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Education and development in early years from cultural-historical theory

Edited by
Aleksander Veraksa, Yulia Solovieva and Gustavo Cunha de Araujo

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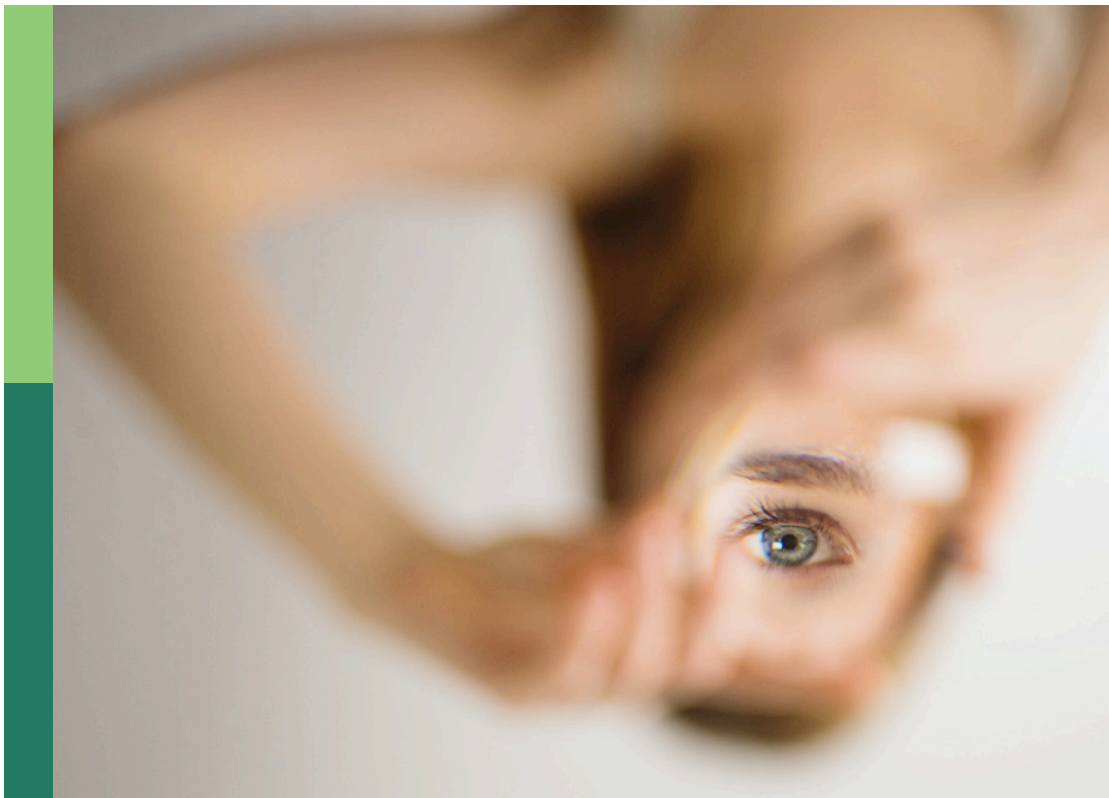

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Education and development in early years from cultural-historical theory

Topic editors

Aleksander Veraksa — Lomonosov Moscow State University, Russia

Yulia Solovieva — Meritorious Autonomous University of Puebla, Mexico

Gustavo Cunha de Araujo — Federal University of North Tocantins (UFNT), Brazil

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EDITED AND REVIEWED BY
Pamela Bryden,
Wilfrid Laurier University, Canada

*CORRESPONDENCE
Alexander Veraksa
✉ aleksander.veraksa@gmail.com

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Editorial: Education and development in early years from cultural-historical theory

Alexander Veraksa[1,2]*, Gustavo Cunha de Araujo[3] and Yulia Solovieva[4]

[1]Faculty of Psychology, Lomonosov Moscow State University, Moscow, Russia, [2]Federal Scientific Center of Psychological and Multidisciplinary Research, Moscow, Russia, [3]Faculty of Psychology, Federal University of North Tocantins (UFNT), Araguaína, Brazil, [4]Faculty of Psychology, Meritorious Autonomous University of Puebla, Puebla, Mexico

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Editorial on the Research Topic
Education and development in early years from cultural-historical theory

L. S. Vygotsky's cultural-historical approach opened new possibilities for understanding childhood and the ways of acquisition of cultural historical experience during this long period of life, which consists of sequential subperiods and phases (Elkonin, 1995; Vygotsky, 1996; Veraksa, 2022). They can be studied following the identification of periods of child's development introduced by Vygotsky (1983) under the name of psychological ages. Each particular period of psychological development is characterized by its proper way of dominion of cultural experience under the existence of the motive of cultural activity, that is, under active participation in the process of leading activity of each psychological age (Elkonin, 1995).

Vygotsky's provisions on the development of higher mental functions had launched a whole line of research, accomplished by his followers. Neuropsychological research was implemented under the leadership of A. R. Luria. It was aimed at the question of regulation of human behavior by instrumental use of speech and other cultural means, as well as the contribution of brain functional systems to this regulation. In Luria's (1973) views, it is possible to identify the role of frontal lobes in such regulation. However, according to Vygotsky (1982), the psychological process of regulation of activity is based on cultural interaction between adult and child. Nowadays, it is possible to argue that Luria's perspective, in fact, does not reduce this regulation to any brain structure or to some unique psychological process. It rather suggests a gradual interiorization of the means of external instrumental control, which might further pass onto the level of internal mental control (Galperin and Kabilnitskaya, 1974; Solovieva and Quintanar, 2021). This approach to regulation is studied in the work of Rivera Valdez et al..

Current interest in the concept of regulation is related to the construct of "executive functions" proposed in the works of Lezak (1982). In the modern literature, the process of psychological regulation of one's own actions is mostly associated with Vygotsky's understanding of the structure of consciousness and its development (Ardilla, 2013). It happens so, that all aspects of acquisition of self-control, regulation, voluntary activity, and the possibility of conscious regulation of the action is reduced to the unique term

of "executive functions." Gavrilova, Aslanova et al. turned to the assessment of executive functions by educators and revealed the differences in the use of the assessment tool on 5–6 and 7 years old children.

From psychological point of view, the search for opportunities for the development of regulation or self-regulation in children from the perspective of the cultural-historical approach, involves the identification of leading activities (Leontiev, 2000), in which such development occurs most harmoniously and remains sustainable. Mendoza-García and Moreno-Núñez show that an adult plays a key role in child's interaction with objects in early years. The study of play activity, the use of toys and symbols in the preschool age, is in the focus of interest for child development and education experts (Singer, 2015; Solovieva and Garvis, 2018; Solovieva and Quintanar, 2019; Fleer et al., 2020; Gonzáles-Moreno and Solovieva, 2022; Gavrilova et al., 2023). In this regard, Sukhikh et al. explored the emotional side of play as a driver for executive functions' development and provided insights in understanding the mechanisms of play. Bredikyte and Brandisauskiene tested the hypothesis of connection between the development of play and executive functions in children, which again emphasized the developmental potential of play. Gavrilova, Sukhikh et al. sought to analyze the relationship of toy preferences with executive functions' development. These authors found that children, who preferred trendy toys demonstrated a lower level of executive functions. It is of special interest that that, according to their study, trendy toys did not actually serve as a tool for play organization, but could disrupt play activity (Gavrilova, Sukhikh et al.).

The study by Dolgikh et al. revealed that activities different from play could also support executive functions' development and thus, could be included in the education process.

There is no doubt that new social challenges that children are facing in their environment, deserve special attention. Widespread digitalization affects children already in the early years and raises the question of the opportunities and risks that digital devices pose for their development. The need to understand the use of digital devices as objects that can be mastered culturally and support child development, or used naturally, without the involvement of an adult and cultural experience is reflected in multiple research works (Veraksa et al., 2022; Veresov and Veraksa, 2022). Bukhalenkova and Almazova found no relationship between imagination and the time spent by preschoolers on computer games, but revealed a strong connection between imagination and the characteristics of parental participation in the use of digital devices by children. These results outline the importance of an adult in the process of transition of cultural tools. Shatskaya et al. revealed how the use of digital devices could be analyzed from the cultural-historical perspective, and linked to executive functions' development. The results of their study suggest that the use of digital devices in cultural vs. entertaining way starts to dominate in primary school.

As parents report, nowadays, family environment and its key characteristics are also undergoing changes (Sobkin et al., 2013). It is one of the factors that the cultural-historical always considered in childhood research. Yakupova and Suarez discovered a previously uncontemplated relationship between maternal depression and child's emotional development, bringing attention to the emotional state of a parent as an essential aspect of the social situation of child development.

The studies on educational environment, included in this Research Topic, are of particular interest in this regard. In comparison to the family environment, the educational environment demonstrated a greater resistance to change, and retained a critical role in child development because of children's systematic interaction with adults and peers. The contribution of the preschool environment to child development has been of a particular research interest for over two decades (Sylva et al., 2004). At the same time, a number of questions formulated within the framework of cultural-historical psychology require additional research. The potential of such well-elaborated tools as CLASS and ECERS is discussed in the work of Bukhalenkova et al. in the light of Vygotsky's theory. The authors show a balanced approach to combining these tools. Meanwhile, Seo and Song focused on the role of teachers in child development during the pandemic: emotional support from teachers can be a longstanding driver for the child. Finally, Khotinets and Shishova raise an important question of the relationship between the development of creativity and the characteristics of the educational environment.

In his works, Vygotsky laid the foundations for studying the processes of mastering sign systems, in which language plays a primordial role (Luria, 1979). The study of the inextricable connection between the development of speech and higher mental functions determined the formation of a research approach to speech development that, in line with cultural-historical psychology, became classical. Oshchepkova et al. revealed a strong relationship between executive functions and writing skills in children. The obtained results provide valuable practical insights on possibilities of writing skills correction. Tulviste and Tamm demonstrated that the social situation of development, determined by adults, played a key role in the development of children's linguistics skills.

