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Emotional and attentional predictors of self-regulation in early childhood

Abstract: *The development of self-regulation in early childhood is related to development of emotional regulation and attention, in particular executive attention (Feldman, 2009; Posner & Rothbart, 1998). As the ability to self-regulate is crucial in life (Casey et al., 2011), it is important to reveal early predictors of self-regulation. The aim of the paper is to present the results of longitudinal studies on the relationships between the functioning of attention, regulation of emotion and later self-regulatory abilities. 310 children were assessed at three time points. At 12 months of age emotional regulation in situation of frustration and attention regulation were assessed. At 18 and 24 months behavioral-emotional regulation in the Snack Delay Task was measured. Additionally parents assessed executive attention using The Early Childhood Behavior Questionnaire when children were 26 months old. Structural equation modelling revealed two different paths to development of self-regulatory abilities at 18 months: emotional (reactive system) and emotional-attentional and only one emotional-attentional path at 24 months. The early ability to focus attention and later executive attention functioning revealed to be important predictors of self-regulatory abilities both at 18 and 24 months of age.*

Key words: *emotion regulation, executive attention, attention focus, self-regulation*

Introduction

One of the hallmarks of early child development is increasing self-regulation. Self-regulation is an ability to monitor and modulate cognition, emotion and behavior to accomplish one's goals or/and to adapt to cognitive or social demands of the situation (Berger, Kofman, Livneh, & Henik, 2007). According to Andrea Berger (2011) self-regulation is not a single process, but rather the group of processes, including both cognitive and emotional component. From the developmental perspective there seems to be a continuity in the development of different forms of regulation: from the physiological level of regulation (heart rate, sleep cycles), through emotional regulation (reaction to stress and frustration) to attentional (attention shifting, attention directing) and cognitive regulation (executive functions; Feldman, 2009).

The aim of the article is to present the results of longitudinal study on the relationships between the functioning of attention and regulation of emotion at 12 month of age and self-regulatory abilities at 18 and 24 months. The analysis of the mechanism of executive attention (Rothbart, Derryberry, & Posner, 1994) and effortful control of behavior as a dimension of temperament (Rueda, Posner, & Rothbart, 2005) enables to consider if there is only one direct developmental pathway from emotional functioning through attentional regulation to self-regulatory abilities of 2 year olds or maybe there are different paths via emotion or attention regulation.

Self-regulation in early childhood

According to the developmental neurocognitive perspective (Berger, 2011), the ability to self-regulate is anchored in both motivational and cognitive processes that are broadly related to as executive functions. These are: attention control and attention shifting, ability to inhibit automatic reaction, ability to hold actual goals and demands in working memory etc. Specific neuroanatomical

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and functional circuitry of the brain stands behind all these basic processes (Berger, 2011).

However, the brain circuities that are a basis for developing self-regulation include not only neural substrates of cognitive, but also emotional and physiological processes (Feldman, 2009). According to Feldman's developmental hierarchical-integrative perspective, self-regulatory functions require integration of brain stem, limbic system and cortical system, although they develop sequentially (together with the development of the brain) – physiological, emotional, attentional and self-regulatory functions develop on the top of each other.

Integrating different levels of self-regulation allows to consider self-regulatory functions as emerging early in childhood, beginning in infancy (see also Kmita, 2013). According to the first developmental model of self-regulation, proposed by Claire Kopp (1982), in the first year of life self-regulation refers mostly to neurophysiological and sensorimotor modulation. The mechanism behind these form of regulation can be seen in the attention orienting processes. The next step in the development of self-regulation is a period between 12 and 18 months of life. At this age children become able to engage in goal-directed behaviors and to react to the commands of other people. In the 2nd and 3rd year of life they develop an ability to control their behavior – at the beginning in the presence of an adult, and later they are able also to self-control. The most flexible and adaptive stage of self-regulation develops after the third birthday. The stages of the development of self-regulation described by Kopp (1982) were also empirically confirmed (Harma, Rothbart, & Posner, 1997; Kochanska, Coy, & Murray, 2001; Rothbart, Ellis, & Posner, 2004; van der Mark, Bakermans-Kranenburg, & van Ijzendoorn, 2002; Vaughn, Kopp, & Krakow, 1984). However, one can argue (see also Kmita, 2013) that even early self-regulatory functions go behind simple self-control or self-restraint behaviors, so we use the term 'self-regulation' to describe regulatory functions in early childhood, using the Kopp's term 'self-control' only to describe children's control of their own behavior (like self-restraint or compliance).

The ability to postpone immediate gratification voluntarily in order to obtain a delayed but preferred outcome is often viewed as a key component of children's early self-control (Mischel, Ayduk, & Mendoza-Denton, 2003). A procedure of delay of gratification is most commonly used in studies of preschool children (Mischel, Shoda, & Rodriguez, 1989; Mittal, Russell, Britner, & Peake, 2013; Yates, Yates, & Beasley, 1987). Researchers typically use compliance and/or resistance to temptation procedures to examine toddlers' self-control. For example, children are introduced to the room where there is very attractive toy, but children are asked not to touch the toy until the researcher returns (e.g., Grolnick, Bridges, & Connell, 1996; Silverman & Ippolito 1995; Mischel, 2012; Peake, Hebl, & Mischel, 2002). In different version of the procedure children are presented with the snack laying on the table and are asked not to eat the snack until the researcher's return (Kochanska, Murray, & Harlan, 2000). The time of delay and strategies that children adopt while waiting can be analysed. As this paradigm proved to be useful, we used Snack Delay task in our study.

Self-regulation and temperament

Many researchers argue that there is a relation between self-regulation and temperament (Kim & Kochanska, 2012; Rothbart et al., 2004; Rueda, Posner, & Rothbart, 2005). According to Rothbart, temperament can be regarded in the categories of individual differences in reactivity and self-regulation (Rothbart & Bates 1998; Rothbart & Derryberry 1981; Rothbart et al., 2004). Temperamental differences are observed both in the sphere of emotions, motor activity and attention.

