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The Preventive Dimension of Executive Function in Preschool Children

Executive functions may be viewed as factors supporting proper development in normative groups of children and adolescents, as well as when compensating or reducing risk factors in children and adolescents from higher risk groups. Current research findings indicate that long-term, longitudinal studies on executive functions in children and adolescents are necessary in order to reveal the key factors for the proper development of a young person and their further functioning in adulthood. From the pedagogical perspective, what is important in prevention is searching for knowledge on the conditions conducive to the development of higher cognitive functions. The development of pedagogical research methods that would allow the developmental conditions of children and adolescents to be diagnosed is no less important. Another significant task that cannot be achieved without the results of longitudinal studies is developing the developmental trajectories for dependencies or disorders, taking into account the level of executive function so as to empirically verify the assumptions adopted in this article.

Keywords: early preventive, protective factors and risks, executive function, preschool children

Profilaktyczny wymiar funkcji wykonawczych u dzieci w wieku przedszkolnym

Funkcje wykonawcze można postrzegać jako czynniki wspierające prawidłowy rozwój w normatywnych grupach dzieci i młodzieży, a także przy kompensowaniu lub ograniczaniu czynników ryzyka u dzieci i młodzieży z grup podwyższonego ryzyka. Obecne wyniki badań wskazują, że długoterminowe, podłużne badania funkcji wykonawczych u dzieci i młodzieży są niezbędne, aby ujawnić kluczowe czynniki dla prawidłowego rozwoju młodego człowieka i jego dalszego funkcjonowania w wieku dorosłym. Z pedagogicznego punktu widzenia ważne w profilaktyce jest poszukiwanie wiedzy na temat warunków sprzyjających rozwojowi wyższych funkcji poznawczych. Nie mniej ważny jest rozwój pedagogicznych metod badawczych,

które pozwoliłyby na diagnozowanie uwarunkowań rozwojowych dzieci i młodzieży. Innym istotnym zadaniem, którego nie można zrealizować bez wyników badań longitudinalnych, jest opracowanie trajektorii rozwojowych dla zależności lub zaburzeń z uwzględnieniem poziomu funkcji wykonawczych, tak aby empirycznie zweryfikować przyjęte w artykule założenia.

Słowa kluczowe: wczesne czynniki ryzyka i chroniące, funkcje wykonawcze, dzieci w wieku przedszkolnym

Introduction

Executive functions, from the neurobiological perspective, refer to the mental skills that are necessary to execute various tasks. They constitute a system that has access to internal representations and operates them in a purposeful manner and whose task is to control cognitive processes. They refer to the higher mental processes that lead to flexible and complex goal-oriented behaviour (Zelazo, Muller, Frye et al., 2003). They include the ability to take structured actions associated with decision-making, planning and managing various types of data that help a person to perform multifarious (ranging from the simplest to highly complex) tasks (Dawson, Guare, 2012). Executive function is a complex and multi-dimensional construct that plays a key role in the self-regulatory processes of every person and is described as psychological processes involved in the conscious control over a person's thoughts and actions or as processes responsible for goal-directed behaviour (Brzezińska, Nowotnik, 2012; Putko, 2008). It also constitutes the base for such skills as controlling primitive reflexes or impulsive reactions, problem solving, planning actions and their initiation combined with their flexible execution (despite the occurrence of disruptive factors), as well as monitoring goal-oriented activity. Executive functions include the three most commonly mentioned skill categories: inhibitory control, working memory and cognitive flexibility (Brzezińska, Nowotnik, 2012; Building the Brains, 2011). Other authors contend that executive functions primarily include: planning, dreams and ambitions, goal setting and the initiation of their execution (Jaśkowski, 2008), inhibiting reactions, working memory, emotional control, sustaining attention, initiation of actions, planning and prioritising, organisation, time management, determinedness in achieving goals, flexibility, metacognition (Dawson, Guare, 2012) and many others taken into account and often overlapping across various studies (Packwood, Hodgetts, Tremblay, 2011). These higher mental functions, which are so significant for humans, may play a key role in building constructive relationships with peers and succeeding in school, which, from the perspective of prevention, are important protective factors that constitute a counterbalance

