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Effect of Blum pedagogy on onset Executive Functions in preschool children

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Abstract
The Blum program is a comprehensive personal and social interaction framework for preschool children. The program focuses on the professional self-awareness of preschool teachers and early childhood caretakers and the conscious use of art and creative practices. Our program is based on the use of integrative arts methods to develop cognitive and communication abilities, problem-solving skills, social and emotional competences, emotional intelligence, emotion regulation, fine motor skills, creativity and resilience. In our research, we hypothesized that children in the Blum program would perform better on tests of executive and language abilities than children in an age- and sex-matched control group (a methodology that does not use elements of the Blum program). We evaluated both domains using 3-3 standardised tests at the beginning and end of the school year to assess the improvement. A total of 51 children participated in this study, the average age was 4.53 years. Our results show that in the test procedures measuring executive functions and language ability, we observed significantly better results for the Blum group. The results of the current phase of the research suggest that the use of the Blum programme may have a positive impact on the development of certain skills that determine school readiness.
Keywords: Blum philosophy; artistic approach; well-being of the caretaker
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Introduction

The first years of life are, along with adolescence, the most determining period for the development of the brain, whether in its organization or in its specialization. Cerebral volume is multiplied by 4 from newborn to adult (Johnson 2001). The areas of child's brain, as well as the connections between its neurons will be expanding, allowing a constantly evolving control of his so-called cognitive skills, namely his motor skills, language, regulation of behavior and emotions, among others (Noble et al. 2015). Their quality of child brain development is governed primarily by genetic predispositions that set the developmental calendar, but also by the demands of the environment (Huang et al. 2013). Neuroscientists now know that a baby, evolving in a family environment conducive to interactions, creates connections denser and more areas of exchange between its neurons, called synapses. In effect, more solicitations and sensory stimulation thus generate a synaptic proliferation, a denser cerebral cortex, and more flexibility intellectual (Author 2020b). All these mechanisms are grouped together under the term "cognitive reserve", a sort of acquired cerebral capital (Stern et al. 2009).

However, being raised in a stimulating environment contributes to the enhancement of cognitive development. It is crucial to provide early and appropriate stimulation to children in order to optimize their emotional and cognitive resources, thereby giving them the best chances for a happier life.

Despite a slight improvement in global access to education, there is still a significant correlation between educational attainment and social background (*Bernardi & Ballarino 2016)*. Children from higher social classes, whose parents have a higher socioeconomic status, tend to achieve higher scores on achievement tests and perform better academically compared to children from lower social classes (Hair et al. 2015). Furthermore, recent studies on brain structure indicate potential differences between children and adolescents from low-income and high-income families, particularly in regions of the brain that support language, reading, executive functions, and spatial skills (Noble et al. 2015). Therefore, parental socioeconomic status strongly influences children's executive function abilities from an early age, which directly impacts their future educational opportunities (*Jednoróg* et al. 2012).

Development of Executive Functions

EFs bring together a set of high-level processes facilitating the adaptation or adjustment of the individual from a behavioral, affective, or cognitive point of view, by considering the social context. These processes advance the processing of multiple simultaneous information, effective strategies, and resistance to parasitic elements (Diamond 2013). Like a behavioral supervisor (Seron et al. 1999), EFs bring together several distinct facets depending on the context involved (Zelazo & Müller 2002). Executive and metacognitive functioning is a powerful predictor of successful academic performance (Andersen et al. 2019). The integrity of executive functioning also enables cognitive reserve, which helps mitigate the clinical expression of potential neurodevelopmental disorders through improved compensation of cognitive and metacognitive strategies (Author 2020a).

The development of EFs is early, but heterogeneous and progressive. However, the maturation of the prefrontal cortex can be disrupted or promoted by a multitude of genetic or environmental factors (Kolk & Rakic 2021), such as physiology, diet, sleep, physical activity, socio-economic status (parental education, poverty…), culture, parental stress, educational practices, screens, pollutants, etc. (e.g. Jirout et al. 2019; Corkin et al. 2021).