The concept of reactivity refers to the onset, intensity and duration of reaction. This concept can be applied to different dimensions of functioning – both more specific physiological reactions, like heart rate reactivity, and more general dimensions, like negative emotional reactivity. The reactive system is supposed to be active from the birth, and individual level of reactivity is rather stable through the life course (Kiss, Fechete, Pop, & Susa, 2014). Many studies have confirmed that reactivity is one of the temperamental factors. For example the study by Garstein and Rothbart (2003) revealed that dimensions related to reactivity loaded two temperamental factors: surgency and negative emotionality. Even in the Thomas and Chess's (1977) description of temperamental individual differences in children, one can find dimensions related to the concept of reactivity: activity level, the threshold of reaction and the intensity of reaction.

Reactive processes are related to positive and negative emotions (Derryberry & Rothbart, 1988). Therefore the high reactivity is related to both high intensity pleasure and frustration. The reactive system is responsible for reacting to internal and external changes in the environment. Its activity can be observed in different forms of reaction, like negative affect, fear or approach (Kiss, Fechete, Pop, & Susa, 2014).

The role of reactive system in the development of emotion regulation was analysed in many studies. Emotional regulation refers to the processes that serve to manage emotional arousal and to support adaptive reactions (Calkins, Smith, Gill, & Johnson, 1998; Eisenberg & Fabes, 1998; Thompson, 1991). Managing emotions can be operationalized as a behavioral strategy in situations that evoke frustration or fear. These strategies are for example self-soothing, active looking for help, or change of behavior. These strategies can be helpful in situations that require control of negative emotional reactions (Calkins et al., 1998; Stifter & Braungart, 1995).

It has been observed that in the second half of the first year of life infants begin to express fearful inhibition in reaction to unknown or high-intensity objects (Derryberry & Rothbart, 1988). This early behavioral inhibition predicted fear, sadness, shyness and low intensity pleasure at 7 years (Rothbart et al., 2001). Fearfulness in infancy allows also for prediction of later tendencies to impulsive and aggressive behavior. There is a negative relation between fear in early childhood and intensity of impulsive and aggressive behaviors in later development (Gray & McNaughton, 1996), suggesting that fear may be involved in regulation of such behaviors. Moreover, more fearful infants showed higher empathy, guilt and shame in childhood (Rothbart, Ahadi, & Hershey, 1994). Fear in infancy, when supported by the gentle socialization techniques, was also a predictor of the development of internalized conscience (Kochanska, 1995), suggesting the role of reactive emotions in the development of self-regulation.

The temperamental concept of self-regulation in Rothbart's theory can be defined as processes that develop at the end of the first year of life and serve to modulate reactivity (Rothbart et al., 2004). In developmental research the measure of temperamental self-regulation is often based on the indicators of effortful control (Bridgett, Oddi, Laake, Murdock, & Bachmann, 2013). However, temperamental self-regulation can be also based on different mechanisms, related to reactive emotions, like fearful inhibition or extravertive approach. Like reactivity, self-regulation also constitutes a temperamental factor. The dimensions of effortful control and attentional regulation as components of temperament were confirmed in many studies (Ahadi, Rothbart, & Ye, 1993; Garstein & Rothbart, 2003; Rothbart, Ahadi, Hershey, & Fisher, 2001).

Attentional regulation

According to the Posner's model of attention, there are three different systems of attention (Posner & Dehaene, 1994), playing different roles: alerting, orienting and executive. These three systems emerge and develop in different time points. At first the alerting system is being activated, allocated in the brain stem. Then the orienting system, responsible for orientation and attention allocation, is being activated. At the end of the first year of life the executive attention emerges, allocated in the prefrontal cortex and responsible for conflict and errors detection, reaction inhibition, monitoring, etc. The results of many studies suggest that this is the executive attention that integrates different forms of self-regulation (Berger, 2011; Fonagy & Target, 2002; Kopp, 1982; Posner & Rothbart, 1998). Attention direction, shifting and maintenance assist children in handling emotional distress, and the emergence of emotional detection promotes focused attention (Bruner, 1984; Posner & Rothbart, 2000). Therefore it is important to take attentional abilities into account, both more simple (for example attention focus and distractibility) and more complex, like executive attention.

Studies on the executive attention system show that it develops between 24 and 36 month of life. In the study of Gerardi-Caulton (2000), children had to push the button with the picture that was also presented on the computer screen. The picture on the screen could appear on the same location as the picture on the button, or on the opposite side. Positive relation between the performance level in this task and age of children was observed. Moreover, performance level was related to the level of different measures of effortful control. Children who managed this task well were described by their parents as more able to regulate their attention, less impulsive and less prone to frustration. They also had higher scores in the Kochanska's Tower task and Snack Delay task (however it is important to note that correlational analyses were not computed with children younger than 30 months due to their relatively poor performance on the task).

Sethi, Mischel, Aber, Shoda and Rodriquez (2000) revealed that infants who at 18 months were able to use distraction of attention strategies during the short separation with a mother were more able to delay gratification at the age of 5. Using distraction of attention strategies can be seen as an attempt to self-regulate a distress caused by the separation with a mother, as children who used this type of strategy showed less negative affect.

Emotions and attention in the development of self-regulation

Summing up, both emotional and attentional regulation seem to be important in a later development of self-regulatory abilities. As the results of described studies suggest, the direction of this relation goes from the emotional regulation in infancy, that allows to predict later regulation of attention, leading to efficient development of later self-regulatory behaviors.

