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Supporting the Development of Executive Functions of Preschool Children as an Early Preventive Action

ABSTRACT

The intensive physical, socio-emotional, cognitive and moral development of children at preschool age means that preventive intervention introduced at such an early age can bring benefits and lead to significant changes in the child's present and future functioning. When supported as a part of preventive activities, the dynamic development of executive functions which falls around the age of 4–5 in a child's life can contribute to the strengthening of school readiness and better results in the following areas: language skills, mathematics and social competences. In the article, the author has presented the concept of executive functions and their types. Also taken into account are arguments for creating conditions for children to develop executive functions as a factor protecting their educational development against future anti-social behaviour, behavioural addictions and psychoactive substances. In the last part, the author presents examples of early prevention measures that can be included in the education of a preschool child.

KEYWORDS

executive function of children, early preventive action, preschool children, executive function as a protective factor

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The concept of Executive Functions

Executive functions (EF)¹ are higher-level cognitive functions the effectiveness of which is acquired at different times. They allow people to manage their actions from the simplest self-service ones to the more complicated ones that require complex procedures, e.g. planning and performing multi-stage household duties or projects at different stages of education and working life. Despite many studies carried out in this area, it is not clearly confirmed by the scientists what exactly the EF skills are.² Most frequently mentioned subcomponents are response inhibition, working memory, set shifting, planning, and fluency linked in research with modulated response. Akira Miyake and Naomi P. Friedman (2012: 8–10) identified three types of executive functions:

- a. Shifting between tasks, processes and actions, understood as the ability of attention to shift between two tasks “managed by independent information processing” (Jersild 1927 after: Nęcka et al. 2013: 184). Attention shifting requires inhibiting one cognitive process and triggering an alternative process, which entails cognitive costs, such as increased time needed to complete the task or greater risk of error.
- b. Inhibition understood as blocking any motives, both external (irrelevant stimuli, distractors) and internal ones (“symbolic” stimuli, impulses, affective or motivational factors), which could trigger responses that are competitive to the activities currently being performed and thus induce a phenomenon of resource interference (Nigg 2000, after: Nęcka et al. 2013: 251–251).
- c. Updating contents of working memory.

¹ Edward Nęcka, Jarosław Orzechowski and Błażej Szymura (2013) translate the English term executive function as “funkcje zarządcze,” whereas Maria Kielar-Turska as “funkcje zarządzające” (Kielar-Turska, Białecka-Pikul, Skórska 2006). In this paper I use Adam Putka’s (2008) translation of executive function as “funkcje wykonawcze” and in its further part I will use the abbreviation EF.

² Sonia Packwood, Helen Hodgetts and Sébastien Tremblay (2011) analysed 60 research results and identified 68 subcomponents of EF. They removed subcomponents that overlapped semantically and psychometrically (the same tasks diagnosed different functions) and having applied cluster analysis (measurements of distance and a hierarchical tree) they first identified 12 areas that were strongly linked to EF, then they defined 18 skills. At the same time, they emphasized the applicability of the analyses used and signalled the need for further research in this area.

From the perspective of mental health, developed executive functions can play a key role in a child's life, providing the basis for both school readiness, school successes, which are manifested not only in linguistic and mathematical performance, but also result from high-level social competence (Blair, Zelazo, Greenberg 2005: 561). I assumed that the initiation of preventive actions well in advance of the possibility of problems in the psychosocial development and risky behaviours may strengthen the completion of developmental tasks (Brzezińska, Appelt, Ziółkowska 2016: 162–164) and raise to a higher level those skills that—today and in the future—may have a significant function not only in coping with constructive requirements of adults but also in building relationships with peers.

At the age of 2–3, a child develops a sense of autonomy. It is then essential for the child to develop gradually by taking control of him/herself and his/her behaviour. The child's important developmental experience, behaviour and inner state are both manifestations of autonomy and subordination, which indicate the acquisition of skills to coordinate one's own will with social requirements. At this stage of development, there is a tension between autonomy versus shame and doubt (Erikson 1997: 261–265). According to Erik H. Erikson (1997: 262), external regulation should gradually guide the experience of autonomy of free choice and “bring considerable comfort, dispel fears,” but when it occurs in an overly invasive form, it can lead to a premature, excessively rigid development of conscience and excessive self-manipulation leading to inhibition of activity or excessive control. Shame occurs when a child starts to realize that he or she is exposed to other people's gazes and wishes to hide. During this stage, the child learns to experience frustration as a natural state that accompanies various events. What is important for the child's proper development is that he or she should have the possibility of decision-making in all those matters that he or she can deal with. Such conditions allow the child to develop a sense of causality.