Certain beliefs about play still tend to circulate in society in general (Richard & Gentaz 2020). For some, playing is a frivolous activity that would deprive the child of real learning. For others, as is the case in Montessori pedagogy, play and more specifically pretend play would not constitute an activity likely to promote the development of the child; in contrast to activities linked to real life, the results of which would be more positive (Lillard & Taggard 2019). In view of these different elements, which activities can best promote the cognitive development in children?

Impacts of childhood activities, on cognitive development and education

It has been reported by several studies (e.g.: Park et al. 2015; Brock et al. 2017; Bowmer et al. 2018; Crenshaw 2020; Moreno et al. 2011; Takács & Kassai 2019) that (complex) art education has a positive influence on the formation of cognitive functions. According to some studies, activity and artistic and playful stimulation significantly increase the capacity for sustained attention (Wandell et al. 2008), including increased sources of motivation (Hutton et al. 2015) through feedback. Positive impact also may be exerted on the development of executive functions and the processes of behavioral and emotional control. Faced with advances in neuroscientific knowledge about education, educational programs have begun to be integrated into national curricula, often in a heterogeneous and unsystematic way between countries.

In South Korea, studies have highlighted the impact of music education and body expression on cortical thickness and cognitive measures, particularly in areas related to executive function development (Park et al. 2015). At age 6, children learning music are more resistant to noise, and show better auditory attention (Wolfe & Noguchi 2009). This improvement has a significant impact on the results of intellectual efficiency tests and on attention (Kieras 2006). The access to exhibition or initiation to visual arts, music, and dance over 2 years significantly improves intellectual efficiency (especially processing speed) and reading skills (Gathercole et al. 2006).

In Japan, dramatic play and musical play programs on preschool children improved working memory development and inhibition performance (Kosokabe et al. 2021). Methods of training in music and visual arts contributed to the development of verbal skills in 90% of a group of Canadian preschoolers (Moreno et al., 2011). Indeed, denser neural connections in areas governing verbal communication are found in children receiving music education (Strait & Kraus 2011). Moreover, MRI studies show common brain activations during musical learning and mathematical thinking. To assess the impact of artistic stimulation on school performance, Wandell and colleagues showed that learning a musical instrument improved grades in mathematics (+50%) and history-geography (+40%) in children from unprivileged backgrounds (study of 300,000 American students). Music also improves recall in memory and visual imagery. Overall, learning to play an instrument also improves some motor and coordination skills, which creates deep and permanent changes in the brain (Posner & Patoine 2009).

In Norway, a program called “Art of Learning” is a 12-week creative learning program involving 1 hour per day 3 days a week around workshops in music, theatre/ drama, dance, literature/poetry/storytelling, visual arts, and photography. Studies have shown that children following this program integrated with traditional education exhibited levels of behavioral regulation and executive functioning, with the incidence of greater collaboration, conflict resolution, inclusion, vocabulary level and confidence. (Andersen et al. 2019). Further away from artistic activities, children’s “free play” also develops language and emotional regulation, imagination and helps to densify the socio-behavioral responses to obstacles and dilemmas (Lillard et al. 2013). Thus, free play allows for a reinforcement of the identification (by the appropriation of other identities) and increases self-esteem. Finally, a large meta-analysis highlighted the impact of mindfulness meditation on the development of executive functions in children (Takacs & Kassai 2019).

However, not all investigations necessarily show conclusive results. Introductory music workshops like the one experimented with English preschoolers failed to show an impact on executive development (Bowmer et al. 2018), which also highlights the importance of the format workshops (frequency, age of inclusion, type of activities, etc.).

Blum pedagogy

“Blum is a philosophy of childcare in which a variety of artistic methods are used to raise caretakers (early level teachers and parents) awareness of the profound impact their attachment styles have on how they play. These artistic approaches serve as a means to sensitively illustrate the interconnectedness of caretaker and child attachment patterns, fostering a deeper understanding of the role they play in shaping cognitive development.»