This direction was also confirmed in many studies. Emotional regulation in infancy predicted cognitive and emotional functioning in the first and second year of life (Feldman, 2004); the ability to regulate affect in arm-restraint procedure predicted a compliance in 18-months old children (Stifter, Spinrad, & Braungart-Rieker, 1999); and longitudinal studies by Putnam, Rothbart and Garstein (2008) revealed that high effortful control in toddlers was based on positive affect in infancy. However it is important to note that in many studies this described direction was somehow "forced" by the design of the study. The emotional regulation was measured during infancy, then attentional functioning was measured during toddlerhood and self-regulatory abilities were measured later on (Feldman, 2004; 2009; Putnam et al., 2008). The rationale for such design is developmental order of brain maturation mentioned earlier (Feldman, 2009); however it does not allow to answer the question if there is only one possible path of relation, leading from emotional to attentional regulation. One can argue, that also different path is possible, leading from attentional functioning to emotional regulation (for example when an infant redirects attention from emotional stimulus).

So the rationale for the study was to further elaborate on the relation between emotional and attentional regulation during infancy and later development of self-regulatory abilities. Important question is if there is only one path to development of self-regulatory abilities, leading from emotional regulation through attentional functioning. It seems possible that in younger children the influence of emotional functioning can be stronger, as their self-regulation may be still based more on reactive emotions than active control of behavior (see Rothbart et al., 2004).

Method

Participants

Participants were 361 children born between February and July 2011. The children were mostly from a large-city (Krakow, Poland) environment (78.5% of the group), and their parents were generally educated to degree level (76% of the group). Parents were invited to participate in the research via regular mail or e-mail. The children were 12 months old at the first assessment (T1, $M = 52.3$ weeks; $SD = 1.73$ weeks); 18 months old at the second assessment (T2, $M = 80.17$ weeks; $SD = 1.9$ weeks); and 24 months old at the third assessment (T3, $M = 104.28$ weeks; $SD = 1.68$ weeks). Because not all children contributed data for each measure at each time point, therefore, the number of children examined in individual analyses varied. At all three stages participated 310 children (170 boys and 140 girls).

Research procedure

The study took place in the Early Child Development Psychology Laboratory at the Institute of Psychology of the Jagiellonian University in Krakow and was a part of the longitudinal project *The birth and development of mentalising ability*. Children participated in the studies together with their parents. The study lasted about 30 (at T1) – 60 (at T3) minutes and took the form of structured play during which the experimenter proposed various activities to the child. The meeting with the child was videotaped. Additional details on the study can be found in the paper of Białek, Białecka-Pikul and Stępień-Nycz (2014).

Measures

Regulation of emotions

At T1 expressions of the emotion regulation were assessed in a situation of frustration after taking away a toy. The task was based on Braungart-Rieker and Stifter (1996). The experimenter and the child sat opposite each other at a table (the child sat on his/her parent's lap). The experimenter said to the child: "Look, I have such toys. Do you want to play with them?". She showed three toys (a ball, a car and a phone) and moved them to a child. The child was allowed to explore toys for a while. When a child chose one of the toys and started to play with it (for about 15 seconds), the experimenter took out a toy from child's hands, saying nothing. The experimenter was holding a toy out of reach of a child for half a minute (or 15 seconds of child's loud crying) while maintaining a neutral facial expression. Toy remained visible for a child. After this time, the experimenter gave the child a toy back, saying nothing. For the next half a minute she did not interact with the child. In coding procedure, 30-second observations (before and after taking away a toy) were divided into six episodes (of 5 seconds each). Each episode was assessed in terms of the intensity and character of facial emotional expression and vocalization on a 7-point scale, ranging from -3 = very strong negative emotion to 3 = very strong positive emotion. Then the mean intensity of facial emotional expression and vocalization was calculated, separately for the two parts of observation (after toy withdrawal and after giving the toy back). Additionally two other indicators were obtained: maximum intensity of negative emotional reaction (separately for the two parts of observation) and latency in emotional reaction (in which episode after toy withdrawal – from 0 to 6 – the reaction occurred) and latency of the extinction of emotional reaction (in which episode after giving the toy back – from 0 – to 6 – the emotional reaction disappeared).

The coding was performed by trained judges, and 20% of the collected material was coded by two judges in order to calculate the extent to which their assessments agreed. This accord was deemed satisfactory (Pearson correlation ranged from $r = .63$ to $r = .82$; $p < .001$ for particular indicators).

Exploratory factor analysis using principal axis analysis revealed three factors that together explained 64.5% of variance in a frustration task (see Table 1). Although the eigenvalue of the third factor is below 1, the analysis of the scree plot revealed that it should be added to the model.

The first factor grouped indicators of the intensity and latency of emotional reaction after toy withdrawal, so it was a measure of emotional reactivity. However due to the direction of interpretation of this factor (the higher score in this factor, the lesser emotional reactivity), it was called *emotional stability* and was defined as (low) intensity and (long) latency of emotional reaction.

The second factor can be seen as *force of regulation* and it was defined as intensity of reaction after withdraw of the situation of frustration. In this indicator, mean and maximum intensity (the last one with negative loading) of emotional reaction after getting back a toy were taken into account.

The last factor, *rate of regulation*, was defined as the speed of extinction of emotional reaction. In this indicator, the moment (i.e. the number of the episode, from 0 to 6) of the emotional reaction extinction was taken into account. Both loadings are negative, so the longer it took to extinct emotional reaction, the lower rate of regulation.

Regulation of attention

At T1 the regulation of attention was assessed in three tasks.

In Task 1, presented at the beginning of the session, the experimenter informed the parent that in order to familiarize the child with the room, they were asked to play for a while. The experimenter demonstrated (on the floor) how to play with a toy vehicle and asked the parent: "Please show your child how to play with this toy". The experimenter left parent and child alone in the room for two minutes.