In the further development, as a 4–6-year-old, the child faces the challenge of tension between initiative and guilt. The pleasure in achieving goals appears, which results in the energy to initiate activities and experience the pleasure of pursuing one's own ideas. With increasing efficiency and energy, there can be conflicts related to the child's desire to take over the sphere of imagination, objects, people

and the need to look for ways to cope with this challenge (Smykowski 2005: 171–177), so that the sense of guilt in justified situations of exceeding social norms would not overwhelm the readiness to act that is justified by development.

All upbringing and educational efforts produce the best results when they are deployed while the particular skill is still underdeveloped (Wygotski 1971: 521). Although EFs develop until the age of 18–25, their most intensive development falls at 4–5 years of age (Carlson 2005; Garon, Bryson, Smith 2008, after: Hammond et al. 2012: 271). Furthermore, it is important that these skills are prone to influences from the physical and socio-cultural environment (Brzezińska, Nowotnik 2012: 3), and a high level of EF is essential for educational achievements and creating satisfactory relationships with peers up to adolescence (Holmes, Kim-Spoon, Deater-Deckard, Tech 2016).

Executive functions as a protective factor

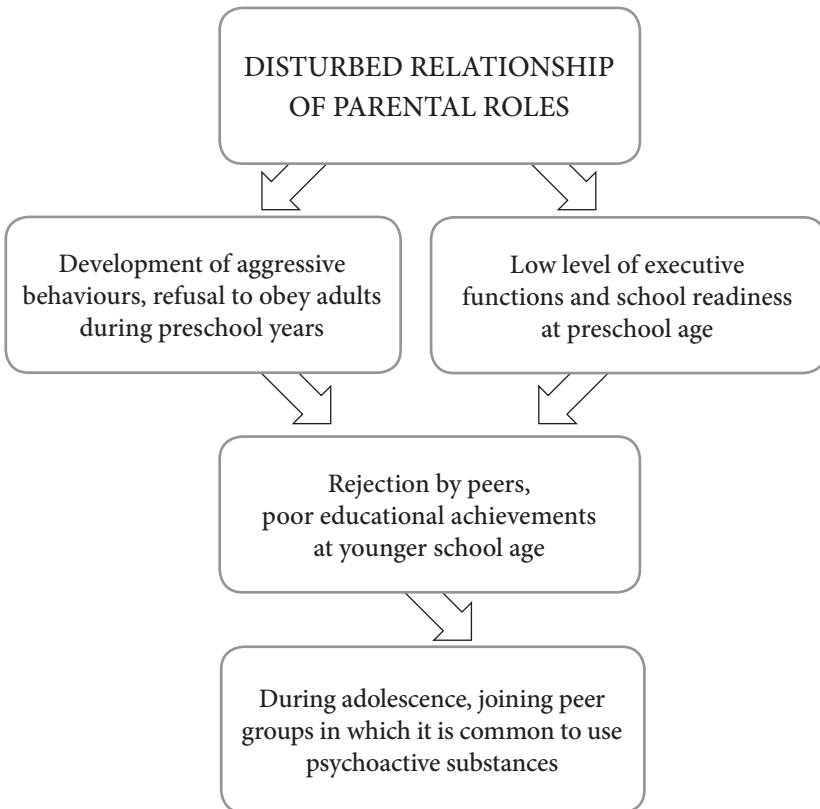
The identification of pathways leading to the risk of psychoactive substances and other risky behaviours involves a combination of both risk and protective factors. One of the risk factors is the inappropriate fulfilment of parental roles, which is manifested by e.g. the lack of affection, excessive criticism, hostility, insufficient or inconsistent discipline, insufficient involvement in childcare (Deptuła 2005: 159–172). The family risk factors include:

- the lack of a positive relationship between the child and his or her caregiver, which may arise from the lack of upbringing skills or inconsistencies in their use;
- the inability to express emotions towards the child or the parent not allowing the child to express his or her emotions;
- the inconsistency of the parental attitude in obeying the rules of the child-parent relationship, characterized by excessive control or over-protection;
- the failure to support the child in overcoming the difficulties he or she is facing (Cierpiałowska, Ziarko 2010: 395–386).