for risk factors (Ostaszewski, 2014). Satisfactory relationships with peers and being successful in school contribute to building an adequate sense of self-esteem, self-efficacy and coping with frustration, which may markedly prevent one from reaching for alcohol and other psychoactive substances during adolescence and in the development of behavioural addictions in adulthood. This article is based on a literature review from the following databases: EBSCO, Wiley Online Library and Web of Science, from where a total of 24 of 2,070 texts concerning the research findings on the components of executive function in preschool children and its predictive power in the context more distant of their of children further development.

The significance of executive function in children's development

Through the development of executive function, the chances of such protective factors that prevent risk behaviours as: success in learning, good relationships with constructive peers and coping with frustration without psychoactive substances, to be enhanced during adolescence and adulthood, increase, and these functions can be considered as having a significant impact on mental health. Therefore, it is worth focusing on the preventive dimension of executive function in the context of earlier prevention, both universal and selective. I assumed in this article that universal prevention is orientated towards whole populations, regardless of the level of the individual risk of problem or unhealthy behaviours occurring, while selective prevention refers to children from groups with an increased risk of problematic behaviour arising.

It turns out that executive function develops particularly intensively in preschool age children (Hammond, Müller, Carpendale et al., 2012), although the first skills appear as early on as at 6 months of age. Infants start the long process of learning control, e.g. by controlling visual fixation and suppressing distractions. From around the 20th week of life, infants continue to fix their gaze on geometric patterns, but look longer at more complex stimulus material like human faces or the 'Sesame Street' children's programme, provided that their attention is attracted (Reynolds, Romano, 2016). Thus, the development of control becomes the basis for the development of working memory. Some sources state that this critical moment for the development of executive function, thanks to changes in the scope of one's inhibitory ability, is at the age of 4 or 5, when executive functions are relatively flexible and sensitive to training (Diamond et al., 2007), although their development is not harmonious and is slow (Jodzio, 2008) and may last even up to the age of 18-25. So far, no unequivocal solutions have been provided as to whether the substantial development of these functions between the ages

of 4 and 6 is associated with the development of the biological maturation of the prefrontal cortex regions of the brain or if they develop through the experience of going to a nursery and the development of speech.

Justification for considering the preventive dimension of executive function in children of preschool age is the result of research indicating the immense significance of this function in further human development. A significant element of executive function is self-regulation, which is the ability to satisfy own needs and fulfil set goals without compromising social norms. A child manifesting self-regulatory abilities is capable of dealing with agitation and tension without losing the ability to effectively act, even under stress. She or he can identify and express their emotions adequately and non-destructively and believes in their own ability to deal with difficulties (Czub, Matejczuk, 2015). Self-regulation researched in preschool children that takes into consideration the suppression of reactions, focused attention and working memory was, to a large extent, linked to early mathematical skills (McClelland et al., 2007; Liew, 2011). Claire Hughes and Rosie Ensor (2007; Holmes, Kim-Spoon, Deater-Deckard, 2016) pointed out that children as early on as in their second year of age and showing a higher level of executive functions demonstrated higher results at the age 3 and 4 in the theory of mind scope, i.e. the child's ability to understand the effect of mental states on the behaviour of other people. Research findings also pointed to the predictive role of working memory (part of executive function) in a group of 4-year-old Scottish and American children. It was found that the higher the results in the scope of working memory in preschool-age children, the higher the level of mathematical skills and overall school achievements in the third year of early school education (Bull, Espy, Wiebe, 2008). The assessment of the state of control, alternating attention, ability to start tasks or activities and suppress responses allows for a prediction of future results during adolescence (Liew, 2011). Based on the level of effortful control, i.e. the ability to inhibit a reaction to a stimulus coming directly from the surroundings when striving for a goal, it is possible to predict the social competences, behavioural problems and school achievements of 6-year-old children when they reach 10 years of age. Children able to exercise effortful control are significantly less likely to exhibit problematic (externalising) behaviours than children with weak control. They also have more positive relationships with their peers, giving them a stronger support network to help them perform better at school (Valiente et al., 2011; Liew, 2011). Research on early childhood levels of the ability to focus attention reveals that it is a good predictor of the ability to regulate negative emotions and exercise self-control appearing in a child at the age of 22 months. Therefore, the main mechanism underpinning the development of self-control is the developmental change in the scope of the functioning of attention – from bottom-up to top-down attention (Kochanska, Coy, Murray,