Task 2, presented in the middle of the session, was derived from Early Social Communication Scales (ESCS) (Mundy et al., 2003). In the first part of the task, the experimenter placed a toy car or a ball within a child's hand and pulled her hands on the table in the gesture of willingness to catch the ball or car. Depending on the behavior of a child, the experimenter either continued alternating activity or tried to encourage a child to engage

Table 1. Factors and factor loadings after Varimax rotation

	Factor 1	Factor 2	Factor 3
Eigenvalue	3.79	1.86	.80
% of variance	37.89	18.61	8.03
factor loads	Factor 1	Factor 2	Factor 3
vocalization_1_intensity (voc_1_int)	.82		
vocalization_1_latency (voc_1_lat)	.69		
facial_1_intensity (fac_1_int)	.73		
facial_1_latency (fac_1_lat)	.49		
neg_emotion_max_1 (em_1_max)	-.93		
vocalization_2_intensity (voc_2_int)		.90	
facial_2_intensity (fac_2_int)		.94	
neg_emotion_max_2 (em_2_max)		-.71	
facial_2_extinction (fac_2_ext)			-.82
vocalization_2_extinction (voc_2_ext)			-.53

in a play. The second part of the task was the subsequent task performed in ESCS. Detailed information on the research procedure can be found in the manual written by the authors of the Scales (Mundy et al., 2003).

Task 3, presented at the end of the session, was a modified version of hiding game devised by Behne, Carpenter and Tomasello (2005). The experimenter placed in front of her a couple of boxes, showed child one of the toys and placed it in the box on the right, saying, “See, now I am hiding a toy in the box”. Then she demonstrated that the toy is in one of the boxes. After turning boxes, she moved them closer to the child (so that he/she could reach them by hand but could not see what was inside), saying “Look for a toy”. The procedure was repeated several times with changes in order to assess informative pointing understanding. Detailed information on the research procedure can be found in Behne et al. (2005).

In coding procedure, three samples of child’s behavior were taken into account. These were: max. 3 minutes from Task 1; max. 4 minutes from Task 2 and max. 5 minutes from Task 3. Child’s behavior was coded by judges in two ways. Using the Interact software designed for analysis of observational data, judges classified child’s behavior as either focused or distracted. Focus on the activity was coded when a child was focused on a toy (touching, keeping, playing with it) or if a toy was out of the child’s reach, he/she was looking at it or at the parent/experimenter or alternately at the toy and parent/experimenter. Distraction was coded when the child did not deal with a toy, or with what was the experimenter (or parent in the first task) doing (e.g. child could look around, turn around to parent, deal with something else than the current task). In addition, every observation was divided into episodes (10 seconds each). Each episode was assessed in terms of child’s focus of attention on a 4-point scale (from 1 = “child seems to be distracted during the whole episode, does not deal with the task” to 4 = “child seems to be focused on the object or on the parent/experimenter during the whole episode”). 20% of the collected material was coded by two judges. This accord was deemed satisfactory at a level of .58 ($p < .001$; Pearson correlation).

In the study two indicators of regulation of attention were assessed: ability to focus on the activity and stability of attention.

Focus on the activity was measured by assessing summarized time of focus (time_toy and time_exp) and distraction (time_dis). The second indicator of attention focus was the mean rate made by the judges in all episodes (foc_judge).

Stability of attention was defined as fluctuation of focus and distraction. In this indicator the number of 3 subsequent episodes (so half-minute periods) with highest rates (4) were taken into account, divided by the whole number of episodes (stab_no). The second indicator of the stability of attention was maximum number of episodes with the highest rate (4; stab_max).

Behavioral-emotional regulation

At T2 and T3 behavioral-emotional regulation was assessed in the Snack Delay Task. The task was a modified version of the Snack Delay task devised by Kochanska (Kochanska, Murray, & Harlan, 2000). At T2 the experimenter and the child sat opposite each other at a table (the child sat on his/her parent’s lap). After asking: “Do you like corn puffs?” and receiving positive answer, an experimenter placed a snack on a tray, and then covered it with a transparent cup. Then she said: “Now you’ll have to wait a moment for this reward. I have to go to the other room for a moment. You’ll get the snack when I come back”. After giving the instruction, she pushed the tray with the snack towards the child and went to the other room for 60 seconds. Upon her return the child received the snack, unless he/she had already eaten it. At T3 the task was slightly altered. Since not all children had been interested in the corn puffs, parents were asked to bring a treat that the child liked. Additionally, the time of delay was extended to 90 seconds.

In coding procedure, child’s behavior was assessed from the point when the experimenter moved the tray towards the child and stopped giving instructions, to the point when the time allotted for the study elapsed or the child ate the corn puff. Child’s behavior was coded using the Interact software (for the details of coding procedure and further analysis of this task see Byczewska-Konieczny, Kosno, Stępień-Nycz, Białek, & Białecka-Pikul, submitted). 20% of the collected material was coded by two judges in order to calculate the extent to which their assessments agreed. This accord was deemed satisfactory at a level of .82 ($p < .001$) at 18 months and .98 ($p < .001$) at 24 months (Pearson correlation).

Two indicators of behavioral-emotional regulation were assessed: the time (time) and the effectiveness of delay of gratification (success).

Executive attention

Executive attention was measured when children were 26 months old[1] using The Early Childhood Behavior Questionnaire (Putnam, Gartstein, & Rothbart, 2006). The ECBQ was designed to assess 18 dimensions of temperament in children between the ages of 18 and 36 months. Factor analysis revealed a three-factor structure: Surgency/Extraversion, Negative Affectivity, and Effortful Control. The Effortful Control factor of ECBQ consists of both cognitive-behavioral subscales (attention focusing, attention shifting, inhibitory control) and emotional-affiliation subscales (low intensity pleasure, cuddliness, soothability and frustration (with negative loading); Putnam, Gartstein, & Rothbart, 2006). Therefore, for this study, as measures of executive attention, only three (more cognitive) subscales of Effortful Control were used. These were: Attention Focusing (att_foc) subscale (12 items, e.g. “When engaged in an activity requiring attention, such as building with blocks, how often did your child stay involved for 10 minutes or more?”), Attention Shifting (att_shift) subscale (12 items, e.g. “During everyday activities, how often did your child seem able to easily shift attention from one activity to another?”), Inhibitory Control (inh_cntrl) subscale (12 items, e.g. “When asked to do so, how often was your child able to stop an ongoing activity?”).