At the same time, the systematization of various means of mastering content (signs, symbols, and models) necessitated the study of the identified conceptual patterns based on mathematics, physics, ecology, geography, and other subjects. Already in early school years, these subjects become important psychological tools in child development. Reflective and conscious mastering of use of cultural conceptual patterns should become a new focus of psychological research in the field of development and learning (Solovieva and Quintanar, 2021). Solovieva et al. describe a training program for mastering basic mathematical concepts in preschool based on Vygotsky's ideas.

The present Research Topic includes relevant methodological considerations and empirical research, related to the cultural-historical theory of child development. The Research Topic contains articles by experts from different countries, which allows investigation of the latest empirical data and its interpretation in cross-cultural aspect.

The Research Topic has opened new ways for the continuation of the discussion of the use of cultural-historical approach in the field of psychological development, and the possibility of a

significant modification of the guiding role of adults and social institutions in child development.

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EDITED BY
Yulia Solovieva,
Meritorious Autonomous University of Puebla, Mexico

REVIEWED BY
Athanasios Koutsoklenis,
Democritus University of Thrace, Greece
Daniel Rosas,
Universidad Nacional Autónoma de México, Mexico

*CORRESPONDENCE
Vera L. Sukhikh
sukhikhvera@gmail.com

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Dramatic Perezhivanie as a driver of executive functions development through role-play in early childhood: Theoretical framework and experimental evidence

Vera L. Sukhikh[1,2]*, Nikolay N. Veresov[1,3] and Nikolay E. Veraksa[1,2]

[1]Department of Educational Psychology and Pedagogy, Lomonosov State Moscow University, Moscow, Russia, [2]Psychological Institute of the Russian Academy of Education, Moscow, Russia, [3]Faculty of Education, Monash University, Melbourne, SA, Australia

Role-play in early childhood is associated with development of executive functions (EFs), although study results remain inconsistent. Due to the complex nature of the role-play, the underlying mechanisms of these associations are not obvious. In this article, play is viewed in the framework of the cultural-historical approach as a special social situation that can become the social situation of development if it results in dramatic perezhivanie of a child. In this study, we compared the level of EFs and play behavior between two play contexts: play guided by an adult and one with less adult involvement. Play behavior was analyzed based on five behavioral measures suggested to be the markers of dramatic perezhivanie. Measures of EFs were taken before and after the experimental procedure. Results show that dramatic perezhivanie might be considered a driver of EFs development through role-play in early childhood. As well as this, the involvement of an adult into play was associated with different patterns of EFs dynamics before and after the intervention. Future work can investigate if the construct of dramatic perezhivanie, microsocial situation of development, and micro-crisis might explain variability of the study results on the association between the role-play and child development.

KEYWORDS

role-play, imaginary situation, dramatic perezhivanie, social situation of development, early childhood, executive functions

Introduction

The influence of play on the development of the executive functions (EFs) in preschool children has been widely studied (Blair and Diamond, 2008; McClelland et al., 2010; Diamond and Lee, 2011; Lillard et al., 2013; Goldstein and Lerner, 2018; Bukhalenkova et al., 2020; Thibodeau-Nielsen et al., 2020). A significant number of studies investigates

how adults and child-adult interactions in play settings might influence the development of executive functions and support the idea that the self-regulation in early development is deeply embedded in the child's relations with others (Hakkarainen et al., 2013; Fleer et al., 2020; Van Oers and Pompert, 2021; Veraksa and Veraksa, 2021; Veresov et al., 2021). At the same time, interesting new play-focused curricula emerged, for example, the Tools of the Mind (Bodrova and Leong, 2001, 2017) and playworlds (Lindqvist, 1996), both originated in Vygotsky's theory of development. Tools of the Mind is a curriculum that started in 1993, but only in 2013/2014 has research been published to suggest that the Tools of the Mind Kindergarten program had a positive effect on executive functions, reasoning ability, and the control of attention (Bodrova et al., 2013; Blair and Raver, 2014). Similarly, the "playworlds" approach was developed in late 1990s and only recently has the experimental data appeared confirming its positive role in supporting children's executive functions and self-regulation (Fleer, 2020; Walker et al., 2020). The researchers report that "playworlds are mostly theorized as collectively created imaginary situations with roles, rules and tasks, but in relation to the opportunities for the development of EF in children, the role of the adult seems to be a vital one and this needs further research" (Walker et al., 2020, p. 137). We believe our study might provide a research-based response to these challenges. However, there are methodological difficulties (i.e., role-playing is difficult to reproduce in the laboratory settings) and theoretical challenges (role-play and its structure are understood differently depending on the theoretical approach). It is also possible that play itself may be a product of other factors, which actually influence development (that is, the play becomes an epiphenomenon), or represents only one of the developmental pathways (equifinality; Lillard et al., 2013).

What needs to be done is to study the individual trajectories of development and identify indicators that show how play intervention influences EFs of a particular child. For now, there is no instrumental basis that allows the study of individual trajectories of development of EFs in young children. And finally, what needs further research is how different types of adult engagement in a role-play (play interventions) influence the development of EFs in children. We consider the cultural-historical approach introduced by Vygotsky (1998) and further developed in works of Luria (Luria, 1980; Vygotsky and Luria, 1993), Leontiev (1981), and Gal'perin (1969) to be fruitful in meeting these challenges. The theoretical framework of the article follows Vygotsky's (2016) conception of play as an imaginary situation which by its duality provides conditions for cognitive development. Concepts of "dramatic perezhivanie" and "microsocial situation of development" are presented as theoretical analytical tools. In this paper, we theorize role-play as a social situation of a special kind, which potentially includes a series of microsocial situations of development. This theoretical framework allows for empirical examination of whether dramatic perezhivanie is a factor mediating the effect of play intervention on child's development by transforming an imaginary situation from microsocial situation into microsocial situation of development.

Role-play and imaginary situation

Vygotsky focused mainly on the sociodramatic role-play as it represents the peak of the development of the play in early childhood (Vygotsky, 2016). In this regard, the role-play is a more mature type of play compared to the director's play (the child only constructs the plot, acting with objects) and pretend play (the child pretends to be something or someone, but does not create a plot with other players; Kravtsov and Kravtsova, 2017).

According to Vygotsky, role-play is a culturally determined phenomenon including three key characteristics (1) an imaginary situation, (2) roles and role actions, and (3) a set of interrelated play rules. An imaginary situation distinguishes a child's play activity from every other form of activity (Vygotsky, 2016). Imaginary situations include a plot, roles, attributes of the play, rules, and role-playing actions. Creation of an imaginary situation becomes possible on the basis of the separation of the visual field and the field of meanings—the ability that develops in the preschool age (Vygotsky, 2016). "In play, the child learns to act not in a visible, but in an intellective, i.e., in an imaginary situation, relying on internal tendencies and motives as opposed to motives and impulses deriving from the object" (Vygotsky, 2004, p. 66). While describing the "hospital play" of children, Vygotsky writes that "in the play the child cries like a patient, and at the same time rejoices like a player" (Vygotsky, 2004, p. 69). The child portrays a patient who faces a disease, but on the other hand, the child is not a patient—there is a discrepancy, a gap between the child and her role. "Action in a situation that is not seen, but only conceived mentally in an imaginary field (i.e., an imaginary situation), teaches the child to guide his behavior not only by immediate perception of objects or by the situation immediately affecting him but also by the meaning of this situation" (Vygotsky, 2016, p. 12). Collectively created imaginary situations represent unique, original, and exclusive relations of participants, shaped and framed by roles, rules, and collective actions which exist and develop only within the imaginary situations (Walker et al., 2020).

Dramatic Perezhivanie and imaginary situation as a microsocial situation of development

Vygotsky mentioned a case of three children with the mother suffering from several nervous and psychological disorders. When drunk, the mother regularly beat the children (Vygotsky, 2019). Despite being in the same terrifying situation, the development of the three children became disrupted in different ways. Thus, the same circumstances resulted in an entirely different picture for the three children. Speaking about aspects (moments) of social environment Vygotsky highlights: "it is not in itself this moment

or that moment, taken without regard to the child, but that moment, refracted through the perezhivanie of the child, which is able to define how that moment will affect the course of future development." (Vygotsky, 2019, p. 70).

So we also can assume that the creation of an imaginary situation itself does not promote development within play. The situation should personally affect the child and be *lived through* by the child. The differentiation of three concepts: (1) social environment, (2) social situation, and (3) social situation of development (SSD) might be helpful when it comes to role-play and development (Veresov, 2019). The social environment is the wider context of life; the social situation is a concrete component of the wider social environment and the social situation of development (SSD) is "a completely original, exclusive single and unique relation between the child and reality" (Vygotsky, 1998, p. 198). In a single social situation several social situations of development can emerge. Being in the same social situation, different children demonstrate different developmental outcomes because the same situation is refracted by different perezhivanie (Veresov, 2019). The social environment is thus the source of development; it influences the child, but what turns the social situation into SSD is perezhivanie (Fleer et al., 2017).

Veresov (2019) suggests the theoretical development of the classic Vygotsky model "social environment - social situation - perezhivanie - SSD"—a theoretical dyad of dramatic perezhivanie and the microsocial situation of development. Dramatic perezhivanie is a special type of perezhivanie as a refraction of a dramatic collision that children experience. Introducing dramatic perezhivanie opens an opportunity to link on a theoretical level the concept of perezhivanie and the principle of development, as "… the basic principle of the functioning of higher functions … is social, entailing interaction of functions, in place of interaction between people. They can be most fully developed in the form of drama" (Vygotsky, 1989, p. 59). Dramatic perezhivanie refers to the contradictory nature of human development—there is no development without conflicts and dramas. Those are refracted through dramatic perezhivanie (Veresov, 2019). Dramatic perezhivanie contains the potential to become a turning point in a child's development, it represents a short-term "microsocial situation of development" and corresponds to the main characteristics of the macrosocial situation of development associated with the age crisis (Veresov, 2019).