Such a relationship with parents at the preschool age results in the development of aggressive behaviour, refusal to obey adults during the preschool years (Deptuła 2005: 159), as well as deficiencies in the EF development and school readiness.

Further implications of inappropriate fulfilment of parental roles occurring at a younger school age are related to the child being rejected by the school class, as well as poor progress in education. As a consequence, there is a danger during adolescence related to searching for peer groups which do not respect constructive and socially accepted rules and prefer using psychoactive substances.

Diagram 1. Individual risk pathway initiated by disturbed fulfilment of parental roles



Source: The author's own study based on: Deptuła (2005); Maccoby, Martin (1983); McGrath, Noble (2010) (after: Whitebread, 2018).

Parental responsiveness and the ability to create “parental scaffolding” in the course of development shape the child’s self-regulation abilities by attributing meaning to and structuring both the child’s activities and sensations (Brzezińska, Nowotnik 2012: 6; Dawson, Guare 2012: 110). Scientists (Maccoby, Martin 1983; McGrath,

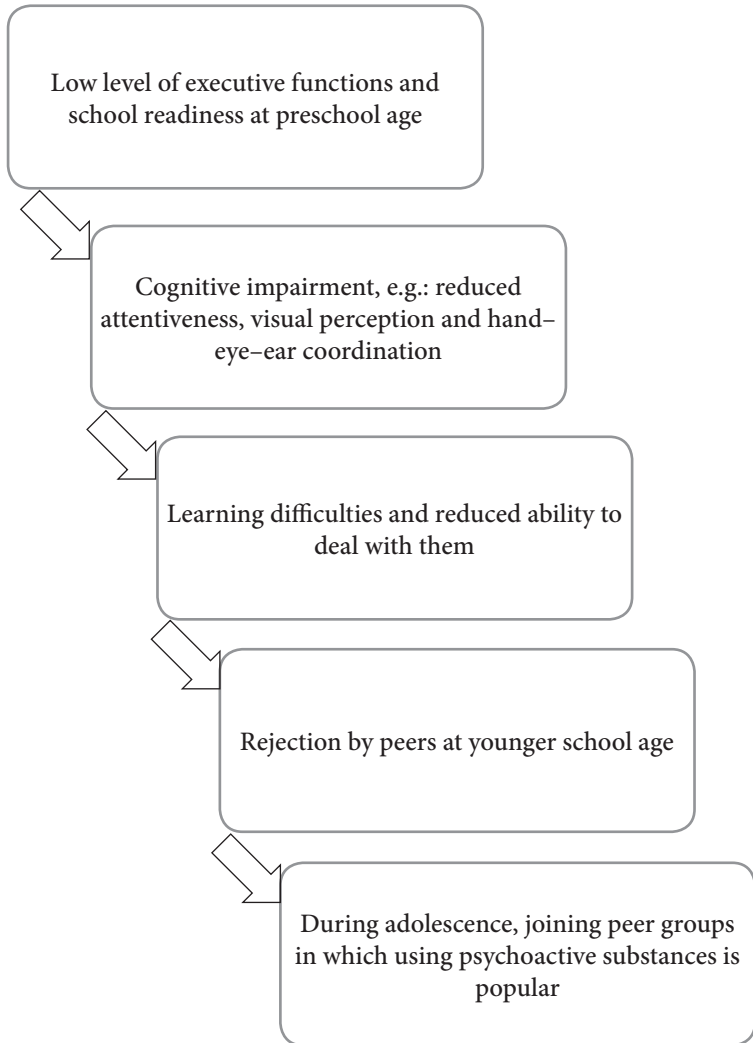
Noble 2010, after: Whitebread 2018: 328) emphasize that parents displaying an authoritative upbringing style create the most favourable conditions for the development of self-regulation, executive skills and social competences. Their style is manifested by building emotionally warm relations with the child, in which there is no lack of kindness and also introducing clear, pre-negotiated rules of conduct. Authoritative parents respect the child's needs (e.g. autonomy, support) and, when enforcing requirements, they explain their actions and rarely resort to manifestations of their authority. Meta-analyses of 42 studies conducted from 2000 to 2012 concerning the significance of parental behaviour for the development of EFs in children aged 0 to 8 indicate a correlation between these variables (Valcan, Davis, Pino-Pasternak 2017). Behaviours classified as positive, such as expressing warmth, responding sensitively to signals coming from the child, supporting their autonomy, building scaffolding, and cognitive stimulation, were related to higher EF levels in children. In addition, the younger the children were, the stronger the correlation between the variables was, with the positive behaviour of parents being visibly statistically related to higher EFs, whereas excessive control, being pushy or indifferent resulted in lower performance of children in this respect. Therefore, early childhood can be a critical period in which parental behaviour can be particularly significant for the child's EF development.

