later in adolescence and especially in adulthood.¹¹ Social factors that are of key importance are family and cultural environment and socio-economic factors in an

⁶ D. R. Rosell, L. J. Siever, *The neurobiology of aggression and violence*, "CNS Spectrums" 20 (2015), pp. 254–279.

⁷ P. Fonagy et al., *Affect regulation, mentalization, and development of self*, New York 2007, NY: Other press; J. B. Kaplow, C. S. Widom, *Age of onset of child maltreatment predicts long-term mental health outcomes*, "Journal of Abnormal Psychology" 116 (2007), pp. 176–187; C. Gostečnik, *Relacijska paradigma in travma*, Ljubljana 2008, Brat Frančišek; A. N. Schore, *Affect regulation and the repair of the self*, New York 2003, W. W. Norton&Company.

⁸ S. Fazel, J. Danesh, *Serious mental disorder in 23.000 prisoners: a systematic review of 62 surveys*. "Lancet" 359 (2002), pp. 545–550.

⁹ D. R. Rosell, L. J. Siever, *The neurobiology of aggression and violence*, "CNS Spectrums" 20 (2015), pp. 254–279.

¹⁰ World Health Organization, *Third milestone of a global campaign for violence prevention report2007: Scaling up*, Geneva 2007, WHO.

¹¹ T. E. Moffitt, *The new look of behavioral genetics in developmental psychopathology: gene-environment interplay in antisocial behaviors*, "Psychological Bulletin" 131 (2005), pp. 533–554.

individual's life. Family environment includes both the observation of violence and being the victim of violence during childhood and adolescence.¹²

Research¹³ shows that children who have been victims of physical and/or sexual violence are in danger of becoming adults who will commit the acts of violence against others or themselves. The analysis of 6,000 American families has shown that half of the men who physically abuse their wives also abuse their children. Child exposure to physical violence between the parents, however, is the highest risk factor for the transmission of violence from one generation to the next.

Social factors such as dysfunctional families, physical and sexual abuse, family conflicts, and violent upbringing have been greatly researched¹⁴ and are among key factors for the changed brain function in regulation (or the inability to regulate) aggressive impulses.

Aggression and violence can accompany various psychiatric diagnoses: antisocial personality disorder, borderline personality disorder, post-traumatic stress disorder, ADHD, bipolar disorder, schizophrenia, and related addictions such as alcohol or drug abuse, or neuropsychiatric conditions, dementia, and autoimmune encephalitis.¹⁵

2. The expressions of aggression through developmental periods

Research shows that throughout developmental periods, aggression is a phenomenon that occurs consistently. Aggression at an early age is associated with aggression in adulthood, and the link shows that its stability is as strong

¹² K. Deater-Deckard et al, *Multiple risk factors in the development of externalizing behaviour problems: group and individual differences*, "Development and Psychopathology" 10 (1998), pp. 469–493; D. M. Fergusson, M. T. Lynskey, *Physical punishment/maltreatment during childhood and adjustment in young adulthood*, "Child Abuse&Neglect" 21 (1997), pp. 617–630.

¹³ A. A. Fagan, *The relationship between adolescent physical abuse and criminal offending: Support for an enduring and generalized cycle of violence*, "Journal of Family Violence" 20 (2005), pp. 279–290; C. S. Widom, *Does violence beget violence?: A critical examination of the literature*, "Psychological Bulletin" 106 (1989), pp. 3–28.

¹⁴ S. H. Rhee, I.D. Waldman, *Behavior-genetics of criminality and aggression*, in: D. J. Flannery, A. T. Vazsonyi, I. D. Waldman (Eds.), *The Cambridge handbook of violent behavior and aggression*, New York 2007, Cambridge University Press, pp. 77–90.

¹⁵ D. R. Rosell, L. J. Siever, *The neurobiology of aggression and violence*, "CNS Spectrums" 20 (2015), pp. 254–279.

as the stability of intelligence¹⁶, which makes the recognition of the beginnings of aggressive behaviour in the early period important for understanding aggressiveness in adulthood.

From the point of view of emotional development, the first year and a half of an individual's life is marked by the first encounters with emotional organic stimuli. In the first year of life, the infant experiences specific emotional expressions¹⁷ in his relationships with adults (most often the mother), which he transforms into permanent patterns of emotional experience. In the child's physical responses, we can recognize the following emotions¹⁸: (1) disgust, (2) joy, (3) distress, (4) anger, (5) fear and (6) sadness. In this developmental period, aggression is associated with dysregulated body states of the child, and it is assumed that excessive exposure of the infant can cause problems in controlling emotional experience, while neglecting the child in meeting his basic needs leads to the absence of emotional response. Both can be linked to the expressions of aggression in later developmental stages.

The second year of life is marked by the feelings of self-awareness, expressed as organic responses, which originate in the child's ability to be aware of himself and to be able to compare his own actions with the others' expectations and rules.¹⁹ Self-awareness enables an important step in emotional development. Along with self-awareness, certain emotions begin to develop that result from attention, comparison with external standards, and negative self-perception.²⁰ The basic emotions that arise from the awareness of one's own existence are shame, guilt and pride. To develop these emotions, the child must be (1) clearly aware of himself and of his separation from others, and (2) able to assess his own behaviour and the behaviour of others. Shame and guilt occur in events that are related to significant others. When the child experiences something that he perceives as bad or threatening, he expresses the feelings of anger, fear,

¹⁶ D. Olweus, *Stability of aggressive reaction patterns in males: a review*, "Psychological Bulletin" 86 (1979) 4, pp. 852–875.

¹⁷ N. A. Fox, C. A. Stifter, C. A., *Emotional development*, in: B. Hopkins (Ed.), *The Cambridge encyclopedia of child development*, New York 2005, Cambridge University Press, pp. 234–241.

¹⁸ N. A. Fox, C. A. Stifter, C. A., *Emotional development*, in: B. Hopkins (Ed.), *The Cambridge encyclopedia of child development*, New York 2005, Cambridge University Press, pp. 234–241.