An imaginary role-play situation could be seen as a specific microsocial situation. The general sociocultural context that determines the content of the play, surrounds children, and exists independently of them, represents the social environment. In play, all the children belong to a common play situation, which may or may not affect their development. Every complex sociodramatic role-play includes numerous micro-crises and contradictions (an argument with playmates, the need to follow the rules or the plot, to wait one's turn, to play a role that was given by other players, etc.). The child might experience internal micro-dramas in play when she has to constantly restrain her impulsive reactions in order to remain within the imaginary situation in play. Thus, as a social situation of a special kind, play potentially includes a series of microsocial situations of development of EFs.

The following sections of the paper present experimental findings on the influence of a role-play intervention on young children's EF development. The data are analyzed through the concepts of dramatic perezhivanie, micro-crisis, and microsocial situation of development. It will be argued that the dramatic perezhivanie might be considered a driver of EFs' development through role-play in early childhood.

Experimental study

Aims of the study

The research presented in this paper aimed to empirically examine the dramatic perezhivanie as a factor mediating the effect of play intervention on child's EFs development. We set the following goals:

1. to identify behavioral patterns of dramatic perezhivanie in a role-play and explore the very possibility of registering it in a role-play;
2. to describe individual trajectories of EFs' development by comparing observation data and the results of the EFs' assessment;
3. to identify if different types of adult engagement in a role-play influence dramatic perezhivanie patterns and results of play intervention regarding EFs development.

Design

The experiment was conducted in 2020 on a Russian sample of preschoolers (n = 199, 46.7% females, 4.5–5.5 years old). Randomized experimental design with repeated measures was used. The study consisted of a preliminary assessment of executive functions levels (September–October); a 7 week-long intervention (October–November); and the testing of executive functions immediately after the intervention (December). The children were divided into groups equal in gender, age, and the initial level of executive function development. In all the experimental groups, the children played in different ways for 20–30 min twice a week: three types of role-play (free role-play; adult-directed play; child-directed play), digital games, and games with rules (board games). In the control group, the play was replaced by drawing on the theme of the story being read by the experimenter.

The testing of executive functions was based on the Miyake model (Miyake et al., 2000). Five tests were used. The NEPSY-II (Korkman et al., 2007) subtests were used to assess the level of development of verbal working memory (Sentences Repetition, SR), visual working memory (Memory for Designs, MD) and cognitive inhibition control (Inhibition). As its authors state, NEPSY-II is based on Luria's ideas and subtests are similar with

tests developed in line with cultural-historical psychology and activity theory. The Dimensional Change Card Sort (DCCS) test was used to assess switching (Zelazo, 2006). Assessment of the motor persistence was conducted using the "Statue" test. The child's task was to maintain a motionless position with eyes closed for 75 s, restraining impulsive reactions in response to distracting sounds. The researchers were fully aware of the limitations of these assessment tests—their quantitative nature and static nature. However, for research purposes (pre and post testing) and for research questions, they seem to be applicable and reliable.

Data collection

The assessment was conducted individually in a quiet room. For two experimental conditions (adult-directed play; child-directed play), video recording was organized. The videos were only available to the researchers, so the confidentiality of the children involved was maintained. The Ethics Committee approved the study and consent procedures of the Faculty of Psychology at Lomonosov Moscow State University (approval no: 2021/72). The parents of each participant gave written consent for their child to participate in the study and their permission to videotape the child.

In both videotaped experimental conditions, the children took on the same roles, made costumes, and acted out the story. In "Adult-directed play" intervention the adult controlled the distribution of roles and the plot development. The adult told the story, and the children were supposed to act in consistency with the plot and their roles. This condition reduced the load from the working memory, as the key aspects of the play were handled by the adult. The adult also reminded the child of his/her role if necessary (addressed him/her using the character's name, reminded him/her of the role features: 'you are a great magician', etc.) and assisted children in playing the role ('let us do it like if you were…'). In other words, the adult accentuated and supported the functions of inhibition and shifting. He/she also basically set for the children an example of 'mature' role-play and taught them how to play. For this experimental condition, scenarios were composed for each session, one story per gathering.

In "Child-directed play" intervention, the adult helped one child to take the director's position: to distribute the roles, to make up a story, and play it with other children. Thus, there was no scenario prepared and an adult was there only to help when needed. The load on a directing child's working memory was higher (as he/she controlled the plot and had to remember the roles of all participants). The directing child also had to apply higher inhibition (to follow the role of the director-in-charge and regulate other children's behavior) and shifting (this child guided the general plotline and the actions of all the characters). Meanwhile, for other participants, the invoked developmental mechanisms were identical to the ones in the "Adult-directed play" option. One play session included two stories with two children performing the director's functions. All participants had equal opportunities to take this position, and on average each had to do it 4 times.

Two digital cameras were used simultaneously in order to increase the coverage. In total over 70 h of video, material was obtained in the study. Given the overall amount of material, only the first and last play sessions were chosen for the analysis. Twenty children (10 from each group) participating in the "Child-directed play" and the "Adult-directed play" were selected for the analysis of the videos. The selection criteria included the attendance of at least 8 sessions, as well as the availability of results of the "The Dimensional Change Card Sort" (DCCS) and "Inhibition" tests (children with high, average, and low scores on these tests were selected into the sample).

Data analysis

For data analysis, we applied a tool built within the framework of cultural-historical tradition. The Play Matrix is a tool for structured observation and includes a number of behavioral indicators combined into three blocks: actions, emotional manifestations, and speech behavior (Veraksa et al., 2022a, b). The category of actions includes such behavioral indicators as role actions, original role actions, field and impulsive actions; voluntary actions outside the play context; and actions in different play contexts. The category of emotional manifestations covers expressive movements and emotional reactions, emotional shouts, and emotionally saturated group actions. The category of speech behavior includes role statements, suggestions on how to act next, regulation of other children's behavior, comments, play-related judgments, and meta-reflexive utterances. The Play Matrix allows evaluation of play not based on the external criteria of the observer, but as a situation experienced by a particular child. We can see how a child is engaged in play, if she seeks to enact the characters as expressively as possible or acts rather formally.

For our analysis, we focused on several indicators of the regulatory and emotional components of a child's behavior:

1. impulsive actions;
2. field actions (actions that are defined by aspects of the field, environment – for example, a child while playing sees picture on the wall and begins to talk about it despite of ongoing play and one's role in it);
3. regulation of other children's behavior (a child tells other children what and how they should/should not do);
4. original role actions (for example, a child thinks up atypical actions or attributes for his or her character);
5. expressive movements and emotional response reactions (smiles, gestures, etc.).

The indicators No 3–5 were chosen as they represent the engagement of a child into play: if a child is emotionally engaged, if she seeks to influence the general plot and takes her role seriously. The indicators No 1 and 2 in turn were chosen as the indicators of a child's self-regulation within the play; they capture the moments when a child "drops out" of the plot or cannot relate

her character actions with the general plot. Analysis of these behavioral manifestations as well as their combination within each microsocial situation allowed us to catch the moments of contradiction and dramatic perezhivanie, which can become a turning point in a child's development.

At the first stage of the analysis, detailed protocols of the playing sessions were created which registered every behavioral manifestation of the child during the session. The next step was to attribute each of the child's manifestations to one or several of the indicators. The number of fixations of each behavioral indicator was counted and entered into the summary table (see Appendixes 1a,b).

The statistical analysis for the two experimental groups was supplemented with additional data including observations. Individual differences in the effect of the play intervention were examined by comparing the observations and test results of individual children.

Results

Behavioral patterns of dramatic perezhivanie in a role-play

The analysis of the video recordings revealed the following general tendencies.

In the "Child-directed play" group, some children derive special pleasure from, and devote much attention to, the regulation of other children's behavior, even if they are not directors. They actively indicate and show other children how to do this or that role action. They express displeasure at not being listened to or doing things "the wrong way." While performing their roles they keep interfering with other children's role-play or the director's story. They disagree and reject the director's story moves if they do not like them. In the "Adult-directed play" group, some children also tend to regulate other children's behaviors when it greatly interests them, so eager to play that they begin to help other children play their roles and direct them.

Impulsive and field actions are clearly evident in several situations. If a child is emotionally involved in play, one performs impulsive actions out of impatience and due to overwhelming emotions. If there is a pause in play and/or the child becomes bored, then impulsive as well as field actions become a way to entertain oneself. This includes a situation when a child or several children continue to play "their game" in spite of the director's instructions. For example, they start to fight again, even though the battle is already over according to the plot. In this case, the observer records a considerable number of impulsive and original actions – the child does possess his or her own creativity in acting out the role, but it does not fit into the general storyline and the other characters' actions and runs parallel.

At the same time, there are children who do not manifest impulsive or field actions even if their character is underrepresented in the story. They wait calmly and observe the play attentively. This can be inferred from their emotional reactions to what is going on—it is a quiet smile often. However, these children also perform their roles in a stiff and stereotypical way. For example, a boy, playing the part of a dragon, simply strolls to where the dragon is supposed to be flying according to the storyline. And even at the last sessions, he has a hard time with his lines, only when the adult gives him the cue, does the child very quietly utter the offered line.

Thus, we can see that the role-play contains multiple situations of contradictions and micro-crisis which can trigger dramatic perezhivanie.

Individual trajectories of EFs development

As mentioned above, play is full of contradictions by virtue of its nature and can serve as a source of dramatic perezhivanie for a playing child. However, there can be different ways of resolving the contradiction that underlies dramatic perezhivanie. Let us illustrate it with some examples.