ECBQ was translated into Polish by two independent translators and has appropriate psychometric properties including factor structure and internal consistency (Cronbach’s alfa ranging from .66 to .87 for particular subscales).

Results

Emotional and attentional regulation at 12 months of age

First of all, descriptive statistics of emotional and attentional functioning at 12 months were calculated (see Table 2). The analysis of descriptive statistics revealed that the distribution of results in many tasks was not normal. Therefore in some of the following analyses non-parametric statistics were used.

Analysis of descriptive statistics (Table 2) indicates that in the frustration task children reacted with rather low intensity of negative emotional reaction, both vocal and facial. However means of negative emotional reaction were under 0, so we can conclude that there was a tendency to react with rather negative than positive emotions in this task. The negative emotional reaction after giving the toy back to the child was significantly lower than the reaction after toy withdrawal (for the maximal intensity of negative emotional reaction: Friedman’s ANOVA = 32.51; $p < .001$).

On the other hand the distribution of results in attention regulation tasks was positively skewed, as children were able to focus their attention on the tasks for most of the time and the percent of distraction time was very low (see Table 2). The time children spent focusing on the tasks was highly correlated with the estimation of attention focus (Spearman’s $R = .85$; $p < .001$), thus confirming the reliability of coders’ estimation. On the other hand, the stability of attention was moderate indicating that despite very high attention focus ability in our sample of children, their attention fluctuated during the tasks.

Analysing the results of the first stage of research, it was found that two indicators of emotional reactions (intensity and latency) were associated with the ability to focus attention. Children who exhibited a higher level of focus of attention, in a situation of frustration (after the toy withdrawal) manifested lower intensity of negative emotions (Spearman’s $R = -.17$, $p < 0.005$), which were also characterized by higher latency ($R = .15$, $p < 0.005$). The relationship in the same direction, although weaker, was also observed due to the stability of attention index ($R = -.14$, $p < 0.01$ and $R = .14$, $p < .01$).

Self-regulation at 18 and 24 months of age

In Table 3 descriptive statistics in self-regulation task at 18 and 24 months are presented.

Significantly more children succeeded in delay of gratification task at 24 than 18 months ($chi^2 = 19.10$; $p < .001$) and they were able to wait significantly longer (Friedman’s ANOVA = 43.33; $p < .001$). The time of delay at 18 and 24 months was significantly, but weakly correlated (Spearman $R = .24$; $p < .01$), thus indicating rather low stability of the ability to delay gratification.

[1] The use of ECBQ at 26 months (instead of 18 months) was caused by the fact, that describing research is only a part of a larger project and the design of other measures (not described here) made it difficult to use ECBQ at 18 months.

Table 2. Descriptive statistics of emotional and attentional regulation at 12 months

indicator	*M*	*SD*	-95% CI	+95% CI	median	range
vocalization_1_intensity	-.12	.33	-.15	-.08	0	-2.5 – 1
vocalization_1_latency	4.71	2.00	4.51	4.92	6	0 – 6
mimics_1_intensity	-.07	.39	-.11	-.03	0	-2.67 – 1.17
mimics_1_latency	4.47	2.11	4.25	4.69	6	0 – 6
neg_emotion_max_1	.47	.73	.39	.54	0	0 – 3
vocalization_2_intensity	-.05	.31	-.08	-.01	0	-2.33 – 1.17
vocalization_2_extinction	.11	.66	.04	.18	0	0 – 6
mimics_2_intensity	.01	.40	-.03	.05	0	-2.33 – 2
mimics_2_extinction	.17	.68	.10	.24	0	0 – 6
neg_emotion_max_2	.24	.59	.18	.30	0	0 – 3
attention_focus_%[a]	91.27	6.54	90.59	91.95	92.93	56.38 – 100
attention_distraction_%	8.73	6.54	8.05	9.41	7.06	0 – 43.62
attention_foc_judge	3.64	.28	3.61	3.67	3.72	2.19 – 4
attention_stability	.50	.19	.48	.52	.50	0 – .91

Note: [a] In this table two indicators of attention focus (time spent dealing with toy and time spent dealing with experimenter/parent) were summarized.

Executive attention

Descriptive statistics for the three subscales of ECBQ are presented in Table 4. The scores of the three subscales were normally distributed in our sample.

The three subscales were positively, low-to-moderately correlated: for attention focus and attention shifting Pearson $r = .29$, $p < .001$; for attention focus and inhibitory control $r = .41$, $p < .001$; for attention shifting and inhibitory control $r = .39$, $p < .001$.

The Polish version of ECBQ proved to be stable between 26 and 30 months at the level of .71 (Pearson correlation).

Correlations between emotional and attentional functioning and later self-regulatory abilities

Correlations for measures of emotional functioning, attentional functioning and self-regulatory abilities at 18 and 24 months are presented in Table 5.