¹⁹ C. Lewis, *Parenting and the family*, in: B. Hopkins (Ed.), *The Cambridge encyclopedia of child development*, Cambridge 2005, Cambridge University Press, pp. 340–343.

²⁰ M. Lewis, *The emergence of consciousness and its role in human development*, "Annals of the New York Academy of Sciences" 1001 (2003), pp. 104–133.

or sadness. However, if this bad or threatening event is linked to a person close to him or important for his development, he expresses the feelings of shame and guilt.²¹

With the regulation of shame, the child develops his self-initiative.²² Shame is an emotion that interrupts the eye contact and thus the contact with another person; it occurs with the development of researching and self-initiative. At that time, the child in his enthusiasm can feel that another person does not accept him, that he is subordinate and even inferior in this relationship.²³ Since shame means the interruption of the contact, the child first experiences shame as the loss of contact with himself. Excessive exposure of the child in relationships can thus cause strong feelings of shame and guilt, which gradually become increasingly threatening. Shame is associated with the feelings of deprivation²⁴, which can lead to aggressive behaviour. We can therefore assume that the excessive internalization of the feeling of shame, due to the interrupted contact combined with the child's self-initiative, leads to the unpleasant sensations of exposure against which one can fight with aggression.

Unlike shame, guilt it is not related to internal psychological imbalance but rather to feelings towards others that are reflected in excessive concern.²⁵ The child feels guilty when, due to the relationship that parents create with him, he feels that he has done something contrary to their expectations. If the child generally fulfils parents' expectations, we can talk about the functional sense of guilt, which helps the child adjust his behaviour. However, if these expectations are unachievable regarding the child's developmental abilities, we can say that this feeling is dysfunctional, since at that time the feeling of guilt is not related exclusively to the event; rather, the child begins

²¹ J. P. Tangney, R. L. Dearing, *Shame and guilt*, New York 2002, The Guilford Press.

²² E. Erikson, *Identity and the life cycle*, New York 1980, Norton.

²³ P. Gilbert, *The relationship of shame, social anxiety and depression: The role of the evaluation of social rank*, "Clinical Psychology and psychotherapy" 7 (2000), pp. 174–189.

²⁴ P. Velotti, J. Elison, C. Garofalo, *Shame and aggression: Different trajectories and implications*, "Aggression and Violent Behavior" 19 (2014) 4, pp. 454–461.

²⁵ P. Gilbert, *The relationship of shame, social anxiety and depression: The role of the evaluation of social rank*, "Clinical Psychology and psychotherapy" 7 (2000), pp. 174–189; J. Stuewig, L. A. McCloskey, *The relation of child maltreatment to shame and guilt among adolescents: Psychological routes to depression and delinquency*, "Child Maltreatment" 10 (2005) 4, pp. 324–336.

to perceive himself as an inadequate person.²⁶ Low self-esteem is associated with aggression²⁷, and the exaggerated feelings of guilt that begin to develop during this developmental period can be linked to aggressive behaviour later on.

In the second and third year of life, aggressive responses of children to their peers or parents can already be seen, with the differences in the expression of aggression between boys and girls increasing up to their sixth year.²⁸ Boys are thought to be more physically aggressive, while girls use more indirect expressions of aggression, such as verbal aggression, denial of attention, etc. For boys it is typical that aggression begins with less serious forms and progresses to more serious forms. Mild aggression thus occurs for the first time at around six and develops in a linear fashion up to the age of 16; physical aggression occurs for the first time after ten years of age, and violence with fighting occurs after the eleventh year.²⁹

Adolescence is an important period for the development of aggression. While mild aggression reaches its peak in the pre-puberty period, more serious forms of aggression are most common in late puberty and early adulthood.³⁰ To understand the changes in this period, we must take into account the developmental changes brought about by adolescence. The adolescent initially faces physiological changes, primarily with accelerated growth which increases the need for food and sleep, and changes in the formation of gender identity which is associated with changes in physical appearance and in perception.³¹ In addition, this period is critical for the development of the neurobiological system that causes changes

²⁶ M. Lewis, *The emergence of consciousness and its role in human development*, "Annals of the New York Academy of Sciences" 1001 (2003), pp. 104–133.

²⁷ P. Velotti, C. Garofalo, F. Bottazzi, V. Carett, *Faces of shame: implications for self-esteem, emotion regulation, aggression, and well-being*, "The Journal of Psychology" 151 (2017) 2, pp. 171–184.

²⁸ R. Loeber, D. Hay, *Key issues in the development of aggression and violence from childhood to early adulthood*, "Annual Review of Psychology" 48 (1997), pp. 371–410.

²⁹ R. Loeber, D. Hay, *Key issues in the development of aggression and violence from childhood to early adulthood*, "Annual Review of Psychology" 48 (1997), pp. 371–410.

³⁰ R. Loeber, D. Hay, *Key issues in the development of aggression and violence from childhood to early adulthood*, "Annual Review of Psychology" 48 (1997), pp. 371–410.

³¹ N. Garcia-Preto, *Transforming of the family system during adolescence*, in: M. McGoldrick, B. Carter, N. G. Preto (Eds.), *The expanded family life cycle: Individual, family, social perspectives*, Harlow 2014, Pearson Education Limited, pp. 226–240.

in cognitive, social and emotional functioning.³² Physiologically, the adolescent brain begins to function differently, which affects its perception and response.³³ This, of course, marks all adolescent's relationships. Aggression in the period of adolescence can be linked with a stronger awareness of one's self, which is related to the adolescent's perception of how he is seen and judged by others. For this reason, the feeling of shame is important for the adolescent's perception, as it marks his response within those relationships. When shame does not lead to an interrupted contact and withdrawal, but the feeling of exposure prompts the individual to seek guilt in others³⁴, the adolescent can become aggressive due to shame. Research suggests that low feelings of shame are associated with the feelings of anger, resentment, and hatred³⁵, which is why young people are particularly exposed to aggressive behaviour.