The girl 'L.' (in the "Adult-directed play" condition) displays a great number of bright emotional reactions and expressive movements. For example, she interacts with the adult easily and swiftly, asking questions about the play; coming up with an attribute for her character and proudly declaring: "This is a sword!"; waiting for her turn to move onstage in the story and listening attentively; and getting scared of the cave monster in an expressive and serious way. L. wants to act, but she has to wait her turn and consider other characters and the plot. There is a struggle of motives—dramatic perezhivanie, a micro-crisis—the resolution of which requires switching on self-regulation skills.

L.'s pre-test results are in the average range, and this situation could well become developmental. However, we can see that "I." often jumps up and down with impatience, and runs around the room, eager to play even if the plot has nothing to do with her character at this particular moment. In essence, self-regulation mechanisms do not work under conditions of intense affect. According to L.'s post-test results, positive dynamics is observable only in respect of visual working memory. There were no positive dynamics in indicators of cognitive flexibility, cognitive inhibitory control, and verbal working memory. A slight decrease in the indicators was registered in relation to physical inhibitory control, which was manifested in playing sessions.

Another example of resolving a similar micro-crisis is the boy "S." (in the "Child-directed play" condition). His pre-test results are also in the average range. The child also shows manifestations of great involvement, both at the beginning and at the end of the experimental series. For example, he shows initiative and desire to be the director at the very first session when the situation is still new to the children. When he fails to get the role of the Martian in the last session, he is greatly annoyed and says "aaah" but when he does get the coveted role, he becomes overwhelmed. When the plot is stalling (the director takes too long to think up the next

move), the boy asks the adult "well?" anxious to see what happens next. When the boy S. performs his role actions, he does them as best as he can: he prostrates himself on the floor pretending to be fast asleep according to the plot. Very much like the girl L., S. displays manifestations of impulsive behavior, but it happens less often, and the episodes are overall shorter – the boy returns to the game by himself and continues to follow the story and his role. On one occasion when S. fails to follow the director's instructions, the experimenter draws his attention. S. explains that he "did not hear it" and continues to follow what is going on very attentively. The experimenter's involvement had a much shorter and weaker effect on the girl L. According to the post-test results of the boy S., we observe positive dynamics in the level of development of cognitive inhibitory control and visual working memory and a small increase in indicators of cognitive flexibility.

One more example of the child's interaction with the play situation is shown by boy 'L.' ("Child-directed play"). As intervention goes by, the boy L. loses his interest in the playing sessions quite quickly, so the play situation does not cause any dramatic perezhivanie. This leads to a significant increase in impulsive actions by the end of the experiment. For example, after hearing a girl mention Basilio the cat, he interrupts and shouts "hey, Basilio the cat!" to no one in particular. The boy often inserts cues or makes actions outside of the plot development, which amuses and distracts other children. He talks spontaneously to a friend and gets distracted from what is going on in play. He peeks out into the hallway to see the goings-on there. The experimenter often needs to invite the boy L. into the play and repeat the story about his character twice to get him "back." It is interesting that the boy L.'s pre-test results are in the high range; however, the play situation which fails to involve the child on a personal level does not lead to inclusion and development of his self-regulation skills. According to the post-test results, there is no positive dynamics in scores of inhibition, physical inhibitory control, and visual working memory; there was even a small decrease in scores of cognitive flexibility and verbal working memory.

The case analysis reveals a role-play as a microsocial situation which is not the social situation of development *per se*, but can become such for each specific child at the moment when dramatic perezhivanie occurs.

The influence of the type of adult engagement

Detailed results of statistical analysis are presented by Veraksa et al. (2022a, b), Veresov et al. (2021). *T*-test was applied for the comparison of the pre- and post-test results for each executive functions' measure. All the variables in the analysis were normally distributed ($p > 0.05$ according to the Kolmogorov–Smirnov test). In the 'Adult-directed play' intervention group ($N = 29$; age in months 60, 30) significant changes were registered in 4 (out of 5) measures of executive functions: inhibition control, motor persistence, shifting, visuospatial working memory. Verbal working memory was the only measure that did not show significant positive dynamic under this condition. However, this intervention was designed to take the load from this memory type due to the presence of an adult director. In the "Child-directed play" ($N = 38$; age in months 61, 21) significant changes were found in three measures of executive functions: in all except verbal working memory and motor persistence (Table 1).

To explore further, we used observation according to chosen behavioral indicators to identify the features of the microsocial situation set by each type of role-play. It seems rather clear that when the adult directs the play, the control is stronger and the responsibility for the storyline rests on the adult rather than on a child. But when the child does the directing, one can express oneself to a greater extent. We surmised that such play should be more emotionally meaningful for the child. Statistical analysis methods were applied to process the data obtained from observation. As we analyzed the initial sessions and those at the end of the intervention, we had the opportunity to analyze the deltas (differences between the last and first play sessions).

TABLE 1 Pre- and post-test differences in measures of executive functions within two experimental conditions of interest: "Child-directed play" and "Adult-directed play."

Executive Functions measures		Pre-test		Post-test		*p*
		M	SD	*M*	SD	
Adult-directed play	Cognitive flexibility*	17.71	2.59	19.15	2.67	$t(26) = -2.84$ $p = 0.009$
	Verbal working memory	16.32	3.95	17.18	4.14	$t(26) = -1.31$, $p = 0.201$
	Visual working memory*	63.54	14.88	72.79	20.14	$t(22) = -2.48$, $p = 0.021$
	Motor persistence*	22.96	6.30	27.29	5.10	$t(22) = -3.20$, $p = 0.004$
	Inhibition control*	9.75	3.03	11.92	3.26	$t(26) = -3.02$, $p = 0.006$
Child-directed play	Cognitive flexibility*	17.92	1.93	19.24	2.55	$t(37) = -2.98$, $p = 0.005$
	Verbal working memory	18.31	3.11	18.68	2.91	
	Visual working memory*	60.78	16.16	71.11	19.83	$t(36) = -3.51$, $p = 0.002$
	Motor persistence	27.39	2.99	28.00	3.04	
	Inhibition control*	8.21	3.38	11.92	3.26	$t(36) = -6.31$, $p < 0.001$

*significant changes were registered.

Due to the small sample size, the nonparametric Mann–Whitney test was used. It was found that the number of expressive movements and emotional reactions at the end of the intervention was significantly higher ($U = 22.000$, $p = 0.032$) in the group of children where they themselves were directors than in the group of children where the director was an adult. The difference in the number of original role actions is significantly lower ($U = 25.500$, $p = 0.062$) at the beginning and at the end of the intervention at the tendency level, and expressive movements and emotional reactions are significantly higher ($U = 27.500$, $p = 0.086$) in the group of children where they directed themselves than in the group of children where an adult was the director. The latter means that at the tendency level, the number of original role actions increased as a result of the "Adult-directed play" intervention. In addition, in the group where children were directors, the number of expressive movements and emotional reactions increased. Indeed, role performance and storyline in the "Child-directed play" condition remained rather stereotypical even at the end of the intervention. Children tend to include fights (battles), death and resurrection, weddings, rambles, transformations into a toad, sleep, and meals. The plot remains more coherent and consistent in the "Adult-directed play" group. This seems to create a condition for original manifestation in children. The adult's story can be relied upon to come up with something of one's own. In the "Adult-directed play" condition, the story has more character interactions and general logic and various plot twists. At the same time, the experimenter's "dictatorship" in the play leads to a situation where the children's manifestations are generally poorer, as can be seen in the summary table (see Appendix). However, even the most reluctant and shy children start to resist the imposed plot towards the final sessions, inventing and acting out something of their own, at least in trifles. The final sessions show that the play often gets out of the adult's control, and the children's plot runs parallel to that of the adult's. This confirms the idea that a certain degree of freedom in play is necessary to make it meaningful, more emotional, and "lived through" for children.

Discussion

Vygotsky differentiated two ways that perezhivanie can be conceptualized: as an empirical phenomenon available for observation and assessment (P1) and as a theoretical tool for examination of the development (P2; Veresov, 2016). In our work, we were challenged to explore the power of the theoretical tool in regard to the role-play and to operationalize empirical phenomena to make it really available for observation and assessment in the role-play. Through the concepts of "microsocial situation of development" and "dramatic perezhivanie" an imaginary situation, which is created within the role-play is analyzed as a specific microsocial situation turning into microsocial situation of development for a particular child in the moment of dramatic perezhivanie. We focused on impulsive, field actions, regulation of other children's behavior, original role actions and expressive movements, and emotional response reactions. We assumed that these behavioral manifestations as well as their combination within each microsocial situation allow us to catch the moments of contradiction and dramatic perezhivanie, which can become a turning point in a child's development.

The case analysis shows that we can consider a role-play as a microsocial situation which is not the social situation of development *per se*, but can become such for each specific child at the moment when dramatic perezhivanie occurs. Dramatic perezhivanie can indicate the degree of the child's involvement in what is happening, and the degree of this involvement allows us to characterize a play situation as a social situation of development. Thus, the behavioral indicators that capture the child's actions, emotional manifestations and speech behavior, can become a tool enabling us to analyze the developmental potential of play. In a broader sense, analysis of dramatic perezhivanie can show which parts, aspects, or components of a situation are reflected in the child's mind, what he responds to and to what he does not. Following Vygotsky (2016), we can say that in play the child is always "a head above himself." However, our data have shown that sometimes this may not be the case. If the play is rich in content, if the child is active and involved in it, we can say that the play situation has a developing potential. But the same play situation may be experienced differently by another child. If the play is not interesting and is weak in content for the child, then it does not contribute to development, and does not show the actual level of the child's development. We saw from the case study that a child in play can be "a head lower himself" comparing the test results and play behavior. This result seems to show how "hot" self-regulation interferes and connects to the "cold" self-regulatory processes in a way the problem of the unity of affect and intelligence is stated in cultural-historical theory (Veraksa and Sukhikh, 2021). Cold (cool executive control, CEC) and hot control (hot executive control, HEC) are two important and interrelated aspects of self–regulation. CEC is more effectively neutral, slow-acting, and developing; HEC is more reflex, fast-acting, early-developing, and stimulus-dependent (Willoughby et al., 2011). Unlike CEC, HEC is launched in the context of emotional and motivational processes. The role-play is the most natural context for the manifestation of such processes in preschoolers. Probably, the Play Matrix can also be the tool for assessing HEC in a personally significant situation, which is (often, but not always, as we see) a joint role-play.