Based on the understanding of the trajectory leading to the use of psychoactive agents, one of the risk factors is cognitive impairment, e.g.: reduced attentiveness, visual perception and hand-eye-ear coordination. Attention deficits are manifested by such difficulties as numerous mistakes, becoming confused with instructions, difficulties in starting and finishing tasks, difficulties in the functioning of working memory and transferring information to long-term memory. Such symptoms may be accompanied by an increased level of impulsivity, which is associated with non-systematic acquisition and integration of incoming information and failure to notice the interdependence between concepts and objects (Nowotnik 2012: 90). This type of problems entail an increased risk of learning difficulties, which is also accompanied by a reduced ability to deal with them. Other elements of this trajectory include the major risk of being rejected by peers, resulting in joining peer groups in which using psychoactive

substances is popular (Deptuła 2005: 3). The reduced ability to deal with learning difficulties is associated with a low level of cognitive, behavioural and emotional self-regulation, which develops rapidly at the age of 2–3. The abilities to regulate cognitive and emotional states and behaviours are revealed through executive functions, and they are a stronger predictor of school readiness, school skills, quality of life and other aspects of the child's development (Veenman, Spaans 2005, after: Whitebread 2018: 327), as well as school achievements (McClelland et al. 2013, after: Whitebread 2018: 327), than the intelligence quotient. The rationale for supporting the development of executive functions of preschool children, i.e. the protective factor, is based on research results indicating the predictive role of working memory (an EF component). Based on the findings of a survey in a group of 4-year-old Scottish and American children, it was concluded that the higher the working memory performance at preschool age is, the higher the level of mathematical skills and overall school success in the third year of early childhood education (Bull, Espy, Wiebe 2008: 205).

Although the above-mentioned trajectory starts at the school age, taking into account the importance of school readiness in achieving school successes, it can be extended by the low level of EFs leading to the low level of readiness for the next stage of education.

Diagram 2. Individual risk pathway initiated by the low level of executive functions and school readiness



Source: The author's own study based on: Deptuła (2005); Bull, Espy, Wiebe (2008).

The understanding of executive functions and ways to support them can be used to plan early preventive actions to reduce the impact of a risk factor associated with the impaired ability to control one's behaviour, attention deficits, cognitive deficits leading to low school performance, whereas working with parents could contribute to the reduction of the impact of the disturbed performance of parental roles.

Supporting the development of the Executive Functions of preschool children

Early preventive actions mainly include preparing parents and teachers to support the development of EFs in children. An important action would be to create conditions for the child's main caregivers:

- to gain knowledge of the child's development, prerequisites for proper development and the importance of executive functions during subsequent life stages;
- to recognise the state of both the primary caregivers' and the child's EF skills and deficits in their area;
- to develop upbringing skills through spatial organisation, building "scaffolding," straightforward communication and use of fun and games;
- to reflect on the previous upbringing practices and search for the ones that support the development of EFs.

In the further part of the paper I focused on presenting the examples of good practices in terms of spatial organisation, building the scaffolding and using fun and games in reinforcing the EF skills.