3. Affect regulation and aggression

Through the paradigm of emotional regulation we will now present the importance of regulation of anger in understanding aggressive behaviour. It is safe to say that anger is the main affect of aggression in relationships, although aggression, when it stems from hostility or revenge, can also occur without the affect of anger.³⁶ Certainly, the affect of anger can occur without expressive aggression. From the point of view of affect regulation, which is the ability to control, maintain and intensify emotions and is shaped through emotional, social and cognitive development of children³⁷, the regulation of anger is a constant

³² D. Yurgelun-Todd, *Emotional and cognitive changes during adolescence*, "Current Opinion in Neurobiology" 17 (2007), pp. 251–257.

³³ D. J. Siegel, *Brainstorm: The power and purpose of the teenage brain*, New York 2013, Penguin Group.

³⁴ M. Lewis, *The emergence of consciousness and its role in human development*, "Annals of the New York Academy of Sciences" 1001 (2003), pp. 104–133.

³⁵ J. P. Tangney, R. L. Dearing, *Shame and guilt*, New York 2002, The Guilford Press.

³⁶ R. Leifer, *Vinegar into honey: seven steps to understanding and transforming anger, aggression, and violence*, Ithaca 2008, Snow Lion Publications.

³⁷ N. A. Fox, C. A. Stifter, C. A., *Emotional development*, in: B. Hopkins (Ed.), *The Cambridge encyclopedia of child development*, New York 2005, Cambridge University Press, pp. 234–241; J. J. Gross, *Emotional regulation: Taking stock and moving forward*, "Emotion" 13 (2013) 3, pp. 359–365.

physical response to the feelings of physical agitation. A key mechanism of emotional regulation is the translation of body responses into emotional, behavioural and cognitive responses. The phases of emotional regulation are³⁸: (1) the child's externalization of agitation, i.e. affect, (2) parents accept this agitation and internalize it, i.e. they feel responsible for making a change, (3) parents tolerate, transform, give a name to this state of agitation and (4) return the processed affect in a safe form to the child, (5) the child accepts the processed affect as his own state (getting the feeling that his agitation is manageable). Anger is primarily a physical expression that occurs at five to six months of age and is initially seen in a specific facial expression when something is taken away from the child or when he is not able to do something.³⁹ Through the mechanism of emotional regulation, the child learns to change this specific physical sensation into a behavioural response which, in the case of anger, should be activation. When the feeling of anger is regulated with acceptance, an individual can turn this body sensation into constructive behaviour.⁴⁰ In the case of emotional dysregulation, which we recognize as an unadjusted, inflexible emotional management strategy, such as a limited expression of feelings, a lack of control over the duration and the intensity of emotions, emotional incompetence, the inability to integrate various emotions, and the inability to speak and think about one's emotions.⁴¹ Emotional dysregulation is expressed as an *overregulated* or *underregulated* emotional expression.⁴² Thus, in the case of dysregulated anger, an excessive expression of anger can occur, which can also be recognized as aggressive behaviour towards others or as a non-verbal feeling of anger, which can be expressed as internal or passive aggression.

³⁸ J. J. Gross, *Emotional regulation: Taking stock and moving forward*, "Emotion" 13 (2013) 3, pp. 359–365.

³⁹ N. A. Fox, C. A. Stifter, C. A., *Emotional development*, in: B. Hopkins (Ed.), *The Cambridge encyclopedia of child development*, New York 2005, Cambridge University Press, pp. 234–241.

⁴⁰ R. Leifer, *Vinegar into honey: seven steps to understanding and transforming anger, aggression, and violence*, Ithaca 2008, Snow Lion Publications.

⁴¹ K. K. Hyoun, K. C. Pears, D. M. Capaldi, L. D. Owen, *Emotion dysregulation in the intergenerational transmission of romantic relationship conflict*, "Journal of Family Psychology" 23 (2009) 4, pp. 585–595.

⁴² B. C. Mullin, S. P. Hinshaw, *Emotion regulation and externalizing disorders in children and adolescents*, in: J. J. Gross (Ed.), *Handbook of emotion regulation*, New York 2007: The Guilford Press, pp. 523–541.

Aggressive behaviour may be due to impulsiveness or the inability to empathize in relationships. In this regard, we speak of hostile aggression and instrumental aggression.⁴³ Hostile aggression occurs in relationships when an individual responds to a stimulus with a dysregulated expression of anger, in order to cause harm (physical, emotional or verbal) to the opponent. Instrumental aggression, on the other hand, is the result of planning with an intent to achieve a desired goal in relationships (financial gain, for example), and as such it is an expression of an inability to empathize with another. From the viewpoint of emotional regulation, it can be said that in the case of hostile aggression, emotional agitation is excessive and cannot be managed by the individual in any other way than with the expression of aggression. In the case of instrumental aggression, on the other hand, there is a lack of emotion, since in his relationships, the individual can, without any feelings of shame, fear or anger, follow his own goal with aggressive behaviour.

4. Aggression in adulthood

To understand aggressiveness in adulthood, we use the *general aggression model*, GAM⁴⁴, the integrative socio-cognitive model for understanding aggression and violence. The GAM determines three key elements of aggression: (1) the person and the situation, (2) current internal states (cognition, affect), and (3) the outcome of the assessment and decision that can cause, maintain, or even increase aggressiveness.⁴⁵

The most common personal and situational factor associated with aggression in adulthood is substance abuse, which, according to some studies, accounts for as much as 70% of aggression in relationships.⁴⁶ The most common internal

⁴³ J.J. Allen, C.A. Anderson, *Aggression and violence: definitions and distinctions*, in: P. Sturme (Ed.), *The Wiley Handbook of Violence and Aggression*, New York 2017, John Wiley & Sons Ltd., pp. 1–14.