The data analysis also provide some grounds to support the suggestion that different conditions of play vary in developmental potential. We observed different trends in children's behavior depending on the experimental condition. Specifically, children seem to be more involved and active in the context of peer play ("Child-directed play"). At the same time, at the tendency level, the number of original role actions increased as a result of the "Adult-directed play" intervention. This experimental condition also became more efficient for behavioral inhibition development. Compared to less guided forms of role-play, articulated and active participation of adults contributes to children's ability to suppress impulses and automated reactions. This finding points to Vygotsky's perspective regarding the role of an adult in play: an

adult is important during play but her involvement should be limited. As previous studies also showed, the adult has to keep a balance when engaging in children's play (Hakkarainen et al., 2013; Fleer, 2015; Smirnova, 2019). The adult is indispensable for play development as a carrier of cultural norms and experience; on the other hand, support for children's initiative is equally necessary for play to be personally meaningful and emotionally engaging for the child.

The study shows that children's behavioral, emotional and speech manifestations can be seen as indicators of a child's attitude toward play and can be used to describe the phenomenology of dramatic perezhivanie. Obvious limitations of this study are its small sample size and newly developed observational tool (not used in prior work). An original tool, *The Play Matrix* has an extensive number of indicators and requires training for observer. So we had to choose only five behavioral indicators. We believe it would be important to continue working on the development, refinement, and validation of a system of behavioral indicators that allow to analyze play from the point of view of a particular child and more accurately capture the moments of dramatic perezhivanie in play. There are very limited reports on the perezhivanie that are operationalized within empirical research (Fleer, 2016; Ferholt, 2018; Veresov, 2019) and there are no tools for dramatic perezhivanie to be observed and captured in a role-play. However, such tools, especially available for use by educational practitioners, would make it possible to predict and increase the effectiveness of interventions for each individual child, which is consistent with the idea of individualization of the educational process. Another possible direction for further research could be to study the effectiveness of play interventions taking into account children's dramatic perezhivanie and their personality traits. Finally, it could be fruitful to further apply the suggested methodology to analyze the results of interventions aimed to develop not only executive functions but other cognitive skills and lines of development as well.

Conclusion

Adopting a framework of the cultural-historical approach, we explore the phenomena of dramatic perezhivanie as a driving force for children's development. We used the data from an experimental study aimed at developing children's executive functions. The play activities in this experiment were specifically designed to provide a load on these cognitive skills. However, the methodological principle proposed in this article for the qualitative analysis of the developmental effect of intervention can be applied to any material. We can create special conditions for the development of certain skills, but the created environment itself does not develop and a microsocial situation will not become a turning point in the child's development if it is not possible to involve him personally and create a microsocial situation of development through dramatic perezhivanie. We assume that this is the general mechanism of development in role-play, and in any other (micro) social situation.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies and consent procedures involving human participants were reviewed and approved by the Ethics Committee of Faculty of Psychology at Lomonosov Moscow State University (the approval no: 2021/72). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin. Written informed consent was not obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

VS obtained data, contributed to methods analyses and preparation of the manuscript. NNV conceptualized research and contributed to results interpretation. NEV introduced theoretical analyses and co-directed the analyses. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.1057209/full#supplementary-material

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EDITED BY
Yulia Solovieva,
Meritorious Autonomous University of Puebla, Mexico

REVIEWED BY
Daniel Rosas,
National Autonomous University of Mexico, Mexico
Gustavo Cunha de Araujo,
Universidade Federal do Norte do Tocantins, Brazil

*CORRESPONDENCE
Arina Shatskaya
✉ arina.shatskaya@mail.ru

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Voluntariness and type of digital device usage: A study in terms of Vygotsky's cultural–historical perspective

Arina Shatskaya[1]*, Margarita Gavrilova[1,2] and Elena Chichinina[2]

[1]Laboratory of Childhood Psychology and Digital Socialization, Psychological Institute of Russian Academy of Education, Moscow, Russia, [2]Department of Education Psychology and Pedagogy, Faculty of Psychology, Lomonosov Moscow State University, Moscow, Russia

Introduction: In recent years, exposure to digital devices during the development stages of a child has been steadily increasing. Exploring the relationship between children's digital device exposure and their voluntariness still shows quite contradictory results. Screen time is the most studied factor on this issue. The purpose of the present study was to suggest the type of digital device used is another factor in addition to screen time. In accordance with the research hypothesis, the use of digital devices as a psychological means is related to higher voluntariness scores.

Methods: The study sample was recruited from Moscow kindergartens and schools: preschoolers aged 5–6 years (n = 408) and 6–7 years (n = 351) and schoolchildren aged 7–8 years (n = 253) and 9–10 years (n = 101). The study participants took part in a voluntariness assessment performed *via* executive functions' (EF) evaluation as well as in a semi-structured interview to identify the type and frequency of digital device usage.

Results: There are three findings of the present study, which are given as follows. First, the "frequency of digital device usage" predictor proved its statistical significance for verbal working memory, inhibition, and cognitive flexibility at 7–8 years, and for verbal working memory at 6–7 years. Second, the number of children who use digital devices as a psychological means increases as they grow older. Third, the number of children who use digital devices as a psychological means tends to demonstrate higher mean scores for any executive function skills at 6–7 and 9–10 years and for visual and verbal working memory at 7–8 years. Multiple regression models did not confirm the significance of the "type of digital devices usage" predictor for executive function skills considering the participants' individual characteristics.

Discussion: "Type of digital devices usage" predictor is assumed to be more applicable to children at the end of primary school and older when exploring executive function skills in the context of children's digital device exposure.

KEYWORDS

preschool children, gadgets, self-regulation, working memory, inhibitory control, cognitive flexibility, executive functions

1. Introduction

Currently, there is an increasing digitalization of human life. The involvement of people around the world in the digital environment is growing annually. This trend is seen in all age groups, including the preschool community (Sowmya and Manjuvani, 2019; Konca, 2022; Scott, 2022). For instance, by 2022, 60% of the US parents reported that their child had started using a smartphone at the age of 5 years, while 31% of them explained that

their children had had digital experiences even before they were 2 years old (DataReportal, 2020). In addition, as the age at which children have their first digital experience on a device (mobile phones, tablets, smart watches, etc.) becomes lower, so does the frequency of digital usage (Smirnova et al., 2022). For example, the total screen time of preschoolers and primary school children varies from 1 to 3 h per day (Soldatova and Vishneva, 2019; Konca, 2022). It is also worth mentioning that the use of digital Internet technologies has grown not only in the northern hemisphere where most of the countries are wealthy but also in the southern hemisphere (Byrne et al., 2016). Thus, the trend toward earlier familiarization of children with digital devices (herein after—DD) and toward an increasing frequency of interaction with such devices has, in fact, become global.

Currently, both adults and children acquire a significant part of social experience *via* interaction with DD–digital socialization (Soldatova and Vojskunsky, 2021; Veraksa A. N. et al., 2021; Podosokorsky, 2022; Sysoeva and Yaroshevskaya, 2022; Zhuravlev et al., 2022). A gradual digital transformation of the educational process in schools (Koinova-Zollner et al., 2022) and preschool institutions (Komarova, 2022) is also taking place. The phenomenon as described creates a new type of child development, a "digital childhood" (Rubtsova, 2019a,b). Interaction with DD at an early age frequently begins on the grounds of entertainment: watching cartoons and playing games (Rideout and Robb, 2017; Nikitina and Rytova, 2019). Later, the content becomes more variable, and new functions, such as communication, searching for information, doing homework, etc., are added (Veraksa et al., 2022).

The intense integration of digital technologies into the children's day-to-day activities from the earliest age poses the question of the potential impact on the children's development. Due to its uncertainty and ambiguity, the DD influence on child development is a matter of debate and discussion in the scientific community. On the one hand, a whole range of research works revealed that some computer games develop planning skills and logical thinking in children (Batenova, 2011), as well as visuomotor coordination (Alekhin and Pul'cina, 2020), spatial orientation (Subrahmanyam and Greenfield, 1994), and visual working memory (Blacker et al., 2014). In addition, it has been shown that digital educational software also positively affects children's cognitive development (Kotler et al., 2016; Klopotova and Romanova, 2020).

On the other hand, there are multiple research data confirming the negative DD influence on child development. For instance, watching too much video content and frequent Internet usage can result in vocabulary deficiencies and lower language skills (Nirwana et al., 2018; Takeuchi et al., 2018; Nikitina and Rytova, 2019; Sari, 2020) and inhibit the processes of emotional development and child socialization because of the lack of two-way communication (Suhana, 2017; Sapardi, 2018). Moreover, a negative effect, especially for attention focus, was registered for cognitive development processes (Christakis et al., 2004; Haier et al., 2009; Cho and Lee, 2017).

Thus, clarifying the issue will help us understand the peculiarities of teaching children in the digital era, which makes the topic particularly timely (Nechaev and Durneva, 2016).