Organising space supporting the development of Executive Functions

When learning new skills, it is worth taking into account the factors that precede the expected behaviour, by creating favourable spatial and material conditions for the children to develop the desired skills. The spatial and material environment becomes an opportunity for the child to explore and manipulate objects, as well as to redesign their application. Employing Augustyn Bańka's (2002) concept of social environmental psychology, Alicja Potorska (Deptuła, Potorska, Borsich 2018: 79–85) suggested her own concept of diagnosing the socio-emotional, spatial and material conditions for the psychosocial development of toddlers. Her description of the tool included the indicators of proper spatial design and the selection of objects needed for different types of activities for children staying at early childhood care and education institutions. The indicators developed in this way

can provide the basis for organizing educational space for preschool children. Below are some examples of how these conditions can foster the development of higher-level cognitive processes. It is worth mentioning that attempting to determine which of the EF skills will be dealt with in a particular task is an artificial procedure³ since every simple or complex activity requires the involvement of many more or less complex cognitive skills, coping with emotions and managing behaviour, which constitute a dynamically developing system of cognitive, behavioural and emotional control.

Training executive functions involves performing daily activities in a particular space both at home and in the nursery. The spatial conditions require a room that is spacious enough to allow children to organize their own games in smaller groups, or to play on their own. It would be important to ensure proper interior design of either the nursery room or the child's bedroom/space at home. It is essential to choose pastel, subtle colours of the walls, which help the children to calm down. The belief that the space where the child resides should be colourful and full of stimuli leads to excessive sensations and difficulties in inhibiting distracting signals coming from outside, which hampers the development of EFs. In addition, the space should have separate areas for particular activities, i.e. eating, sleeping/resting, playing, toileting. Particular areas of the room can be separated by calm colours, suitable carpet textures, floorboard colours, delicate curtains or hammocks. It is also worth including a space at home and in the nursery for the child to remain on his or her own, so that he or she could be discreetly watched by an adult supervisor willing to accept the need for solitude as well as to provide help whenever the child needs it. Such spatial organisation allows the child to decide on the choice of activities (during free play periods), setting them in particular spaces and learning how to follow certain rules related to, e.g., eating meals. When the child becomes informed by an adult that there will be a meal soon, he or she starts performing a sequence of actions:

³ These difficulties also arise in the preparation of diagnostic tasks according to which the level of EF is evaluated. It appears that it is not possible to schedule tasks that do not require the use of target memory, or to perform them under the conditions that do not require the involvement of irrelevant information inhibition (Nęcka, Orzechowski, Szymura 2013: 184).

- puts the toys back into the box marked with an appropriate sign or drawing,
- puts the box on the shelf,
- checks if the toilet is free so that he or she could wash their hands,
- enters the toilet,
- rolls up his or her sleeves,
- turns the water on,
- wets his or her hands,
- presses the soap dispenser with one hand, while placing the other hand underneath where the soap comes down,
- soaps his or her hands to make foam and distributes it over his or her hands,
- rinses the soap off the hands with water,
- finds his or her towel or pulls the paper towel out of the dispenser,
- dries his or her hands,
- hangs back the towel or throws the used paper into the bin,
- rolls down his or her sleeves.

The whole sequence of behaviours requires attention focus from the child, cognitive control, updating the hand-washing stages in the working memory and often starting the process of inhibiting the distractors, because other children do similar activities around them while talking and singing. Sometimes the child overcomes the temptation to play with water for too long or updates his or her memory with the information that after leaving the toilet, the hands should be dry. Therefore, it would be important for the child, in the space where he or she performs these daily activities, to have access to all the objects necessary to perform the whole sequence of actions. While constraining the child at home and in the nursery from, e.g., preparing the table for a meal (setting the plate and the cup, arranging the cutlery), taking the food from the platters by him/herself, pouring water and clearing the table afterwards, not only do we limit the child's independence, but also the opportunity to practice significant cognitive skills that control the whole action process. It is also essential that the child has enough space to store his or her personal belongings, which no one has the right to access without the child's consent. At home it can be a desk/shelf or one separate drawer (depending on the family's