⁴⁴ C.A. Anderson, C. Groves, *General aggression model*, in: M. S. Eastin (Ed.), *Encyclopedia of Media Violence*, Los Angeles 2013, Sage, pp. 182–187; C. N. DeWall, C. A. Anderson, B. J. Bushman, *The general aggression model: theoretical extensions to violence*, “Psychology of Violence” 1 (2011) 3, pp. 245–258.

⁴⁵ C. N. DeWall, C. A. Anderson, B. J. Bushman, *The general aggression model: theoretical extensions to violence*, “Psychology of Violence” 1 (2011) 3, pp. 245–258.

⁴⁶ T. V. McCann, D. I. Lubman, G. Boardman, M. Flood, *Affected family members’ experience of, and coping with, aggression and violence within the context of problematic substance use: a qualitative study*, “BMC Psychiatry” 17 (2017) 209, pp. 2–11.

states that can be associated with aggression are the affect of anger and hostile cognitive perception in relationships.⁴⁷ As the third factor in aggression, the GAM includes the inability of a person to decide according to the consequences, or the inability to control his responses in a given situation and under a certain affect.⁴⁸

Aggression in adulthood is thus a combination of multiple factors that influence the perception and behaviour of an adult. In addition to the factors mentioned above, research also reveals the link between early abuse and aggressiveness in adulthood, concluding that violence in intimate couple relationships is associated with early trauma in both men and women⁴⁹, and that aggression in relationships is also associated with the feelings of hostility, impulsiveness, and emotional sensitivity.⁵⁰ In addition, researchers point out that in order to understand aggressiveness in adulthood, it is important to differentiate between the types of aggression, since the dynamics of aggression differs in dependence on whether the act is carried out thoughtlessly and impulsively, or as a result of a thoughtfully planned and deliberate intent.⁵¹

5. Brain functioning and aggression

a. Prefrontal cortex

The prefrontal cortex is crucial to aggressive responses regulation, and research suggests that if a patient whose prefrontal cortex has been injured finds himself

⁴⁷ C. N. DeWall, C. A. Anderson, B. J. Bushman, *The general aggression model: theoretical extensions to violence*, "Psychology of Violence" 1 (2011) 3, pp. 245–258.

⁴⁸ C. N. DeWall, C. A. Anderson, B. J. Bushman, *The general aggression model: theoretical extensions to violence*, "Psychology of Violence" 1 (2011) 3, pp. 245–258.

⁴⁹ H. Raskin White, C. Spatz Widom, *Intimate partner violence among abused and neglected children in young adulthood: the mediating effects of early aggression, antisocial personality, hostility and alcohol problems*, "Aggressive Behavior" 29 (2003), pp. 332–345.

⁵⁰ D. Murray-Close, J. M. Ostrov, D. A. Nelson, N. R. Crick, E. F. Coccaro, E. F. *Proactive, reactive, and romantic relational aggression in adulthood: measurement, predictive validity, gender differences, and association with intermittent explosive disorder*, "Journal of Psychiatric Research" 44 (2010) 6, pp. 393–404.

⁵¹ N. A. Card, T. D. Little, *Proactive and reactive aggression in childhood and adolescence: A meta-analysis of differential relations with psychosocial adjustment*, "International Journal of Behavioral Development" 30 (2006) 5, pp. 466–480.

in a conflict situation, he may react with physical intimidation and threats.⁵² According to research, the injuries of the prefrontal cortex are also characteristic of all types of relational trauma. In children who are exposed to violence, abuse and/or neglect, the neural connections (synapses) in their brains are dying out. Individuals with such biological predispositions, where the dysregulation of aggressive behaviour occurs, are particularly susceptible to an additional negative impact such as psychosocial disadvantage with its many challenges⁵³ to which they can respond with aggression.

b. The amygdala

The main task of the amygdala is the emotional evaluation of learning and memories, and thus the formation of cognitive, affective and sympathetic presentations and responses to affectively and motivationally important stimuli.⁵⁴

Another task of the amygdala is that of assessing faces, first of the infant's caregivers, and later all others, from the beginning of one's life, according to their acceptability, accessibility and trustworthiness.⁵⁵ Relational trauma can be perceived through a facial expression that can manifest aggressive signals on a purely unconscious level.⁵⁶

The amygdala is always involved in the process when it comes to the identification of hostile and threatening affects, which occurs on the basis of somatic, unconscious memory, which was created during childhood experiences. The amygdala cannot distinguish the present from the past, therefore this identification can involve many distorted perceptions.⁵⁷

⁵² J. Grafman et al., *Frontal lobe injuries, violence and aggression: a report of the Vietnam head injury study*, "Neurology" 46 (1996), pp.1231–1238.

⁵³ D. J. Marks et al., *The interaction of psychosocial adversity and biological risk in childhood aggression*, "Psychiatry Research" 151 (2007), pp. 221–230.

⁵⁴ D. R. Rosell, L. J. Siever, *The neurobiology of aggression and violence*, "CNS Spectrums" 20 (2015), pp. 254–279.

⁵⁵ A. N. Schore, *Affect regulation and the repair of the self*, New York 2003, W. W. Norton & Company.

⁵⁶ T. H. Diseth, *Dissociation in children and adolescents as reaction to trauma-an overview of conceptual issues and neurobiological factors*, "Nordic Journal of Psychiatry" 59 (2005), pp. 79–91; C. Gostečnik, *Relacijska paradigma in travma*, Ljubljana 2008, Brat Frančišek.

⁵⁷ C. Gostečnik, *Relacijska paradigma in travma*, Ljubljana 2008, Brat Frančišek.