There are significant correlations between different measures of emotional functioning, as well as between different measures of attentional functioning. Emotional and attentional functioning seem to be correlated with later self-regulatory abilities; however, these correlations differ depending on the time measurement of self-regulation. For self-regulatory abilities at 18 months there are significant correlations with both emotional and

Table 3. Descriptive statistics in delay of gratification task at 18 and 24 months

self-regulation	*M*	*SD*	-95% CI	+95% CI	median	range	% success
time of delay at 18	26.26	20.66	23.53	29.00	18.92	0 – 60	22.58
time of delay at 24	62.15	35.39	57.78	66.52	89.85	.57 – 90	53.15

Table 4. Descriptive statistics for the ECBQ at 26 months

Subscales of ECBQ	*M*	*SD*	-95% CI	+95% CI	median	range
Attention focusing	4.58	.89	4.47	4.70	4.67	2.09 – 6.42
Attention shifting	4.59	.67	4.51	4.68	4.58	2.58 – 6.17
Inhibitory control	3.83	1.03	3.70	3.96	3.75	1.08 – 6.92

Table 5. Correlations between variables at 12, 18, 24 and 26 months of age

variables	emot_ stability_12	reg_force_12	reg_rate_12	att_focus_12	att_ stability_12	executive_ att_26
emot_stability_12	–					
reg_force_12	.26***	–				
reg_rate_12	-.36***	-.58***	–			
att_focus_12	.19**	.09	-.085	–		
att_stability_12	.064	.053	-.058	.71***	–	
executive_att_26	.07	.05	.087	.26***	.13*	–
self-regulation_18	-.14*	-.05	.14*	-.07	-.005	.16*
self-regulation_24	.063	-.03	.057	.056	.044	.28***

Note: * $p < .05$; ** $p < .01$; *** $p < .001$.

attentional functioning, whereas for self-regulatory abilities at 24 months only correlation with executive attention is statistically significant.

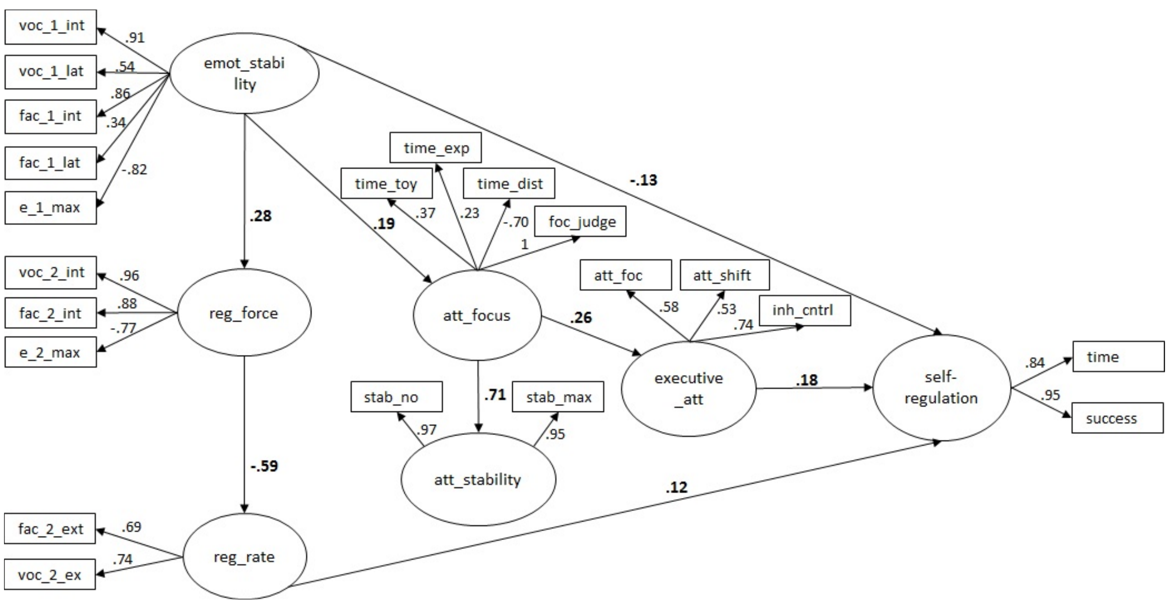
Predictors of self-regulation at 18 months of age

To analyse the relationship between emotional and attentional abilities at 12 months and later self-regulation ability, the structural equation modelling was used. In the presented model, executive attention was proposed as a step between attention at 12 months and self-regulatory abilities and 18 and 24 months, even though it was measured at 26 months. However, the stability of scores in the three subscales made it adequate to assume that the executive attention measured at 26 months reflects child's ability in this area in the previous period of time.

The tested model is presented in Figure 1. In this model two possible paths are examined: a direct path from emotional functioning at 12 months to self-regulatory abilities at 18 months, and indirect path leading from emotional functioning at 12 months, through attentional abilities at 12 months and executive attention, to self-regulatory abilities at 18 months. It should be noted that several models with different paths were tested and only the best-fitting model is presented here.

First of all we should consider the direction of interpretation of the paths. At 12 months of age, there are three factors of emotionality: emotional stability (the higher scores in the observable variables, the higher emotional stability); the force of regulation (the higher scores in the observable variables, the higher force of emotional regulation); and the rate of regulation (this indicator is interpreted in the opposite direction: the higher scores in the observable variables, the lower rate of emotional regulation). These three factors are interrelated

Figure 1. Predictors of self-regulatory abilities at 18 months (for the sake of clarity, the errors and correlations between observable variables are omitted)



at 12 months: more emotionally stable children, who react with lower intensity of emotions, regulate their emotions more successfully (the force of regulation is stronger); and children who are able to successfully regulate their emotions, do it faster, as there is a negative relation between the force of regulation and (low) rate of regulation.

The two indicators of attention at 12 months are also related. Children, who are able to focus their attention for the longer time, are not so easily distracted during the task, as their attention is more stable.

Emotional stability seems to influence positively the focus of attention at 12 months of age: there is a significant path indicating this direction of relation. Attention focus at 12 months is also positively related to later executive attention, and this ability directly predicts the ability to self-regulate at 18 months. So the first path of prediction begins at the emotional stability at 12 months and then proceeds through attentional functioning, both simple (attention focus) and more complex (executive attention).