The Blum program promotes the internal innovation of caretakers, based on the principle that the well-being of the caretaker is the foundation of high-quality and successful education. Their philosophy is that the source of educational impact is always the caretaker’s individual personality and professional competence.

To these purposes, they offer a comprehensive and innovative program that uses a variety of artistic methods to support the development of following domains: cognitive and communication skills, problem-solving abilities, social competences, emotional intelligence, emotion regulation, fine motor skills, creativity, and resilience.

The Blum program also aims to promote scientific knowledge and discussion at a society-wide level, to facilitate the establishment of a social activity, and to address the parent-family partnership.

The basic approach of this concept is that the pedagogical interventions that support the child’s development are created by the fundamental interaction between the child, the caretaker, and the family. The program therefore involves children, the professionals working with them, the family, and the social environment. This approach can be integrated into the everyday work of professionals working with children, into the institutional pedagogical program, into the world of public education, private education and into the everyday practice of family parenting.

The aim of the study

The aim of the inquiry is to carry out a detailed study of the children who were randomly selected for groups led by teachers that participated in a 180 hour long accredited Bluming program for further education. In addition, control groups matching the children selected in terms of sex and age, were also created, where the primary concern was to include children, whose teacher had not participated earlier in a Bluming program. The performance of the two groups were then matched, based on some preselected criteria. The tests employed were designed to assess mainly the executive functions and communicative skills. In selecting the kindergartens three different, random locations were chosen in the country.

It was assumed that considerable improvement would be found in the test group with respect to any function in comparison with that of the control group that may be explained by the introduction of the special and complex methodology acquired by the teachers (Crenshaw 2020; Moreno et al. 2011; Takács & Kassai 2019).

Matherials and Methods

Participants

A total of 51 children from two group (Blum vs. control) took part in our study. All together 21 girls and 30 boys, whose average age was 4,53 years (range 3,00-7,20; SD=1,08). The performance of Blum was compared with a control group matched for age and gender. Kindergarten teachers in control group had not participated in the Blum training.

In the Blum group 10 boys and 16 girls were tested, their mean age was 4,46 years (range 3,00-6,20; SD=1,02). Control group consisted of 11 boys and 14 girls, with the mean age of 4,61 years (range 3,10-7,20; SD=1,15).

Children were selected from three cities chosen based on the socioeconomic status, using publicly available economic indicators from national data. From the city with the best socio-economic status (Town1) were selected 19 children 11 boys and 8 girls. In Town2 were chosen 10 boys and 8 girls, and in Town3 there were 4 boys and 10 girls.

The different group were matched in terms of sex and age for each city selected.

	Blum			Control		
	N	Average age (SD)	Range	N	Average age (SD)	Range
Town1	10	4,82 (0,94)	3,10-6,10	9	5,05 (0,82)	3,50-6,00
Town2	9	4,84 (1,01)	3,40-6,20	9	5,08 (1,24)	3,50-7,20
Town3	7	3,45 (0,28)	3,00-3,70	7	3,44 (0,39)	3,10-4,10

Table 1. Distribution of individuals by city

Measures

Six tests were selected and included in the final protocol to investigate executive functions in preschool-age children as well as the development of language skills.

Three tests were chosen to measure the level of development of the executive functions. They are as follows:

A child's version of Rey's complex figure (Szenes 2004): a child is supposed to copy a figure in the test, then he/she is immediately supposed to recall it first, then next 20 minutes later. The performance is analysed against four criteria: the number, the ratio and relation of elements drawn, and the number of secondary elements portrayed.

Semantic fluency test (Tanczos et al. 2014): the child is required in one minute to name as many elements of three categories (animal, fruit, and food) as he/she can. Analysis is done along three indices, i.e. the number of words recalled, fails, and perseveration.

Hungarian echo test (MAMUT Test, Kas & Lukacs 2008): complex sentences need to be repeated without making a mistake.

Three tests were used to assess language competences:

Checks on active vocabulary (Hungarian term: LAPP, Lőrik et al. 2015): naming pictures; the children were asked to identify pictures of objects (identified by nouns and verbs).