possibilities), and in the nursery it can be a drawer, a box, a textile pocket hung from the chair where the child sits down to meals every day. In this way he or she learns that he or she has the right to decide about the space where he or she stays. Additionally, in the nursery it is worth making sure that the child has some photos of his or her closest family. This is because looking at his or her things while feeling miserable, he or she learns self-regulation to help them cope with difficult emotions, e.g. longing for parents, sadness caused by quarrels. The child trains his or her memory by using his or her things, and learns to put them away, because among other nursery toys he or she may have trouble finding the ones he or she brought from home. If the child happens to have lost his or her toy, he or she can use the memory traces with the teacher and his or her peers, to recall what he or she has been doing recently so as to know where to look for it; that is another opportunity to learn how to inhibit a prepotent response (e.g. crying) in order to achieve the goal—memory training and attention concentrating. The space for satisfying the child's important emotional needs fosters the development of the ability to experience, name and communicate emotions—the crucial skills that form the basis of emotional regulation strongly linked to EFs. If this emotional need is not satisfied, the child generally does not have the energy and willingness to explore or transform the world around. In addition, the child who “knows that certain events can evoke certain emotions, can be better at controlling emotions and inhibiting impulses” (Dawson, Guare 2013: 113), which may impede or prevent effective actions.

Economic situation and supporting the Executive Functions

An essential aspect in both the family and nursery setting is the economic situation which “equips the child's functioning space with objects necessary for various types of activities. Thus, the economic situation comprises:

- furniture and accessories necessary for performing daily routines and activities;
- toys intended for the cognitive and motor development;
- educational materials supporting the cognitive and socio-emotional development” (Deptuła, Potorska, Borsich 2018: 81).

When using the objects available at home and in the nursery, pre-school children should have the opportunity to wait for their turn, which is related to the ability to inhibit responses. Combined with the economic situation, this happens, for example, when the child:

- is waiting for another child to finish playing with the desired toy or for the possibility of doing a jigsaw puzzle; is waiting to play a particular game or to build a huge structure using a record number of blocks;
- wants to use the same artistic materials as other children;
- is waiting for the teacher to distribute drawing paper or a colouring book;
- is waiting for his or her turn to take the obstacle course.

It is important that the child is given enough time to plan his or her actions, for example when making a torn paper collage. The child can, therefore, decide whether to tear the coloured papers into pieces first and then glue them onto the pattern on a piece of paper, or to tear the papers piece by piece and glue them on immediately—such an action requires control and organisation, and poses a challenge to developing executive functions. When the child has the opportunity to make such decisions and puts his or her plan into practice, he or she develops higher-level cognitive functions by practising updating relevant data in the memory or inhibiting prepotent responses, tries to adapt flexibly to changing conditions (e.g. when a certain shade of coloured paper is not available), and when an adult asks a question about the work done, he or she learns to reach a higher level of thinking about his or her own actions and reflects on his or her own performance (at the age of 5–6).

Particular significance in the development of executive functions is attached to various board games and card games. Most games and fun activities require performing a sequence of actions under certain rules, which fosters the development of execution functions. The simplest board games (“Mushroom Eaters” or “Car Racing”) or card games (“Black Peter”) require that children maintain their attention—follow what changes on the board when the opponents make their moves, inhibit prepotent responses, boost their working memory, persist in pursuing their goals, and deal not only with external interferences but also with emotions occurring during the game. Particularly noteworthy is the educational series of Mini PUS books

with blocks for the youngest ones, which can be used as early as at the age of two. The child is supposed to use a book (with a particular story, heroes or tasks) to find a rule according to which he or she should put the blocks in the box. The child trains attention focusing skills, attentional set-shifting and combining the sequences of actions (first you have to take the block from the box, then check which picture shows the same number and colour as the block, then find the answer in the book, verify the number in the picture with the answer, find this number in the box, and put a block in its place using a different colour of the number). Once arranging the blocks is complete, the child closes the box, turns it over, opens it and checks whether the task has been done properly—if not, he or she finds out what has gone wrong and why the desired pattern has not appeared. Another opportunity to develop executive functions is the game “Guess who?” (for ages 5 and up). Apart from the inhibitory skills and attentional set shifting, during this game the child learns to store a large amount of information in the working memory, as in the “memory” type of games. A preschool child can learn how to plan strategies of action by playing “Dobble” (for ages 4 and up). In addition to practising these skills during games, it is worthwhile for the adult caregiver to help the child see in which situations outside the game he or she can apply the acquired skills.