Certain studies indicate the link between aggression and the reduced amygdala volume⁵⁸, but the question remains whether the reduced amygdala volume is a result of an overactive or under-performing amygdala. Further observation of its activity has shown that it is more labile and unpredictable in individuals with pathological expressions of aggression.⁵⁹

Coccaro et al.⁶⁰ discuss increased amygdala activity as an answer to watching threatening faces (especially anger and fear) in aggressive adult individuals compared to the control group. Some findings suggest that when a group of aggressive individuals were watching scared and even neutral faces, increased activity in the amygdala could be traced compared to the control group.⁶¹

Lozier et al.⁶² discovered the apparent absence of activity in the right part of the amygdala in adolescents watching scared faces as compared to the control group. There was also a negative link between a ruthless threat, proactive aggression and amygdala responses to scared faces.

c. The Sympathetic and parasympathetic nervous system

The regulation of the affect in the brain is facilitated by the sympathetic and parasympathetic nervous system. When the brain detects danger, the amygdala activates the sympathetic nervous system. The sympathetic nervous system stimulates arousal in the body and the secretion of *cortisol*. During these activities, the prefrontal cortex is almost entirely excluded. The amygdala stimulates the locus coeruleus and the adrenaline medulla, which overflows the brain

⁵⁸ D. R. Rosell, L. J. Siever, *The neurobiology of aggression and violence*, "CNS Spectrums" 20 (2015), pp. 254–279.

⁵⁹ D. R. Rosell, L. J. Siever, *The neurobiology of aggression and violence*, "CNS Spectrums" 20 (2015), pp. 254–279.

⁶⁰ E. F. Coccaro et al., *Amygdala and orbitofrontal reactivity to social threat in individuals with impulsive aggression*, "Biological Psychiatry" 62 (2007), pp.168–178; D. R. Rosell, L. J. Siever, *The neurobiology of aggression and violence*, "CNS Spectrums" 20 (2015), pp. 254–279.

⁶¹ M. A. Bobes et al., *Linkage of functional and structural anomalies in the left amygdala of reactive-aggressive men*, "Social Cognitive and Affective Neuroscience" 8 (2013), pp. 928–936; D. R. Rosell, L. J. Siever, *The neurobiology of aggression and violence*, "CNS Spectrums" 20 (2015), pp. 254–279.

⁶² L. M. Lozier et al., *Mediation of the relationship between callus-unemotional traits and proactive aggression by amygdala response to fear among children with conduct problems*, "JAMA Psychiatry" 71 (2014), pp. 627–636; D. R. Rosell, L. J. Siever, *The neurobiology of aggression and violence*, "CNS Spectrums" 20 (2015), pp. 254–279.

with *norepinephrine* and the body with *adrenaline*. Cerebral activity, heart rate and blood pressure increase. This is the state of alarm that alerts the individual to danger. If the arousal increases, the individual's sole response is fight or flight to survive.

When the threat is gone, the *parasympathetic nervous system* lowers heart rate, relaxes the muscles, and lowers blood pressure. Social factors in the environment that involve constant risk (abuse, neglect), cause both nervous systems to no longer work complementary but simultaneously⁶³ and thus prevent the child from developing a functional response to stressful situations that he encounters in childhood and later in life.

Prolonged activation of the sympathetic nervous system or alarm system leads to hyper-alertness, excessive vigilance to dangerous phenomena, and inhibits attention during non-hazardous events.

Already at birth, in the right brain hemisphere there is a neural network which is responsible for dealing with stressful situations. Its neural centres are responsible for the most basic life functions of survival as well as the basic functions of stress responses.⁶⁴ The right brain hemisphere is responsible for receiving and expressing emotions as well as for controlling spontaneously stimulated emotional reactions, while the left hemisphere is responsible for processing various information and is involved in more complex processes. The two hemispheres communicate through the corpus callosum, which, however, can be affected by the excessive amount of stress hormone which reduces its volume. The reduction of corpus callosum can give rise to emotional, behavioural and dissociative problems.⁶⁵

The functions and strategies which are necessary to successfully deal with stress in the right hemisphere are strongly associated with organ functions, with the autonomic nervous system, the limbic system and the arousal system, making the right hemisphere dominant in the processing of somatic, emotional and social information.

⁶³ B. Rothschild, *Help for the helper: the psychophysiology of compassion fatigue and vicarious trauma*, New York 2006, W. W. Norton&Company.

⁶⁴ T. H. Diseth, *Dissociation in children and adolescents as reaction to trauma-an overview of conceptual issues and neurobiological factors*, "Nordic Journal of Psychiatry" 59 (2005), pp. 79–91; J. B. Kaplow, C. S. Widom, *Age of onset of child maltreatment predicts long-term mental health outcomes*, "Journal of Abnormal Psychology" 116 (2007) 1, pp. 176–187; A. N. Schore, *Affect regulation and the repair of the self*, New York 2003, W. W. Norton&Company.

⁶⁵ M. D. DeBellis, *Abuse and ACTH response to corticotropin releasing factor*, "American Journal of Psychiatry" 159 (2002), pp. 157.

Recent brain research suggests that a dysfunctional prefrontal cortex which is supposed to regulate aggression is a biological risk factor for impulsively aggressive behaviour⁶⁶ which means that the prefrontal cortex is unable to modulate or correct the function of the amygdala. The amygdala is not able to receive feedback information that the danger is over; hence the body remains in the state of alert to the response that is needed to deal with the threat.

Functional action and the process of the regulation of stress and aggressive impulses include the interconnection of the amygdala, where there is a centre for fear and aggression, and the prefrontal cortex, as well as the connection between the frontal part of the brain and the limbic system and the hypothalamus, which is the basic organ of the autonomic nervous system and the fight-or-flight control system.⁶⁷ The prefrontal part of the brain, which is responsible for the cognitive reception of sensations from the five senses, is strongly connected with the amygdala, which invests the received sensory information with its emotional value. This allows the prefrontal cortex to take a decision. The three processes that depend on the functional prefrontal cortex and which, in case of dysregulation, influence impulsive aggression, are: the feeling of emotions, the processing of social information and impulsiveness.