Assessment of language competence development (Hungarian term: PPL, Pléh et al. 2007): run to test the use of nominal allomorphs, locative suffixes, and prepositions.

Test for Reception of Grammar - Hungarian (TROG-H Test, Lukács et al. 2012): by using coloured flashcards the processing of grammar structures of various difficulty is assessed.

Procedure

Children from three cities (Town1 Csemő, Town2 Nagykovácsi, and Town3 Hajdúszoboszló) were selected for the study based on the socio-economic status of the area. Three different districts (the smallest administrative unit) were included.

There is a useful indicator that shows the personal income tax base income. Town1 was the best status (147,2), representing the northwest-central region of Hungary. Town2 was a region (central, southern region of Hungary) with less good indicators (86,2), while Town3 (eastern Hungary) represented a region (82,5) which is disadvantaged with the highest number of disadvantaged children among our study sites.

We signed a contract with a kindergarten in each municipality, where we first informed the head of the institution and the kindergarten teachers in detail about our study, then we informed the parents of the children selected by the teachers, who then gave their permission to carry out our study.

Based on our method, in each city we divided the children into two groups. The study group (Blum) consisted of children whose teachers had already completed the Blum training and were using elements of it in their daily routines. The children were selected randomly from their group. Then we matched children by gender and age from a group where the teacher was not trained in Blum's methodology.

The test was carried out twice. First in the autumn of 2021, at the start of the Blum training, and then at the beginning of the summer of 2022, at the end of the kindergarten year.

We hypothesized that incorporating Blum's philosophy and methodology would result in quantified changes in children's performance.

The tests were delivered in the mornings in all the three kindergartens. A separate and quiet room was allocated for us where the children were led in by the teachers. Testing was usually done in a dialogue situation. A test would usually last for 30 minutes and the exercise was run in a play like manner by using several colourful kits and by observing the peculiarities of the competencies and the behaviour of the children.

Statistical analyses

The findings were analysed by groups (Blum vs control groups) involved. Numerical results were computed by making use of IBM SPSS Statistics 23 program. Since our data did not follow normal distribution non-parametric tests were used in all cases with 95% confidence interval.

During the analyses, we examined the performance of the participants based on several parameters. We examined whether significant differences appeared in the individual tasks by group (Blum vs. control) during the pre- and post-measurement.

Ethics statement

This study was carried out in accordance with the recommendations of the Hungarian Centre for Research Data with written informed consent from parents of all subjects. All parents gave written informed consent in accordance with the Declaration of Helsinki.

Results

Firstly, the differences in overall performance on the tasks between the groups in each city between the pre- and post-measurements were analyzed (Table 2). In the analysis, a score was assigned to each task. This was calculated as each correct answer was worth 1 point, which was then added together. The results show that overall, across all cities and groups, children achieved better average performances on the second measurement, highlighting the benefits of kindergarten education on language development and higher cognitive functions.

City	Measurement	BLUM	Control	Mann-Whitney U-probe		
				U	z	p
Town1	pre	17.46	23.66	26.00	-1.28	.20
	post	20.10	23.75	38.00	-.22	.825
Town2	pre	8.88	11.11	7.00	-2.23	.025*
	post	11.66	11.64	11.50	-1.66	.096
Town3	pre	3.28	7.64	21.00	-1.96	.050*
	post	3.88	9.08	27.00	-1.47	.141

Table 2: Overall performance

Performance between pre- and post-tests per task was analysed by group (Blum vs. control). For all tasks, both groups performed significantly better on the post-tests. Examining the results by task, in the rey complex task, children in the Blum group performed significantly better on the post-test (Z=-3.04; p=0.002), with no statistically significant difference detected in the control group (Z=-1.47; p=0.141). In the MAMUT task, both groups performed significantly better in the post-test (Blum Z=-2.52; p=0.010; control Z=-3.33; p<0.001). In the TROG test, the Blum group performed significantly better in the post-test (Z=-2.52; p=0.012), while there was no significant difference between the input and output measurements for the control group (Z=-1. 56; p=0.118). In the PPL test, there was a significant difference in the performance of the control group (Z=-3.00; p=0.003), with no significant difference in performance for the Blum group (Z=-1.41; p=0.160). In the LAPP test, there was also a significant increase in performance for the Blum group (Z=-2.75; p=0.006), with no significant difference for the control group (Z=-0.99; p=0.320).