2001; Brzezinska, Nowotnik, 2011). Greg J. Duncan and others, having analysed six studies taking into account data concerning children aged 5 to 6 years, noticed that focusing attention is a stronger predictor of school achievements than manifestations of socio-emotional behaviours (internalising and externalising) and social competences (Duncan et al., 2007; Liew, 2011).

A high executive function level as a protective factor

The analysis of models of the shaping of psychological resilience during childhood, focused on the resources enabling positive adaptation and development despite difficult conditions, also allows for the identification of threads linked to executive functions. Below are three models that I have selected, the focal point of which are protective factors, along with their descriptions entailing the elements associated with the components of executive function.

In the protective factor model of resilience developed by Paul A. LeBuffe and Jack A. Naglieri (1999; Grzegorzewska, 2016), three protective factors were identified: initiative, self-control and attachment, which are incredibly important in early childhood. Self-control, understood as the ability to control impulses, calm oneself down and respect norms and rules, is similar to the self-regulation necessary to use higher cognitive skills. The interaction and differentiation between the mentioned protective factors leads to the appearance of subsequent factors, like the ability to manage oneself, make decisions and behave in a goal-oriented manner (LeBuffe, Naligieri, 1999; Grzegorzewska, 2016) – even more of elements of executive functions.

Iwona Grzegorzewska (2016), drawing on research findings concerning psychological resilience by Edith Grotberg (2000), grouped protective factors into three categories: 1. I have; 2. I am; 3. I can. Each of the three categories contains five aspects presented in the figure below.

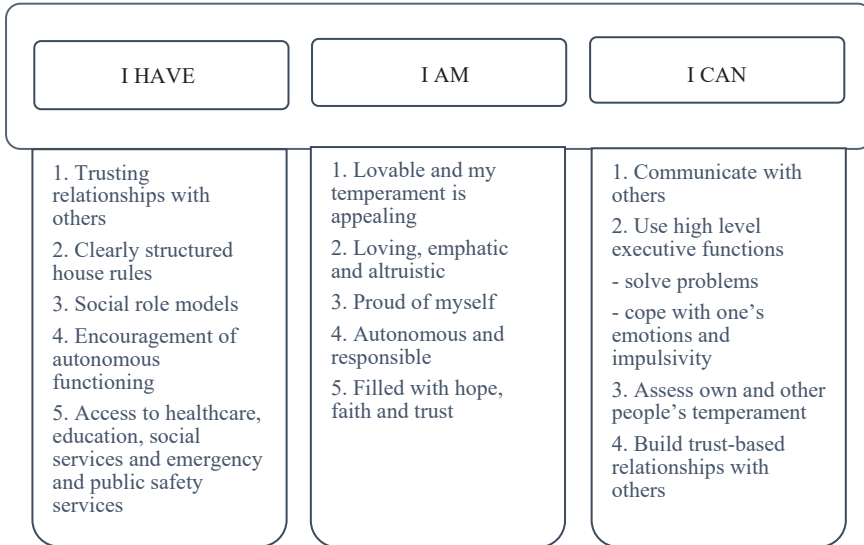


Figure 1. Model of psychological resilience by E. Grotberg (2000), prepared by I. Grzegorzewska (2016), developed by B. Poćwiardowska (2019).

In the third category, abilities like coping with own emotions and impulsivity appear, which can be referred to as self-regulation and response suppression comprising executive function, as well as problem solving, which results from a high level of these functions.

Another model containing the components of executive function is the Three Factor Model of Personal Resiliency developed by Sandra Prince-Embury (2006/2007; Grzegorzewska, 2016).