An early traumatic experience strongly inhibits the establishment of a link between the prefrontal cortex and the amygdala⁶⁸. This eliminates the most basic possibility of functional regulation of the stressful situation. Thus, even an apparently innocent stressful situation can trigger dysregulated, uncontrollable horror and fear in the individual, and this horror then awakens a painful dysregulated organic feeling, which is inscribed in the somatic memory of the limbic autonomic part of the right brain hemisphere.⁶⁹

⁶⁶ C. Gostečnik, *Relacijska paradigma in travma*, Ljubljana 2008, Brat Francišek.

⁶⁷ C. Gostečnik, *Relacijska paradigma in travma*, Ljubljana 2008, Brat Francišek; R. Lee, E. F. Coccaro, *Neurobiology of impulsive aggression: focus on serotonin and the orbitofrontal cortex*, in: D. J. Flannery, A. T. Vazsonyi, I. D. Waldman (Eds.), *The Cambridge handbook of violent behavior and aggression*, New York 2007, Cambridge University Press, pp. 170–186; J. A. Cohen et al., *Treating trauma and traumatic grief in children and adolescents*, New York 2006, Guilford Press; A. N. Schore, *Affect regulation and the repair of the self*, New York 2003, W. W. Norton&Company.

⁶⁸ C. Gostečnik, *Relacijska paradigma in travma*, Ljubljana 2008, Brat Francišek.

⁶⁹ V. Carter, M. R. Myers, *Exploring the risks of substantiated physical neglect related to poverty and parental characteristics: A national sample*, "Children and Youth Services Review" 29 (2007), pp. 110–121.

6. Childhood abuse and aggression

Here we can add the findings of research dealing with the effects of abuse and, in particular, neglect in children's brain functions during their development. When the child's caregivers are unresponsive and no one recognizes his distress and heavy emotions, the child is left to self-regulation which, however, does not bring satisfactory results as the regulatory system is still developing. This „self-regulation” consumes a huge amount of energy and new synaptic links in the right hemisphere cease to form, resulting in a slowed or even paused maturation of the right hemisphere. Instead of new synaptic links, dead spots occur in the brain. The child enters the state of dissociation. Later, in adulthood, such individual may also respond to the stimuli of day-to-day stress with dissociation.⁷⁰ In the state of dissociation, the child responds by slower heart rate – which cannot be found in any other psychiatric disorder⁷¹, but it is possible in the event of a fearless response.

Many studies⁷² show a link between low heart rate in children when at rest and subsequent anti-social and pro-aggressive behaviour in adults, and high cardiac reactivity is also strongly linked to antisocial behaviour.

Children with low physiological arousal, indicating hostile physiological conditions, need special types of stimulation to increase their physiological level of arousal. Thus, aggressive behaviour is understood as a form of stimulation, which is expressed in angry outbursts, fights and cruelty.⁷³

The original purpose of dissociation is the conservation of energy, which is found among animals as the “apparent death.” An animal quickly recovers

⁷⁰ V. Carter, M. R. Myers, *Exploring the risks of substantiated physical neglect related to poverty and parental characteristics: A national sample*, “Children and Youth Services Review” 29 (2007), pp. 110–121.

⁷¹ T. H. Diseth, *Dissociation in children and adolescents as reaction to trauma-an overview of conceptual issues and neurobiological factors*, “Nordic Journal of Psychiatry” 59 (2005), pp. 79–91; J. B. Kaplow, C. S. Widom, *Age of onset of child maltreatment predicts long-term mental health outcomes*, “Journal of Abnormal Psychology” 116 (2007) 1, pp. 176–187; A. N. Schore, *Affect regulation and the repair of the self*, New York 2003, W. W. Norton&Company.

⁷² K. A. Dodge, M. R. Sherrill, *The interaction of nature and nurture in antisocial behaviour*, in: D. J. Flannery, A. T. Vazsonyi, I. D. Waldman (Eds.), *The Cambridge handbook of violent behavior and aggression*, New York 2007, Cambridge University Press, pp. 215–244.

⁷³ T. H. Diseth, *Dissociation in children and adolescents as reaction to trauma-an overview of conceptual issues and neurobiological factors*, “Nordic Journal of Psychiatry” 59 (2005), pp. 79–91.

from this state, but not humans. In humans, the activity of metabolism and physical activity decrease organically. During this state, endogenous opiates, which dissolve pain, and stress hormones, such as cortisol, are secreted in the body. The activity of the middle part of the brainstem, which is called the medulla, causes dramatic decrease in blood pressure, heart rate and metabolic activity. All this happens despite the fact that due to strong arousal, increased amounts of adrenaline and noradrenaline circulate through the body. Both the parasympathetic and sympathetic autonomic nervous system are simultaneously aroused. After strong arousal the child becomes quiet, withdraws from the external stimuli, retreats into himself and gets a blank stare. In this state, his brain cells may die out.⁷⁴

Early experiences of physical and sexual abuse and neglect can lead to affect dysregulation: intense fear refers to the dysregulation of the brain system responsible for flight, and uncontrolled aggression refers to the dysregulation of the brain centre responsible for fight – it is the dysregulation in the autonomic nervous system, the dysregulation of sympathetic arousal, which exceeds the individual's ability to deal with the resulting stress in a functional and effective way. The flight response is triggered by enormous fear, while the fight response is triggered by intense anger and rage, which is functional in response to trauma, but when it comes to dysregulation, this is a disorder that has long-term effects, among other things, in the child's neurobiological system, which can be the basis for later disorder or psychopathology.⁷⁵

This early trauma results in the inability to regulate aggressive impulses⁷⁶, which is characteristic of various personality disorders, especially the borderline personality disorder and antisocial personality disorder.⁷⁷ Among violent individuals, 47% of men and 21% of women have antisocial personality disorder.

Both personality disorders are characterized by hyperactive and subcortical psychobiological impulses, but they are unregulated in their intensity

⁷⁴ J. B. Kaplow, C. S. Widom, *Age of onset of child maltreatment predicts long-term mental health outcomes*, "Journal of Abnormal Psychology" 116 (2007) 1, pp. 176–187.