Task	Group	Pre/post measure-ment	Negative ranks			Positive ranks			Test statistics		
			n	Mean rank	Sum of ranks	n	Mean rank	Sum of ranks	Ties	Z	p
Sum of all tasks	Blum	pre-post	5	9.90	49,50	20	13.78	275.50	1	-3.04	.002*
	Control	pre-post	6	11.92	71.50	19	13.34	253.50	0	-2.45	.014*
Rey	Blum	pre-post	7	4.71	33.00	15	14.67	220.00	4	-3.04	.002*
	Control	pre-post	11	8.95	98.50	13	15.50	201.50	1	-1.47	.141
Semantic	Blum	pre-post	10	9.85	98.50	13	13.65	177.50	3	-1.20	.229
	Control	pre-post	13	12.38	161.00	10	11.50	115.00	2	-.70	.483
MAMUT	Blum	pre-post	3	3.00	9.00	10	8.20	82.00	12	-2.52	.010*
	Control	pre-post	1	4.50	4.50	15	8.77	131.50	7	-3.33	<.001*
TROG	Blum	pre-post	3	9.50	28.50	15	9.50	142.50	7	-2.52	.012*
	Control	pre-post	7	10.14	71.00	14	11.43	160.00	2	-1.56	.118
PPL	Blum	pre-post	11	9.18	101.00	13	15.31	199.00	2	-1.41	.160
	Control	pre-post	3	13.17	39.50	20	11.83	236.50	2	-3.00	.003*
LAPP	Blum	pre-post	5	9.60	48.00	18	12.67	228.00	3	-2.75	.006*
	Control	pre-post	9	10.67	96.00	13	12.08	157.00	3	-.99	.320

Table 3: Summary of pre- and posttest

Regarding the performance on the Rey complex test, in addition to the overall test score, four additional parameters were analysed: the number, the ratio and relation of elements drawn, and the number of secondary elements portrayed. For item number, a significant improvement in performance was observed in the Blum group (Z=-2.41; p=0.016). The control group did not show such an improvement in performance (Z=-1. 35; p=0.177). In terms of drawing proportions (Blum Z=-2.67; p=0.008; control Z=-0.413; p=0.680) and secondary items (Blum Z=-2.83; p=0.005; control Z=-0.64; p=0.522) parameters, there was also a statistically significant performance improvement in the Blum group.

Task	Group	Pre/post measurement	Negative ranks			Positive ranks			Test statistics		
			n	Mean rank	Sum of ranks	n	Mean rank	Sum of ranks	Ties	Z	p
Rey sum	Blum	pre-post	7	4.71	33.00	15	14.67	220.00	4	-3.04	.002*
	Control	pre-post	11	8.95	98.50	13	15.50	201.50	1	-1.47	.141
Item number	Blum	pre-post	8	5.81	46.50	13	14.19	184.50	5	-2.41	.016*
	Control	pre-post	11	10.23	112.50	14	15.18	212.50	0	-1.35	.177
Ratio	Blum	pre-post	0	0.00	0.00	9	5.00	45.00	17	-2.67	.008*
	Control	pre-post	6	7.67	46.00	8	7.38	59.00	11	-.413	.680
Relation	Blum	pre-post	3	2.83	8.50	5	5.50	27.50	18	-1.33	.183
	Control	pre-post	3	3.83	11.50	9	7.39	66.50	13	-2.17	.030*
Secon-dary elements	Blum	pre-post	2	1.50	3.00	10	7.50	75.00	14	-2.83	.005*
	Control	pre-post	9	9.78	88.00	11	11.09	122.00	5	-.64	.522

Table 4: The results of the Rey complex figure test

Semantic fluency was tested with three categories: animal, fruit, food. Total word count, perseveration and errors in the different categories were examined separately. There were no significant differences between the groups in the word counts and perseverations produced in each task, but the Blum group made significantly fewer errors on the post-tests (Z=-2.23; p=0.026) than the control group (Z=-0.20; p=0.839).