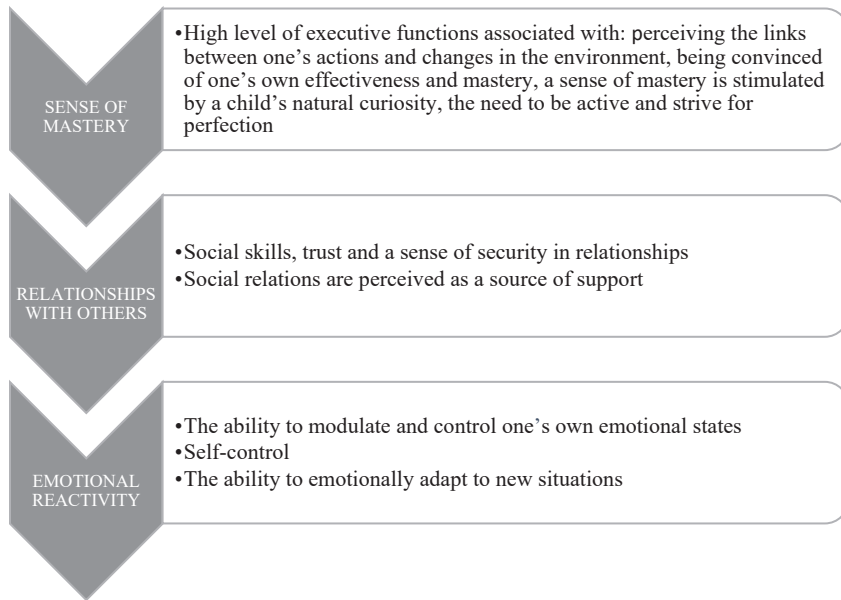


Figure 2. Three Factor Model of Personal Resiliency, developed by S. Prince-Embury (2006/2007), prepared by I. Grzegorzewska (2016), developed by B. Poćwiardowska.

Executive functions are associated with the ability to perceive the relationship between one's own actions and changes in the surroundings. This ability, within the Three Factor Model developed by Prince-Embury, belongs to a sense of mastery defined as a child's positive expectations with respect to the effects of his/her behaviour, as well as a sense of being competent and effective. A child's perception of their own influence on the environment is particularly important for flexibility in action (one of the skills of EF), as it requires the perception of change and verification of whether what has been achieved is adequate to the adopted goal. Assumptions that are different from the effect may activate a process that leads to a change in an action or goal. As in the previous models of psychological resilience, so too here does a reference appear to self-regulatory abilities that are termed within executive functions as response inhibition (the ability to think before acting; the ability to resist the desire to do or say something, allowing for an assessment of the situation and of one's own actions) and emotional control (the ability to manage emotions in order to achieve goals, complete tasks or direct one's behaviour) (Dawson, Guare, 2012). The emotional reactivity entailed in the presented model, namely individual sensitivity and the ability to control emotions and restore emotional balance, is allied with emotional control and may constitute the basis for response suppression.

From the mental health perspective, a high level of executive function may play a key role in the life of a child, constituting the basis of both a willingness to learn, as well as of social competences (Blair, Zelazo, Greenberg, 2005). Thus, if a child of preschool age has properly developed executive functions, the future dynamics of key elements of their cognitive, emotional and social development can be predicted. A child who achieves higher results in linguistic and mathematical learning and has satisfactory peer relationships right at the beginning of their educational path is fulfilling developmental tasks attributed to relevant stages of development: autonomy and initiative are developed at preschool level, a sense of competence at school level and identity formation in adolescence.

A low executive function level as a risk factor

Executive function may be an example of a bipolar factor (Ostaszewski, 2014) that, when properly developed, can be a protective factor, and when there are deficits, it significantly increases the risk of behavioural difficulties and risky behaviours. Difficulties appearing early on in the development of executive functions are harbingers of problems with executive skills (executive function) lasting throughout the entire period of childhood and adolescence, which increases the risk of such behaviours as alcohol and psychoactive substance abuse, juvenile delinquency and gambling addictions in adulthood (Blaszczynski, Nower, 2002; Raver, 2012). The lowering of the level of executive functions in school-aged children is also alarming (O'Shaughnessy et al., 2003; Diamond et al., 2007).