⁷⁵ T. H. Diseth, *Dissociation in children and adolescents as reaction to trauma-an overview of conceptual issues and neurobiological factors*, "Nordic Journal of Psychiatry" 59 (2005), pp. 79–91; A. N. Schore, *Affect regulation and the repair of the self*, New York 2003, W. W. Norton&Company.

⁷⁶ C. Gostečnik, *Relacijska paradigma in travma*, Ljubljana 2008, Brat Frančišek.

⁷⁷ S. Fazel, J. Danesh, *Serious mental disorder in 23.000 prisoners: a systematic review of 62 surveys*. "Lancet" 359 (2002), pp.545–550.

and duration, and at the same time cut off from the feedback system, both internal and external. Without this feedback system, an individual is deprived of basic information that would allow him the ability to judge.⁷⁸ Relational trauma is always accompanied by an increased level of corticosteroid which accelerates cell death in the limbic centre⁷⁹, especially in the early development of the limbic system. The limbic mechanism is responsible for social control. The only defence that the child has is dissociation, but all dissociated affects – anguish, anger, rage – remain written in his psychosomatic memory and awaken completely unpredictably; they even surprise the individual himself. When there is a gesture or a person nearby, who is actually or only apparently threatening to this child and later adult, he reacts without the possibility of thinking, without a moment of discernment or the ability of (self)reflection; and often without mercy and compassion for the victim, just as had happened to him.⁸⁰

Injuries in the limbic system and in dopamine, noradrenaline and serotonin receptors are essentially related to the dysregulation of aggression.⁸¹ An ineffective and damaged prefrontal system is unable to regulate the subcortical limbic structures that are responsible for the control of aggression. A sufficiently mature prefrontal cortex can help or inhibit defence reactions that awaken in the amygdala, and can thus regulate the amygdala that is driven by autonomic hyperarousal. Stress can shut down prefrontal brain functions and turn on more routine responses, guided by a subcortical structure.

⁷⁸ T. H. Diseth, *Dissociation in children and adolescents as reaction to trauma-an overview of conceptual issues and neurobiological factors*, "Nordic Journal of Psychiatry" 59 (2005), pp. 79–91; A. N. Schore, *Affect regulation and the repair of the self*, New York 2003, W. W. Norton&Company.

⁷⁹ P. Fonagy et al., *Affect regulation, mentalization, and development of self*, New York 2007, NY: Other press.

⁸⁰ C. Gostečnik, *Relacijska paradigma in travma*, Ljubljana 2008, Brat Francišek.

⁸¹ J. B. Kaplow, C. S. Widom, *Age of onset of child maltreatment predicts long-term mental health outcomes*, "Journal of Abnormal Psychology" 116 (2007) 1, pp. 176–187; D. R. Rosell, L. J. Siever, *The neurobiology of aggression and violence*, "CNS Spectrums" 20 (2015), pp. 254–279; A. N. Schore, *Affect regulation and the repair of the self*, New York 2003, W. W. Norton&Company.

7. Aggression and relational trauma

Since aggression can be the result of a specific perception of an affect, or a specific response to the situation⁸², aggression in adulthood can also be explained by exposure to stress, which the person either does not recognize, or reacts to with an emotionally unregulated manner. The most severe stress that a person can experience in his body is referred to as relational stress, which can be caused by the fear of being lonely or by the break-up of a relationship⁸³, or the fear of the consequences of a relationship resulting from traumatic experiences in relationships or traumatic attachment styles between the child and his caregiver.⁸⁴ In relational trauma, the human body is exposed to threatening relational stimuli that prevent development and can even act as an existential threat.⁸⁵ The body is most exposed to relational stimuli in the early period of development, therefore relational trauma in this period leads to a marked inability to maintain relationships, to deal with stress and to regulate emotional states, which crucially affects the development of right hemisphere structures.⁸⁶ In a relational trauma, the relationship between the infant and the mother is characterized by unregulated emotional responses. In this case, the mother fails to recognize, hold and transform the child's physical agitation, and also transmits her unregulated physical state to the child, thereby becoming the source of relational stress. Such a relationship is characterized by psychological, physical or sexual violence against the child, whose vulnerable organism can „defend” itself with excessive arousal, or with the numbness of all his senses,

⁸² C. N. DeWall, C. A. Anderson, B. J. Bushman, *The general aggression model: theoretical extensions to violence*, "Psychology of Violence" 1 (2011) 3, pp. 245–258.

⁸³ J. H. Warren, C. W. Cavert, R. L. Snider, *Relational stress: An analysis of situations and events associated with loneliness*, in D. Perlman (Ed.), *Understanding personal relationships: An interdisciplinary approach*, New York 1985, Sage Publications, pp. 221–242.

⁸⁴ A. N. Schore, *Relational trauma and the developing right brain: an interface of psychoanalytic self psychology and neuroscience.*, "Annals of the New York Academy of Sciences" 1159 (2009), pp. 189–203.

⁸⁵ A. N. Schore, *Relational trauma and the developing right brain: an interface of psychoanalytic self psychology and neuroscience.*, "Annals of the New York Academy of Sciences" 1159 (2009), pp. 189–203.

⁸⁶ A. N. Schore, *Relational trauma and the developing right brain: an interface of psychoanalytic self psychology and neuroscience.*, "Annals of the New York Academy of Sciences" 1159 (2009), pp. 189–203.

or dissociation.⁸⁷ Both defence mechanisms prevent the adult to correctly detect relational stimuli, which means that even a weakest stimulus can cause uncontrollable relational stress, or, on the other hand, no stimulus whatsoever can trigger a stressful reaction. In the case of relational trauma, the body can never perceive the relationship as a safe haven, which means that to some extent, the relationship is always a source of stress. In case of too much stress, the individual begins to avoid relationships (in the case of hyperarousal) or is abuser in his relationship (in case of dissociation). In the first case, the individual can respond to hyperarousal with hostile aggression⁸⁸, when in the affect of anger he physically, emotionally or verbally hurts another person. In the case of dissociation, he is able to plan and carry out an aggressive act without empathy for the victim.