What factor can adequately represent the effect of DD usage on children's mental development and future performance? Screen time is the most widely studied factor of how gadgets impact a child's development and voluntariness (Jusiene et al., 2020; Martins et al., 2020; McHarg et al., 2020; Vohr et al., 2021). However, not all studies support the predictive power of screen time (Huber et al., 2016; Radesky and Christakis, 2016; Jusiene et al., 2020; Papadakis et al., 2022). What other factors can be explored besides screen time? The present study attempts to answer this question based on the cultural–historical perspective. The advantage of this approach lies in the fact that it considers human activity as the product of historical social development as a result of the interaction of an individual with the objects in the environment, which also includes DD in the present world (Soldatova and Vojskunsky, 2021).

According to Vygotsky, the developmental act in its essence consists of achieving the mastery of cultural means (signs, sign systems, certain ways of activity, etc.) and leads to the transition from non-mediated to mediated actions. Vygotsky's cultural–historical perspective describes three stages of child cultural development. In the first stage, children do not master any cultural experience or signs, but the adults do it for them. In the second stage, a child moves to master the signs by using them in his/her own interaction with others, as if controlling their behavior. For example, a toddler points at a toy and the adult names it and gives it to the toddler. Finally, in the third stage, children learn to apply signs to their own behavior (Vygotsky, 1983). Thus, the development of voluntariness turns out to be an important indicator of a child's mental development (Solovieva et al., 2021), and therefore, it has gained utmost research interest.

If we talk about voluntariness within the framework of the cultural–historical perspective, it is necessary to distinguish between voluntary and volitional behavior (voluntariness and will). A key feature of voluntary behavior is the awareness of the ways of one's or own actions, as well as the ability to mediate them using cultural signs (Smirnova, 2015). Voluntariness is directed at oneself, at the means and methods of one's external or internal activity. Will is a motivation that encourages a person to take some action (Smirnova, 2015). Thus, these two concepts have not only much in common but are also diverse. On the one hand, if the motive and purpose of the action do not belong to the child himself/herself (e.g., acting according to instructions), the child's actions may be voluntary and mediated but not volitional. On the other hand, a strong-willed person with a stable system of motives, even having a definite goal, may not have the voluntariness of his/her actions. The development of will can be conceived as the formation of stable motivation and the formation of the child's own stable desires and aspirations. From this point of view, the development of voluntariness can be considered as mastering the means of organizing one's behavior, which allows the person to objectify and realize his/her own actions. A person with developed voluntariness demonstrates organized and consciously controlled behavior, which he/she can subordinate to norms and rules.

The present study deals with the development of voluntariness from the perspective of executive functions (EF) within Miyake's approach (Miyake et al., 2000). According to this cognitive concept, EF are a family of top-down mental processes required for voluntary planning, control, and regulation of one's actions in accordance with the current task and selective attention to stimuli (Diamond, 2013). Fundamental executive function skills are working memory (visual and verbal) that preserves and

manipulates information that is not available for perception anymore; inhibitory control that inhibits domineering responses in favor of the one required by the task; and cognitive flexibility (switching between several alternatives, rules, or perspectives) (Miyake et al., 2000). A large range of research works proved that this three-component model is enough to describe the features of EF structure in children (Diamond and Lee, 2011; Almazova et al., 2016). Executive functions are often considered the most reliable predictors of success in adulthood to a higher degree than even the IQ level or the socioeconomic status (Moffitt et al., 2011). All these arguments elaborate on the attention paid to appropriating EF (voluntariness) as a key developmental task in preschool childhood (Almazova et al., 2016) and its relation to contemporary cultural practices, especially those including DD usage.

However, understandings of the voluntariness concept within the cultural–historical perspective and the cognitive perspective are different. In the cultural–historical perspective, Venger's theory of abilities and his diagnostic toolkits are widely used when exploring voluntariness (Venger, 1986). The theory of abilities is based on the idea that voluntariness develops in relation to cultural means (sensory standards, visual models, etc.). The cognitive approach evaluates the development of voluntariness through the concept of EF as a set of cognitive skills. However, Almazova et al. (2016) assessed child voluntariness using both the Venger toolkit and the EF diagnostics and compared the results. The same reality is studied in each of the approaches, and voluntariness can be studied using executive function diagnostics.

Vygotsky considered sign usage as a key moment in the development of higher mental functions (Vygotsky, 1983). It is important to distinguish between the concept of a practical means and the concept of a sign. A human being uses both psychological and practical means in his/her activity (Cole and Engeström, 1993; Vygotsky, 2006; Nussbaumer, 2012). The former includes signs that transform the mental processes of a person and allow mastering one's own behavior and influencing other's behavior. Since psychological means are directed inwardly, they allow the regulation of one's own and other people's behavior, while practical means are directed outwardly and are meant for the transformation of external objects (Vygotsky, 1982). All these means have natural and cultural components, that is, a material aspect with certain physical properties and a social one reflecting culturally established ways of their use (Veresov and Veraksa, 2022).

The Internet and DD usage can be considered as a new means of symbolic mediation of activity. All types of activities with DD can perform both as practical and as psychological means simultaneously (Rubtsova, 2019a,b; Veraksa N. E. et al., 2021). Using DD, children can directly affect the objects around them to fulfill their needs (a DD acts as a practical means). At the same time, DD can be used to influence one's own and other people's behavior, and in this study, the "sign" aspect of a DD manifests itself (e.g., the alarm, notes, or calendar functions of a smartphone serve as a means of self-regulation). In addition to DD usage as a psychological means, DDs are used for reading, playing gadget games, etc., which changes the structure of the related psychological processes compared to their natural counterparts—reading books and playing non-virtual games (Vygotsky, 1982; Rubtsova, 2019a,b). Thus, by what criterion can the varieties of DD usage be distinguished from each other?

According to the cultural–historical activity theory, activity is a holistic unit of analysis directed by a group of individual goals and motives (Leontiev, 1974; Galperin, 1992; Davydov, 1999). Within this concept, any activity has a three-component structure: activity–action–operation. Activity is determined by a motive, action is determined by a goal, and operations are determined by the specific conditions of the process (Leontiev, 1978).

From this point of view, the DD usage can be considered in two ways. (A) On the one hand, the motive of activity involving a DD is to actively transform and regulate the behavior and mental processes of oneself or others. For example, a child makes a note in the calendar application so as not to forget to complete a project (a gadget as a means of memory regulation) or a child communicates with relatives using WhatsApp (a gadget as a means of communication to influence interlocutors). Using DD as a means, people aim to get a certain outcome in regulating their own or someone's else behavior. In this case, we talk about the usage of DD as an active psychological means.

(B) On the other hand, a DD can be used directly for interaction with another DD to enjoy this process. For example, some people enjoy surfing the Internet without any purpose, and many play digital games or watch video content. Since people are enjoying the process, it matters more than the result. In this case, we believe that DDs are used as entertainment (Veraksa and Buhalenkova, 2017).

Thus, it seems interesting to consider whether DD usage as a psychological means contributes to a higher degree of voluntariness. We do not deny that a child can simultaneously develop and change the behavior and mental functions of himself/herself and others even in the case of using DD for entertainment. However, we suggest that, in these cases, the self-regulating act is not the main purpose of the child's activity.

The main purpose of this study was to suggest the type of digital device usage as another factor in addition to screen time when exploring the relationship of voluntariness with DD usage. It was hypothesized that DD usage as a psychological means is related to higher executive functioning scores.

2. Materials and methods

2.1. Participants

The participants were recruited from several public kindergartens and primary schools in Moscow. The present study was performed with the data acquired from the four age groups: (a) *preschoolers aged 5–6 years* from the senior kindergarten groups ($n = 408$, $M = 64$ months, $SD = 4$; 47% boys), (b) *preschoolers aged 6–7 years* from the preschool kindergarten groups ($n = 351$, $M = 64$ months, $SD = 3.8$; 49.5% boys), (c) *schoolchildren aged 7–8 years* from the first grade ($n = 253$, $M = 90$ months, $SD = 6.2$; 39.5% boys), and (d) *schoolchildren aged 9–10 years old* from the third grade ($n = 101$, $M = 118$ months, $SD = 3.7$; 49.5% boys).

Participation in the study for preschoolers and schoolchildren was organized on a voluntary non-reimbursable basis. The parents of each participant signed the informed consent for their child's participation. All the participants were involved in basic education programs and had no developmental delays or

disabilities. All the assessment tasks were performed during an individual meeting with each participant lasting 30–35 min in a quiet room of the child's kindergarten or school in the first half of the day.

2.2. Measures

2.2.1. Voluntariness

The level of voluntariness development was assessed by evaluating the EF skills: visual and verbal working memory, inhibitory control, and cognitive flexibility.

Visual working memory was assessed *via* the "*Memory for design*" subtest (Korkman et al., 2007). Children could obtain (1) "Content scores"—for remembering the image elements correctly, (2) "Spatial scores"—for indicating the correct location of the image elements in the field, (3) "Bonus scores"—for meeting both criteria, and (4) "Total score" as the sum of all three parameters (150 points max.).

The "*Sentence Repetition*" subtest (Korkman et al., 2007) was used to assess verbal working memory. This technique consists of 17 sentences that gradually become longer and more complex grammatically. Each sentence recalled accurately is awarded 2 points. In case of three or more errors, or no answer at all, 0 points are assigned. If the respondent receives 0 points four times consecutively, the trial stops (34 points max.).

Inhibitory control was evaluated by means of the "*Inhibition*" subtest (Korkman et al., 2007). This technique consists of two blocks: a row of black and white circles and squares, and a row of black and white arrows pointing upward and downward. With both blocks, children had to perform two tasks: (1) "Naming"—to name all figures as quickly as they possibly could and (2) "Inhibition"—to name the opposite figure or direction as quickly as they possibly could (a square instead of a circle and vice versa). The number of corrected and not corrected errors and the time spent on the task were registered. These parameters were converted into a combined score for convenience in accordance with the authors' guideline (20 points max.).