However, there are also two other paths of prediction. The first one begins at the emotional stability at 12 months and goes directly to the self-regulation at 18 months. This relation is negative, so less emotionally stable children at 12 months (reacting with faster and more intensive negative emotions) are better at self-regulatory abilities 6 months later. This path is significant at the level of *p*-value equal .037. The second path also begins at the emotional stability at 12 months, but then proceeds through emotional regulation also at 12 months and then there is a direct, marginally significant ($p = .068$) path from the (low) rate of emotion regulation to the self-regulation at 18 months. It is important to note the direction of this prediction: children, who regulate their emotions for the longer time (their regulation rate is lower), are more able to self-restraint in the delay-of-gratification task 6 months later.

The whole model fits the data well: $chi^2 = 316.33$, $df = 173$; CFI = .96; RMSEA = .049 (.040 – .057).

Predictors of self-regulation at 24 months of age

In the second structural equation modelling the same predictors were taken into account, and the predicted variable was self-regulation ability at 24 months. The results of this analysis are presented in the Figure 2. Once again, only the best-fitting model is presented.

The pattern of relations between emotional and attentional functioning and self-regulatory abilities at 24 months reveals the path from emotional stability at 12 months through attentional focus at 12 months and executive attention in toddlerhood. This path is similar to the previously presented results of self-regulatory abilities at 18 months: the direction and strength of the paths are similar. However, at 24 months this “emotional-attentional” path seems to be the only one, as the direct paths between emotional stability and emotional regulation at 12 months and self-regulation at 24 months are no longer significant.

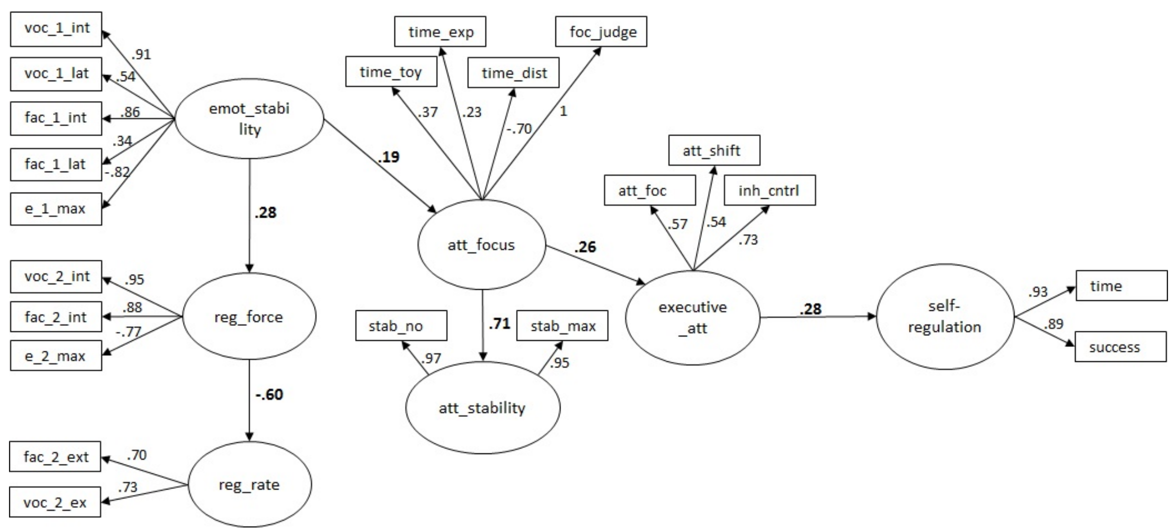
The whole model fits the data well: $chi^2 = 284.65$, $df = 175$; CFI = .97; RMSEA = .04 (.03 – .05).

Discussion

The goal of the study was to analyse the relations between emotional and attentional functioning at the end of the first year of life and later development of self-regulatory abilities. The results suggest that at 12 months children seem to be able to regulate their emotions in a frustration task, as they showed rather low intensity of negative emotions. On the other hand, they are also able to regulate their attention and keep focus on the task.

It is important to note the internal relations in the domain of emotional functioning on the one hand and in the domain of attentional functioning on the other hand. In both domains several different aspects can be distinguished. In the emotional domain, three factors have been revealed: emotional stability, force of regulation and rate of regulation. These three factors were interrelated (see

Figure 2. Predictors of self-regulatory abilities at 24 months (for the sake of clarity, the errors and correlations between observable variables are omitted)



Rothbart et al., 2004), and it was emotional stability that appeared to be the basis of emotional regulation ability at 12 months of age: children who reacted with less intense negative emotion in the frustration situation were more able to successfully extinct this reaction when the frustrating situation disappeared, and the rate of this extinction was faster. Even though the temperamental concept of self-regulation is supposed to modulate the reactivity (Rothbart et al., 2004), in the first year of life the level of reactivity or emotional stability can also influence the ability to regulate emotions in an emotion-eliciting situation.

Also the attentional domain can be regarded as consisting of different, but interrelated factors. At 12 months of age two factors were distinguished: the ability to focus on the task and the stability attention index, that can be referred to as sustained attention. Children who were more able to focus on the task were less prone to distraction. These basic aspects of attention measured in the laboratory setting were also positively related to later executive attention ability, assessed in the parent-based questionnaire, thus confirming the validity of our laboratory measure. On the other hand, the adopted measure of executive attention also deserves some thoughts. Although the executive attention was measured at 26 months, it has been proved to be rather stable between the ages of 18 and 24 and between ages of 18 and 30 (Putnam et al., 2006). Also in our study the measure of executive attention was stable between 24 and 30 months.