8. Conclusion

The human brain is formed in a relationship, so it can be said that the period of child development is also the period of affect regulation. As we have seen on the basis of studies, for the child's brain to regulate emotional states that he experiences, he needs a "good enough" adult to help him regulate these sensations and affects that occur in stressful situations.

Any emotional response to stressful situations also affects the body, but traumatic experiences leave the deepest impact. These experiences, when the child has no external stress regulation, are engrained deeply in his implicit memory and stay there. These can be seen in the most recent brain studies using fMRI.

Aggression and aggressive behaviour are the uncontrolled response of an individual to an external stimulus that the individual recognizes as a threatening one, and with the help of recent research we have shown what happens in the individual during such responses.

The regulation of the affect, in our case of anger and rage, with the help of an adult, is the translation of the body's response through the amygdala and limbic system in the brain, as well as synaptic connections, into appropriate behavioural and cognitive responses – as a response of the prefrontal cortex.

⁸⁷ B. Rothschild, *The body remembers: the psychophysiology of trauma and trauma treatment*, New York 2000, W. W. Norton & Company.

⁸⁸ J.J. Allen, C.A. Anderson, *Aggression and violence: definitions and distinctions*, in: P. Sturmey (Ed.), *The Wiley Handbook of Violence and Aggression*, New York 2017, John Wiley & Sons Ltd., pp. 1–14.

The individual is able to transform the affect of anger, which he feels in his body, into constructive behaviour.

The dysregulation of the affects of anger and rage as a body response to traumatic stress experience means that severe emotional states based on neurobiological activity in the brain – simultaneous activation of the sympathetic and parasympathetic system, and the secretion of stress hormones – result in a true disaster in the brain. In the developmental period, in cases where the child with his immature regulatory system of cerebral connections tries to calm down on his own and regulate the heavy sensations stemming from a traumatic stress situation, the result is dissociation, i.e. „apparent death”. Instead of the creation of new synaptic links, which would occur with a good enough caregiver, synaptic connections die out and the development of the right brain hemisphere is hindered.

On the basis of the latest research and articles, we pointed out the key moments in the development of the human brain related to aggressive behaviour in adulthood. However, further research would be necessary to better understand this area, especially neurobiological changes that can be brought about by the regulation of difficult affects at a later age.

Bibliography

- Anderson C.A., Groves C., *General aggression model*, in: M. S. Eastin (Ed.), *Encyclopedia of Media Violence*, Los Angeles 2013, Sage, pp. 182–187.
- Bobes M.A. et al., *Linkage of functional and structural anomalies in the left amygdala of reactive-aggressive men*, “Social Cognitive and Affective Neuroscience” 8 (2013), pp. 928–936.
- Card N.A., Little T.D., *Proactive and reactive aggression in childhood and adolescence: A meta-analysis of differential relations with psychosocial adjustment*, “International Journal of Behavioral Development” 30 (2006) 5, pp. 466–480.
- DeWall C.N., Anderson C.A., Bushman B.J., *The general aggression model: theoretical extensions to violence*, “Psychology of Violence” 1 (2011) 3, pp. 245–258.
- Diseth T.H., *Dissociation in children and adolescents as reaction to trauma-an overview of conceptual issues and neurobiological factors*, “Nordic Journal of Psychiatry” 59 (2005), pp. 79–91.
- Flannery D.J., Vazsonyi A.T., Waldman I.D. (Eds.), *The Cambridge handbook of violent behavior and aggression*, New York 2007, Cambridge University Press.
- Gostečnik C., *Relacijska paradigma in travma*, Ljubljana 2008, Brat Frančišek.

- Gross J.J., *Emotional regulation: Taking stock and moving forward*, "Emotion" 13 (2013) 3, pp. 359–365.
- Kaplow J.B., Widom C.S., *Age of onset of child maltreatment predicts long-term mental health outcomes*, "Journal of Abnormal Psychology" 116 (2007) 1, pp. 176–187.
- Leifer R., *Vinegar into honey: seven steps to understanding and transforming anger, aggression, and violence*, Ithaca 2008, Snow Lion Publications.
- Loeber R., Hay D., *Key issues in the development of aggression and violence from childhood to early adulthood*, "Annual Review of Psychology" 48 (1997), pp. 371–410.
- Lozier L.M. et al., *Mediation of the relationship between callous-unemotional traits and proactive aggression by amygdala response to fear among children with conduct problems*, "JAMA Psychiatry" 71 (2014), pp. 627–636.
- Murray-Close D., Ostrov J.M., Nelson D.A., Crick N.R., Coccaro E.F., *Proactive, reactive, and romantic relational aggression in adulthood: measurement, predictive validity, gender differences, and association with intermittent explosive disorder*, "Journal of Psychiatric Research" 44 (2010) 6, pp. 393–404.
- Rosell D.R., Siever L.J., *The neurobiology of aggression and violence*, "CNS Spectrums" 20 (2015), pp. 254–279.
- Schore A.N., *Relational trauma and the developing right brain: an interface of psychoanalytic self psychology and neuroscience*, "Annals of the New York Academy of Sciences" 1159 (2009), pp. 189–203.
- Schore A.N., *Affect regulation and the repair of the self*, New York 2003, W. W. Norton & Company.
- Siegel D.J., *Brainstorm: The power and purpose of the teenage brain*, New York 2013, Pinguin Group.
- Siever L.J., *Neurobiology of aggression and violence*, "American Journal of Psychiatry" 165 (2008) 4, pp. 429–442.
- Velotti P., Garofalo C., Bottazzi F., Carett V., *Faces of shame: implications for self-esteem, emotion regulation, aggression, and well-being*, "The Journal of Psychology" 151 (2017) 2, pp. 171–184.
- Widom C.S., *Does violence beget violence?: A critical examination of the literature*, "Psychological Bulletin" 106 (1989), pp. 3–28.