We assessed cognitive flexibility in preschoolers and schoolchildren by different age-appropriate techniques. Primary school children were asked to perform the third task from the aforementioned "Inhibition" subtest, the "Switching" (Korkman et al., 2007). It required naming the figures in a row as quickly as possible according to the following set of rules: if a figure was white, it should be named oppositely (it was correct to say "a circle" instead of "a square," and vice versa), but if a figure was black, it should be named correctly (a circle was a circle). The number of corrected and not corrected errors and the time spent on the task were registered.

In preschoolers, cognitive flexibility was assessed by the "*DCCS*" tool consisting of three tasks (Zelazo, 2006). In the first one, children had to sort the cards by color; in the second one, children had to sort the cards by their shape, and in the third one, children had to sort the cards following a special rule (if the card had a black frame, it was to be sorted by color; if it did not have any, it was to be sorted by shape). Each correct sorting was awarded 1 point (24 points max.).

The validity of using the psychometric tests to evaluate EF skills is supported by the fact that these tests have already been approved by the standardized diagnostic system to be used when it is necessary to acquire relevant measurements for all groups under study (Veraksa et al., 2020). At the same time, previous studies proved the diagnostic tools of the standardized NEPSY-II and DCCS tests to be analogous to the Venger tests (Venger and Kholmovskaya, 1978), which are widely used within the cultural–historical concept to assess voluntariness (Almazova et al., 2016).

2.2.2. DD usage

To assess the type of interaction with digital devices, a semi-structured interview was elaborated. The interview included two blocks of questions about the frequency of DD usage and the ways by which children use them. The first block concerned the type of usual activity with digital devices:

(Q1) How often do you use gadgets for communication (conversations and messaging)?
(Q2) How often do you use gadgets for information search?
(Q3) How often do you use gadgets to do homework?
(Q4) How often do you use gadgets for the purpose of self-organization (alarm clock, maps, planner, etc.).
(Q5) How often do you use gadgets to take pictures and make videos?
(Q6) How often do you use gadgets to listen to music?
(Q7) How often do you use gadgets to draw?
(Q8) How often do you use gadgets to play games?
(Q9) How often do you use gadgets to watch cartoons, videos, and movies?

The responses received were recorded and classified into four categories: hardly ever, sometimes, often, and very often. Then, the children's responses were divided into three categories: (1) DDs are mostly used as "psychological means" (most frequently used categories are a–g); (2) "for entertainment" (h, i); and (3) "both" (a–i).

The second block of questions related to the frequency of using gadgets. The participants answered the question:

(Q10) How often do you use your smartphone/tablet/laptop/computer? The responses received fell into one of the three categories: rarely—several times a week or less; every day; very often—more than 2–3 h every day.

The age, gender, and non-verbal fluid intelligence and parental educational level were included as participants' characteristics. The child's non-verbal fluid intelligence was assessed with the help of Raven's Colored Progressive Matrices (Raven, 1998). The participants performed assessment tasks until four mistakes were made and the number of tasks completed correctly was counted. Parental educational level was assessed in the parental interview and attributed to one of the following categories: secondary general education; specialized secondary education; incomplete higher education; higher education; and academic degree.

The research hypotheses were tested using multiple linear regression models and *t*-tests. All computations were processed

TABLE 1 Characteristics of child digital device usage at different ages.

Age period	Total no DD usage (%)	Total DD usage (%)	DD usage			
			Type of DD usage (%)		Frequency of DD usage (%)	
5–6 y. o.	32.1	67.9	Mean	7.4	Rarely	8
			Entertainment	35.2	Everyday	48.7
			Both	25.3	Very often	8
6–7 y. o.	5.4	94.6	Mean	10.5	Rarely	41.7
			Entertainment	60.2	Everyday	47.4
			Both	23.8	Very often	6.0
7–8 y. o.	0.008	99.15	Mean	20	Rarely	0
			Entertainment	78.0	Everyday	64.4
			Both	2	Very often	35.6
9–10 y. o.	0	100	Mean	38.0	Rarely	0
			Entertainment	55.7	Everyday	43.0
			Both	6.3	Very often	57.0

using the R language software (version 4.1.2) and Jamovi (version 2.3.16). G*Power 3.1.9.4 was used to perform the *a posteriori* power analysis.

3. Results

At the first stage of analysis, the general descriptive data on DD usage and EF skills were acquired for all the age groups from the youngest one [5–6 years old (years old) to the oldest (9–10 years old (y.o.)]. The acquired data are presented in the following paragraph.

3.1. DD usage

The descriptive data on the features of DD usage are summarized in Table 1. The percentage of children who do not use DD tends to decrease as children grow older. However, in the senior kindergarten group, 67.9% of the children use gadgets, and in the first grade, nearly all of them use DD (99.15%). By the third grade, all children use digital devices (100%). At the same time, the number of children who use DD very often, that is, for more than 2–3 h daily, grows from the senior kindergarten to the third grade (chi-square test, $\chi^2 = 271$, $df = 15$, $p < 0.000$).

We can state that most children use DD as entertainment in all four age groups. The percentage of children who use DD as a psychological means increases from 7.4% for the 5–6-year-olds (the senior group) to 38% for the 9–10-year-olds (the third grade) ($\chi^2 = 117$, $df = 6$, $p < 0.000$). Thus, the older the children, the more likely they will use DD mainly as a psychological means.

3.2. EF skills and type of DD usage

The descriptive statistics for all EF skills for all age groups, delineated by the type of DD usage, are presented in Table 1. In this study, we focused on two types of DD usage—as a means or for entertainment—and the children were attributed to one of the two groups according to their preferred type of usage. The differences in EF skills between these two groups were analyzed using Student's *t*-test/Mann–Whitney U-test for normally/non-normally distributed interval variables (see Table 1).

As a result, no significant differences were found between the "means" and "entertainment" groups for the 5–6- and 6–7-year-old children. As regards the 7–8-year-old children and their EF skills, a significant difference was found for verbal working memory in favor of the "means" group (Rank-Biserial Correlation as an effect size = 0.184). For the 9–10-year-old children, significant differences between the two groups were found for verbal working memory (the Cohen's *d* as an effect size = 0.504) and for inhibition (Cohen's $d = 0.487$) in favor of the "means" one.

We decided to evaluate the general EF skills trend for all groups under study. As can be seen from Table 2, for the children 5–6 years old, averaged EF skills in the "means" group never exceed the values of the "entertainment" group. Among the 6–7-year-old children, the "means" group exceeds the "entertainment" group in average values for all EF skills. Among the 7–8 year-old children, the "means" group exceeds the "entertainment" group in average values for visual and verbal working memory. Among the 9–10-year-old children, the "means" group exceeds the "entertainment" group in average values for all EF skills (in view of equal mean values for visual working memory, the medians were estimated: for the "means" = 134 and for the "entertainment" = 129).

A posteriori power analysis was performed for all the comparisons between the "means" and "entertainment" groups for all test groups considering the achieved effect sizes in each comparison, the size of the groups, and $\alpha = 0.05$ (total 16 power values). As a result, the maximum statistical power among all comparisons was 68%. We assumed the unbalanced size of groups to be the reason for such a low statistical power, mainly the small size of the "means" group. Low statistical power combined with the fact that, in 62.5% (10 out of 16) of comparisons, there was a tendency for the "means" group to prevail over the "entertainment" group, suggests that this negative result may be false (type II error).

TABLE 2 Descriptive data for EF development in children from 5 to 10 years.

Age period	Type of DD usage	Visual working memory	Verbal working memory	Inhibition	Cognitive flexibility
5–6 y. o.	Mean	67.2 (21.9)	16.9 (6.64)	9.0 (0.01)	7.5 (3.19)
	Entertainment	79.4 (20.3)	19.1 (5.04)	9.09 (0.29)	7.54 (3.14)
	Both	72.3 (19.9)	18.8 (4.66)	9.18 (0.385)	8.29 (2.48)
	Mean vs. Entertainment	$T = 1.862$, $p = 0.067$	$T = 1.312$, $p = 0.194$	$U = 300$, $p = 0.289$	$U = 328$, $p = 0.829$
6–7 y. o.	Mean	88.6 (23.8)	22.1 (3.99)	11.2 (3.58)	9.24 (2.41)
	Entertainment	82.9 (24.0)	21.2 (4.89)	11.0 (3.05)	8.87 (2.58)
	Both	84.2 (21.8)	21.6 (4.60)	10.8 (3.09)	9.43 (2.53)
	Mean vs. Entertainment	$U = 2888$, $p = 0.200$	$T = -0.935$, $p = 0.351$	$U = 3183$, $p = 0.653$	$U = 3190$, $p = 0.623$
7–8 y. o.	Mean	113 (28.1)	23.0 (4.25)	11.5 (2.85)	10.6 (2.96)
	Entertainment	106 (31.4)	21.8 (3.94)	12.0 (3.11)	11.2 (3.40)
	Both	110 (24.7)	23.0 (5.83)	12.8 (3.03)	8.20 (0.84)
	Mean vs. Entertainment	$T = -1.407$, $p = 0.161$	$\mathbf{U = 3799, p = 0.047}$	$U = 3721$, $p = 0.174$	$U = 3935$, $p = 0.405$
9–10 y. o.	Mean	125 (19.9)	27.2 (5.07)	15.3 (2.58)	14.0 (3.32)
	Entertainment	125 (20.0)	25.0 (3.86)	13.9 (3.28)	13.3 (3.91)
	Both	130 (25.5)	25.4 (4.39)	16.6 (2.19)	16.2 (1.92)
	Mean vs. Entertainment	$T = 0.055$, $p = 0.956$	$\mathbf{T = -2.13, p = 0.037}$	$\mathbf{T = -2.06, p = 0.043}$	$T = -0.80$, $p = 0.430$

Standard deviation (SD) is reported in parentheses. **Bold** text indicates a statistically significant predictor (p-value < 0.05).