Knowledge on the state of executive functions could increase the possibilities of prevention in risk groups and be harnessed to plan activities that diminish the strength of the influence of risk factors associated with difficulties in controlling one's own behaviour, attention problems and cognitive deficits leading to poor academic performance. One such process strongly linked to executive function is self-regulation. This is manifested thanks to executive functions and is a stronger predictor of school readiness, learning skills, quality of life and other aspects of a child's development and academic achievements than IQ (McClelland et al., 2013; Whitebread, 2018). Children showing attention deficiencies encounter difficulties in learning – often making mistakes, having trouble following instructions and starting and ending tasks and having problems with working memory and with committing information to long-term memory. Additionally, these difficulties may be accompanied by elevated levels of impulsivity, which lead to a lack of systematicity in assimilating and integrating newly arriving information and failing to see the relationships between concepts and objects (Nowotnik, 2012). Weak inhibitory control at the age of 3 allows for the prediction of negative inter-

actions with peers at the age of 4.5 years (Holmes, Kim-Spoon, Deater-Deckard, 2016). Preliminary research findings from studies on reducing the efficiency of the response control functioning at 3 years of age may forestall problems with inhibitory control appearing in the form of gambling problems at the age of 32 (Slutske et al., 2012). Lower executive function results in children between the ages 4 and 6 being associated with more frequent externalising and internalising behaviours, as well as a worse understanding of social relationships (Hughes, Enns, 2007; Holmes, Kim-Spoon, Deater-Deckard, 2016).

Children from marginalised communities with a low socioeconomic status (SES) experience problems related to low executive function levels. These factors are also connected with starting to drink alcohol during adolescence (Cierpiałkowska, Ziarko, 2010). Children from low-SES families:

- have reduced hearing due to untreated ear infections, higher levels of lead exposure and a higher prevalence of asthma, which all contribute to reducing their ability to focus attention, leading to worse reasoning ability and worse memory performance;
- have significantly smaller vocabularies, making it difficult for them to ‘name’ their experiences and limiting their ability to control their emotions and, as a consequence, to direct their behaviours;
- give the impression of being poorly motivated to learn and experience symptoms of depression, and their passivity may be a symptom of stress and depression;
- have decreased levels of cognitive abilities: a narrow scope of attention, a high level of scatteredness, difficulties in monitoring work quality and coming up with new solutions to problems;
- live in unstable conditions, wherein they cannot become securely attached to their primary caregiver, who gives twice as many negative than positive comments, which effectively leads to low self-esteem;
- experience the effects of acute or chronic stress, having a negative effect on brain development, performance at school and social competences and which reduces the level of attentional control while increasing impulsivity (Deptuła, Potorska, Borsich, 2018).

Difficulties in the scope of executive function, which are the foundation of many cognitive abilities, fit in to the pathway of a risk of psychoactive substance dependence, illustrated on the risk pathway pattern initiated by cognitive impairment (Deptuła, 2005).