In addition to the overall scores on the PPL test, the Blum group showed a significant improvement in prepositions (Blum Z=-3.10; p=0.002; control Z=-1.60; p=0.111). In locative suffixes, only the control group showed a significant improvement (control Z=-2.87; p=0.004; Blum Z=-1.62; p=0.105).

Task	Group	Pre/post measurement	Negative ranks			Positive ranks			Test statistics		
			n	Mean rank	Sum of ranks	n	Mean rank	Sum of ranks	Ties	Z	p
Overall score	Blum	pre-post	8	11.69	93.50	16	12.91	206.50	2	-1.92	.055
	Control	pre-post	6	7.33	44.00	17	13.65	232.00	2	-3.30	<.001*
Allomorf	Blum	pre-post	6	10.08	60.50	15	11.37	170.50	3	-.26	.793
	Control	pre-post	4	7.63	30.50	19	12.92	245.50	1	-1.87	.062
Prepositions	Blum	pre-post	7	10.14	71.00	10	8.20	82.00	7	-3.10	.002*
	Control	pre-post	7	10.00	70.00	15	12.20	183.00	2	-1.60	.111
Locative suffixes	Blum	pre-post	4	6.75	27.00	17	12.00	204.00	3	-1.62	.105
	Control	pre-post	6	8.25	49.50	12	10.13	121.50	6	-2.87	.004*

Table 5: Summary of results in PPL tasks.

In terms of overall LAPP performance, both groups showed a significant improvement in performance, but only the control group performed significantly better on verbs (control Z=-2.15; pp=0.032; Blum Z=-1.71; p=0.088).

Task	Group	Pre/post measurement	Negative ranks			Positive ranks			Test statistics		
			n	Mean rank	Sum of ranks	n	Mean rank	Sum of ranks	Ties	Z	p
Overall score	Blum	pre-post	8	11.31	90.50	16	13.09	209.50	2	-2.75	.006*
	Control	pre-post	6	9.00	54.00	15	11.80	177.00	4	-2.15	.032*
Noun	Blum	pre-post	6	7.08	42.50	16	13.16	210.50	2	-1.29	.196
	Control	pre-post	6	8.33	50.00	15	12.07	181.00	3	-1.67	.096
Verb	Blum	pre-post	5	8.70	43.50	11	8.41	92.50	8	-1.71	.088
	Control	pre-post	7	6.00	42.00	10	11.10	111.00	7	-2.15	.032*

Table 6: Summary of results in LAPP tasks.

Conclusion

This study, which is at a stage of impact measurement, represents a first step in the analysis of an educational method based on early stimulation through art, play, and experience, and its impact on the development of kindergarten children and their predisposition to future basic learning. Considering the small number of participants and certain uncontrolled variables, the conclusions of this initial study should be taken with caution.

However, it already provides insights into the positive impacts of early child stimulation on cognitive abilities and emphasizes the importance of teacher training and competence when working with these children. It is also reinforcing the idea of the universality of education and the importance of early childhood programs for children's neurodevelopment and training for kindergarten professionals.

In general, we observe an evolution of children's skills in cognitive development (language, visuospatial, planning, working memory) over one preschool year. Nevertheless, the one-year progress on certain tasks exclusively related to executive functions or planning and working memory (as evident in the final recall of the Rey-complex task), appears to be significant only in the Blum group and not in the control group.

We also found language factors that showed greater improvement in the test group (reception of grammar, active vocabulary). These abilities found in kindergarten children from the Blum Group could predispose them to more effective entry into writing and mathematical skills (Cornu et al. 2017; Gizzonio et al. 2022; Stokes et al. 2017).

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