Building scaffolding

A well-organised space and available materials alone do not provide sufficient conditions for the child’s development. It is only the person who can reflectively manage them that can make the exemplarily designed space become a suitable context for development. Learning executive skills can occur during natural daily activities accompanied by conversation. Three-year-old children who experienced “verbal scaffolding” as a help from their mothers at the age of 6 display higher-level problem-solving skills and persistence in pursuing their goals, than children of mothers who do not use the technique (Dawson, Guare 2012: 110).

The primary caregiver can provide the child with explanations and guidance and ask questions suited to his or her level of development to help them do the task. This way, the child learns to see and

understand relationships and to combine new knowledge with previously acquired information. All these skills are related to meta-cognition, i.e. the ability to distance oneself from one's own actions, and they allow one to monitor the actions taken (Dawson, Guare 2012: 10). By building scaffolding that the child climbs up with the help of an adult, there is a greater chance of completing the task, which, in fact, appears in the child's sphere of immediate development.

The following table presents the examples of verbal scaffolding used during the interaction with a preschool child.

Table 1. Examples of scaffolding intended for a preschool child that supports the development of the executive functions

Scaffolding category	Example of message
Questions/statements connecting objects with the place	"Which saucer goes with this cup?" "What's missing on the table if we want to have our afternoon tea?"
Associating the present action, subject or topic of conversation with the previous experience	"This is a train, it runs on rails just like the tram we ride to Grandma." "This game is like our chasing game, because you also have to run away when someone chases you."
Using words to describe experiences, especially with respect to sensory experiences	"In this photo the girl has a very wrinkled nose and squinted eyes when she puts a slice of lemon into her mouth." "This lady sings with a very high voice."
Describing the properties of an object indicating its uniqueness/function/specific features that may be useful to solve the problem	"This ball colour is different from the colour of the balls you have already put into the basket." "We need a round transparent block, suitable for a car wheel."
Determining a function or action that can be performed using a particular object	"You can dig a hole in the sand with a spoon as well." "These are scissors that cut out patterns at the edge of paper."
Describing verbally how something works	"We take out all the pieces of the jigsaw puzzle and turn them around so you can see the coloured side." "This is how I button up the teddy bear's vest."
Associating emotional states with their causes	"Your little sister was glad you shared your sand moulds." "Grandma will be upset if you step on the carpet in muddy shoes."
Emphasising the correlation between cause and effect	"If you keep throwing the book, its cover will tear." "We won't go sledging without a hat on, because you might catch a cold."

Scaffolding category	Example of message
Combining objects in general categories	<p>“Here’s an apple, there’s a pear and if we buy more bananas, we’ll have a lot of fruit in the basket.”</p> <p>“There’s a hammer, a screwdriver and a saw in your workshop—it’s a workshop that’s well-equipped with tools.”</p>
Assisting in understanding an action by combining its two aspects	<p>“Let’s make some cakes, we’ll need flour, butter and eggs.”</p> <p>“Let’s play hide and seek, we need someone to wait until we hide and then to look for us.”</p>

Source: The author’s own study based on Dawson, Guare (2013).

Building the scaffolding requires parents and teachers to take a kind interest in the child’s activities, and it can be one of the ways to reduce disorders that arise in the fulfilment of parental roles, i.e. the risk factor of reaching for addictive substances and risky behaviours. Even though the parents are not able to provide their child with proper conditions for his or her development, the nursery teacher can help him or her to develop EFs. In such a situation, the nursery becomes a place for equalizing the children’s educational opportunities and gives them hope to experience success in further education despite the lack of support from parents.

Summary

The knowledge of the status of executive functions intensively developing in preschool children may lead to planning early prevention actions, which provides an opportunity not only to improve the present well-being of children, but also to help them cope with school requirements and the sense of belonging to a peer group in the near future—important factors protecting them against the use of alcohol. Proper organization of spatial and material conditions determines the potential of the family environment and the kindergarten, but the most important are early preventive actions which are taken by parents and teachers who are reflective, empathic and warm in their interactions with the child.

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