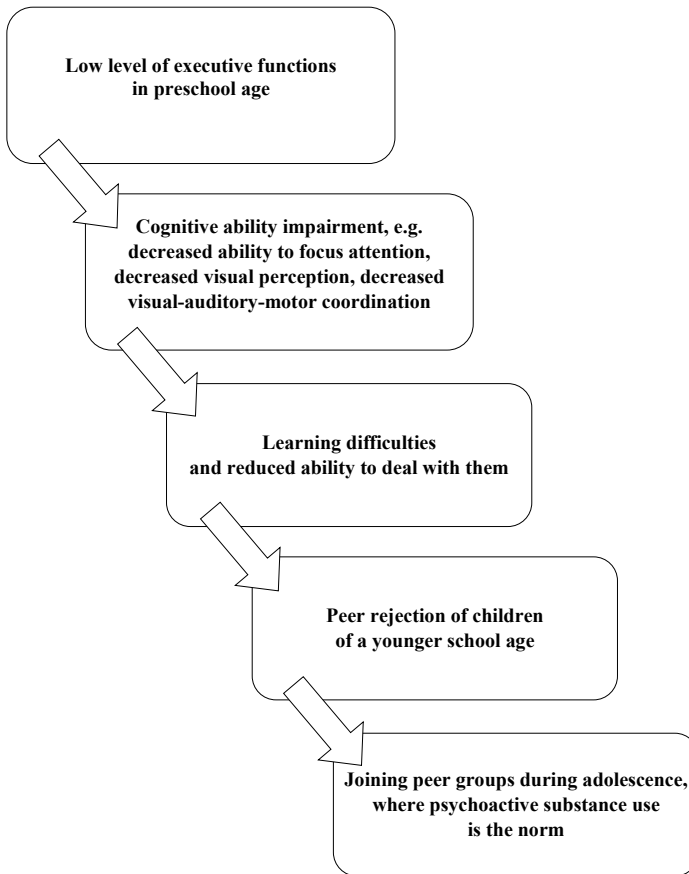


Figure 3. Individual risk pathway of reaching for psychoactive substances, initiated by cognitive impairment, by M. Deptuła (2005), developed by B. Poćwiardowska (2019).

Developmental deficits and difficulties were also taken into account in the Model of Development of Antisocial Behaviour developed by Krzysztof Ostaszeński (2014).

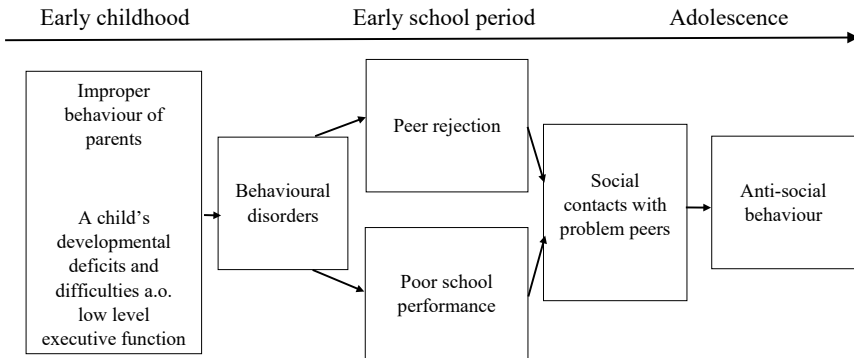


Figure 4. Model of Development of Anti-Social Behaviour. K. Ostaszewski's adaptation of the (2014) model developed by G. Patterson and colleagues (1989), developed by B. Poćwiardowska (2019).

Adapting the model developed by Gerald R. Patterson and colleagues, he assumed that strict or inconsistent treatment and the lack of support and supervision on the part of parents during the early development of a child, as well as their developmental deficits, may lead to the difficult behaviours that underpin peer rejection and poor academic performance. Further stages in this trajectory during adolescence include contacts with deviant peer groups, which may lead to crime.

Additionally, difficulties appearing in the scope of the abilities developing on the basis of executive skills can lead to behavioural dependencies. In the assumptions described in literature relating to the developmental pathways in externalising behaviours that lead to dependencies, difficulties appear in childhood and concern the vulnerability to behavioural disinhibition, which may lead to behavioural dependencies during the course of development as a result of interactions between genetic, neurobiological, psychological and social factors (Grzegorzewska, Cierpialkowska, 2018).