The results obtained in a transverse scheme (in the first phase of the study) indicate a positive relationship between the ability to regulate negative emotions and attention regulation and thus confirm the interdependence of self-regulatory mechanism in various aspects – emotional and attentional. Children at 12 months are able to use attention-based strategies to regulate their emotions by redirecting their attention from the frustrating object (Posner & Rothbart, 2000; see also Stępień-Nycz et al., 2013). However the structural equation modelling procedure revealed that it is emotional stability that is a predictor of attention focus, thus confirming the direction of this relation predicted by the developmental order of the brain maturation and found in other studies (Feldman, 2004; 2009). This result is also in accordance with the results of Putnam's et al. (2004) study, in which attentional functioning was based on the positive affect in infancy. It is important to note that in this study the direction of this relation was not forced by the design of the study, as both emotional and attentional regulation were assessed at 12 months.

The analysis of the delay of gratification task at 18 and 24 months revealed the growth in performance in this task, both in the time children are able to wait and the rate of success. However there was rather weak relation between the ability to delay a gratification at 18 months and this ability 6 months later. This lack of continuity can be explained by the development in attention-based strategy use, as only children who started to use this type of strategy improved their results in this task (see Byczewska-Konieczny et al., submitted).

The longitudinal analysis of the data using structural equation modelling revealed two different paths to development of self-regulatory abilities at 18 months: emotional and emotional-attentional. The emotional path seems to be connected to the reactive system of the regulation of behavior through negative emotions (for example fear; Rothbart et al., 2004; Rueda et al., 2005), as children who are more prone to negative emotions (react faster and with greater intensity of negative emotions) are more able to self-restrain in the delay of gratification task 6 months later. It is important to note that previous studies exploring the relation between regulating of frustration and later self-regulation brought opposite results (Stifter et al., 1999). However, the results of some studies indicate, that children who are more prone to react with fear develop conscience earlier and are more able to comply with demands of adults (Kochanska, 1995; 1997). In our study we did not distinguish fear from other negative emotions, coding them only according to their intensity and latency and not according to the type of negative emotion, so we can only hypothesize that the better ability to self-restrain at 18 months was due to fearful reactivity at 12 and 18 months. In the frustration task at 12 months children could react with anger and frustration because of the withdrawal of desired object, but they could also react with fear and anxiety when the researcher took the toy out of their hands. And at 18 months the delay of gratification task required children to comply with the demand of the adult not to touch the snack until her return. The more fearful children could react in compliance because of their fear and inhibition. It would be fruitful to further explore this hypothesis in connection with the laboratory measure of temperamental inhibition, that was conducted in our project at 18 months. This mechanism seems plausible especially at 18 months of age, when the ability to self-regulate is still at the beginning of development (Kopp, 1982) – we should note that the rate of success at this age was very low. On the other hand, at 24 months this "reactive" path seems to no longer be significant, as children are more able to regulate their behavior in a more active way, through executive attention mechanism (Kochanska, Murray, & Harlan, 2000; Rothbart et al., 2004).

The early ability to focus attention and later executive attention functioning revealed to be important predictors of self-regulatory abilities both at 18 and 24 months of age. This result confirms also the results of other studies (Feldman, 2009; Rueda et al., 2005). The ability to inhibit a dominant, but somehow not adequate reaction, the ability to redirect the attention from tempting object and to focus on something else seem to be crucial mechanisms laying behind the development of self-regulatory abilities in toddlerhood and preschool period (Berger, 2011; Posner & Rothbart, 1998). The results of some studies indicate that children who are able to use attention-based strategies of self-regulation are more effective in the tasks that require self-regulatory abilities, like the delay of gratification task (Sethi et al. 2000; Byczewska-Konieczny et al., submitted). This mechanism becomes especially important later in development, when the reactive system of behavioral control is no longer adaptive, as children have to learn to overcome their reactive emotions of fear or approach (Rothbart & Bates, 1998).

Coming to the conclusion, the obtained results seem to support the developmental hierarchical-integrative model of self-regulation (Feldman, 2009), as there seems to be a stable (visible at 18 and 24 months of age) path leading from emotional, through attentional functioning. Although at 24 months the attentional functioning seems to become more important for successful self-regulation, the impact of early emotional functioning is still visible, even though it is only indirect. And, as Feldman (2009) argues, even some minor disruptions at the lower levels of functioning (physiological or emotional) can lead to dysfunctions in higher systems (at the attentional or behavioral levels). Thus, the successful deployment of attention (both orienting and executive) is anchored in other levels of functioning. However, as children get older, this attentional – cognitive and effortful – aspect of functioning becomes more and more important for the development of successful self-regulation (see Berger, 2011).

The results of the study have also applicative aspect. As the ability to self-regulate is crucial in life (Mischel, Shoda, & Rodriquez, 1989; Casey et al., 2011), it is important to successfully support children in their development of this ability. There are many different programs that help to develop some aspects of the ability to self-control, including delay of gratification or executive functioning (Dawson & Guare, 2009). However the results of the studies suggest that it would be useful to support self-regulation through the training of more basic aspects of this ability, especially executive attention (Rueda et al., 2005), that seems to play a crucial role in the development of successful self-regulation.

The limitations of the study should also be noted. First of all it is important to note that the generalization of the results is limited as the group of children in our study was not representative: they were mostly from the large city and their parents were well educated, so they represented rather high SES group. Secondly, the results of many measures were not normally distributed. Our sample of children was very efficient at attention focus abilities and rather low emotionally reactive, as they did not show very intense negative reactions in the frustration task. This low negative reaction could be both due to low reactivity and high emotion regulation ability. Maybe it would be useful to conduct the analyses separately for children who reacted negatively in this task and children who did not react with negative emotions.

As the presented results explored the relation between emotional and attentional regulation and the ability to self-regulate in the delay of gratification task at 18 and 24 months, it is interesting to further examine later development of self-regulatory abilities in both hot (emotional) and cool (cognitive) context (Hongwanishkul, Happaney, Lee, & Zelazo, 2005). This analysis would allow to further elaborate on the two different paths of development of self-regulatory abilities.

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