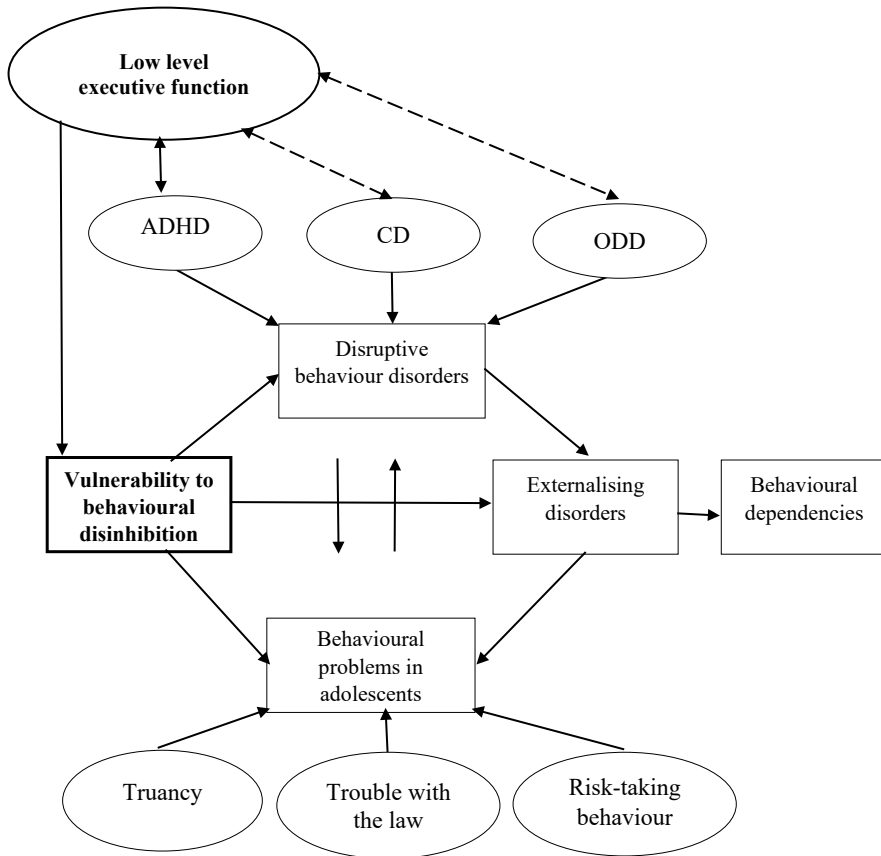


Figure 5. Externalising (impulsive-aggressive) developmental pathway leading to dependencies.

Source: developed by I. Grzegorzewska, L. Cierpiałkowska (2018), based on W.G. Iacono, S.M. Malone (2011), developed by B. Poćwiardowska (2019).

Vulnerability to behavioural disinhibition may lead to the various difficulties presented in Figure 5. A high level of self-regulation, which is part of executive function, is the opposite of disinhibition and may be a protective factor against entering the impulsive-aggressive developmental pathway leading to dependencies.

The relationship between a low level of executive function and the risk of dependencies can also be noticed in the internalising (anxiety/depression) developmental pathway leading to dependencies. If children are already experiencing anxiety and have mood disorders at preschool age, they are three times more likely to manifest these disorders at 10 years of age (Mesman, Koot, 2001), and

social anxiety may appear during adolescence, the probability of which increases from 2 to 15% (Grzegorzewska, Cierpiałkowska, 2018). The experience of anxiety and mood disorders may be connected with difficulties with emotional self-regulation and involvement in cognitive activities (through difficulties with focusing attention). Therefore, anxiety, by weakening the efficiency of cognitive task performance, may significantly hinder the execution of the developmental task attributed to those between 4-5 years of age, namely, showing initiative.

Scientific reliability requires stating that the results of longitudinal studies on the relationship between executive functions and peer relation problems in children aged 4.5, 9 to 10 and 15 years are inconclusive. A substantial relationship between the identified peer relationship problems and a low level of executive function appeared in childhood but did not occur in the case of adolescence. The results of these studies point to the significance of organised social activities in childhood for developing proper relationships with peers and a high level of executive function and, at the same time, allow for the conclusion to be drawn that a low level of executive function (e.g. inhibition of attention and working memory) during adolescence gradually becomes less and less significant for communication skills that are key to establishing peer relationships. It may also be the case that risky and impulsive behaviour resulting from a lower level of executive function development is more appreciated by peers during adolescence, which explains the absence of a relationship between a low level of executive function and peer relationship problems (Holmes, Kim-Spoon, Deater-Deckard, 2016).

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