3.2.1. Multiple linear regressions for EF skills

At the second stage of analysis, multiple linear regression models were built to assess the contribution of the DD usage type to the EF skills for all test groups, considering the participants' individual characteristics. Thus, 16 linear regression models (4 EF skills × 4 test groups) were simulated. The dependent variables were EF skills (visual and verbal working memory, inhibition, and cognitive flexibility), as measured in each test group. The following variables were used as predictors in the models: (a) the type of DD usage—mainly as entertainment; as both entertainment and means; as a psychological means (hereinafter referred to as a "type-predictor") and (b) the frequency of DD usage—rarely; every day; and very often (hereinafter referred to as a "frequency-predictor"). Factors such as gender, age, non-verbal fluid intelligence (Raven test), and parental education were considered covariates. The survey of parents showed that more than 93.8% of them had received a university education. Therefore, the parental education covariate was not considered in the final models (the sample for this criterion was almost homogeneous).

To determine whether it is necessary to include the "sex × type of DD usage" interaction factor in the models, we examined the relationship between these factors using the chi-square test. As a result, in all the test groups, neither the boys nor the girls demonstrated any significant preference for the type of DD usage. Therefore, we decided not to include this interaction factor in the final models. All necessary statistical assumptions for constructing multiple linear regressions were successfully tested.

Having constructed all the regression models, we performed power analysis for each of them considering the achieved effect sizes as f_2 in each model, the size of sample, and $\alpha = 0.05$ (total 16 power values). Individual characteristics showed statistical significance in some models (see Tables 3–6 for more details). We now proceed to the findings concerning the main type- and frequency-predictors, which were yielded from model simulations carried out for all EF skills and all test groups.

3.2.1.1. Visual working memory

First, for visual working memory, we derived that the type- and frequency-predictors are not significant in any of the test groups (see Table 3). *A posteriori* power analysis showed that the sample size was insufficient for drawing reliable conclusions for Model 2 (visual working memory of 6–7 year-olds) and Model 4 (9–10 year-olds).

3.2.1.2. Verbal working memory

Second, we constructed four equivalent regression models for verbal working memory (see Table 4). As a result, in none of the test groups, the type-predictor appeared to be significant. On the other hand, the frequency-predictor turned out to be significant in Model 1 [$t_{(101)} = -2.146$, $p = 0.034$, $d = 0.258$, 95% CI [−1.42, −0.056]] and Model 3 [$t_{(225)} = -2.138$, $p = 0.034$, $d = 0.596$, 95% CI [−1.23, −0.049]]. The higher the frequency, the lower the score for verbal working memory. *A posteriori* power analysis for all models revealed that the statistical power is sufficient in all cases (minimum power value = 0.992), and the sample size is sufficient everywhere.

3.2.1.3. Inhibition

Third, the equivalent models for inhibition were constructed (see Table 5). The type-predictor was found to be statistically significant only for Model 4 [$t_{(66)} = 2.02$, $p = 0.0493$, $d = 0.185$, 95% CI [0.003, 2.365]]. Children from the "means" group had an inhibition score higher than those who used DD as entertainment. The frequency-predictor showed statistical significance for Model 3

TABLE 3 Multiple linear regression analysis for the study variables predicting visual working memory from the senior kindergarten group to third school grade.

Model coefficients	Model 1 5–6 y.o.			Model 2 6–7 y.o.			Model 3 7–8 y.o.			Model 4 9–10 y.o.		
	β	*SE*	*p*	*β*	*SE*	*p*	*β*	*SE*	*p*	*β*	*SE*	*p*
Intercept	60.03	33.1	0.073	46.32	28.93	0.110	182.8	46.22	0.000	67.72	97.83	0.492
Sex	1.398	4.12	0.735	0.98	2.77	0.724	−1.518	4.253	0.722	−3.56	5.628	0.530
Age	0.23	0.50	0.644	0.37	0.37	0.311	−0.918	0.490	0.063	0.470	0.848	0.582
Raven	0.77	0.30	**0.012**	0.34	0.203	0.092	0.757	0.261	**0.004**	0.592	0.423	0.169
Type DD usage	−5.61	3.01	0.065	2.35	1.99	0.239	2.287	2.449	0.351	−2.615	3.638	0.476
Frequency DD usage	−0.998	1.47	0.497	−0.73	2.33	0.756	−0.744	2.102	0.723	1.213	2.932	0.681
F-statistic (p-value)	$F_{(6.93)} = 2.908, p = 0.017$			$F_{(5.284)} = 1.255, p = 0.283$			$F_{(5.164)} = 2.575, p = 0.028$			$F_{(5.46)} = 0.94, p = 0.4611$		
Multiple R^2 ($AdjR^2$)	0.134 (0.09)			0.022 (0.004)			0.0728 (0.045)			0.093 (−0.005)		
Is the sample size sufficient? (Power-analysis)	Yes			No			Yes			No		

Bold text indicates a statistically significant predictor (p-value < 0.05).

TABLE 4 Multiple linear regression analysis for the study variables predicting verbal working memory from the senior kindergarten group to third school grade.

Model coefficients	Model 1 5–6 y. o.			Model 2 6–7 y. o.			Model 3 7–8 y.o.			Model 4 9–10 y.o.		
	β	*SE*	*p*	*β*	*SE*	*p*	*β*	*SE*	*p*	*β*	*SE*	*p*
Intercept	10.29	7.81	0.190	1.276	5.58	0.819	10.83	4.181	**0.010**	18.25	21.01	0.389
Sex	1.770	0.95	0.066	1.829	0.54	**0.000**	1.256	0.612	**0.042**	0.001	1.21	0.99
Age	0.113	0.12	0.342	0.231	0.07	**0.001**	0.087	0.043	**0.042**	0.352	0.18	0.059
Raven	0.148	0.07	**0.033**	0.074	0.04	0.061	0.103	0.038	**0.007**	0.032	0.09	0.722
Type DD usage	−0.85	0.70	0.233	0.273	0.39	0.479	0.500	0.358	0.163	1.034	0.78	0.192
Frequency DD usage	−0.73	0.34	**0.034**	−0.254	0.45	0.574	−0.644	0.301	**0.034**	0.361	0.63	0.569
F-statistic (p-value)	$F_{(5.101)} = 4.127, p = 0.0018$			$F_{(5.287)} = 5.603, p < 0.000$			$F_{(5.175)} = 4.358, p = 0.0009$			$F_{(5.46)} = 2.199, p = 0.070$		
Multiple R^2 ($AdjR^2$)	0.134 (0.09)			0.089 (0.073)			0.110 (0.085)			0.192 (0.105)		
Is the sample size sufficient? (Power-analysis)	Yes			Yes			Yes			Yes		

Bold text indicates a statistically significant predictor (p-value < 0.05).

[$t_{(225)} = -2.801$, $p = 0.005$, $d = 0.159$, 95% CI [−1.098, −0.190]]. The higher the frequency, the lower the score for inhibition. *A posteriori* power analysis revealed that the power and sample size were sufficient for all models, except Model 1.

3.2.1.4. Cognitive flexibility

Finally, the equivalent models for cognitive flexibility were constructed (see Table 6). The type-predictor was not significant in any of the test groups. The frequency-predictor revealed statistical significance in Model 3 [$t_{(225)} = -4.106$, $p < 0.000$, $d = 0.306$, 95% CI [−1.548, −0.543]]. The more often a child uses a DD, the lower his cognitive flexibility is. *A posteriori* power analysis revealed that, for all models, the power and sample size were sufficient.

4. Discussion

The development of voluntary behavior is considered by most researchers to be a key acquisition of preschool age in the framework of mental development and the child's readiness for school (Vygotsky, 1984; Elkonin, 2006; Smirnova, 2015). However, the features of the development of voluntariness in the era of digitalization are still not so clear (Veraksa et al., 2022). This explains the relevance of the study of voluntariness in the context of digital device usage by modern children. The purpose of this study was to gain a better understanding of the possible factors that are worth considering when studying the impact of digital devices on child development of voluntary behavior. The current study explored the development of voluntary behavior through Miyake's concept of EF skills (Miyake et al., 2000). Within the framework of research on this topic, the most widely studied factor is screen time. However, children spend more and more time with gadgets, but not in all cases are negative effects on development observed. It is worth refocusing on other factors since the factor of screen time has limitations and cannot always explain the details of the influence of digital devices on child development (Christakis et al., 2013; Huber et al., 2016; Radesky and Christakis, 2016; Papadakis et al.,

TABLE 5 Multiple linear regression analysis for the study variables predicting inhibition from the senior kindergarten group to third school grade.

Model coefficients	Model 1 5–6 y. o.			Model 2 6–7 y. o.			Model 3 7–8 y.o.			Model 4 9–10 y.o.		
	β	*SE*	*p*	*β*	*SE*	*p*	*β*	*SE*	*p*	*β*	*SE*	*p*
Intercept	10.20	0.525	0.000	11.46	3.78	0.002	13.67	3.19	0.000	29.82	15.8	0.065
Sex	0.046	0.064	0.469	0.479	0.36	0.184	0.210	0.46	0.653	−0.52	0.91	0.566
Age	−0.017	0.008	**0.027**	−0.021	0.05	0.658	−0.027	0.03	0.408	−0.15	0.14	0.289
Raven	0.001	0.005	0.857	0.102	0.03	**0.000**	0.113	0.02	**0.000**	0.05	0.07	0.503
Type DD usage	0.003	0.047	0.933	−0.101	0.26	0.695	−0.104	0.27	0.704	1.18	0.59	**0.049**
Frequency DD usage	−0.017	0.023	0.456	−0.166	0.30	0.582	−0.644	0.23	**0.005**	−0.05	0.47	0.904
F-statistic (p-value)	$F_{(5.98)} = 1.28, p = 0.2789$			$F_{(5.283)} = 3.45, p = 0.0048$			$F_{(5.174)} = 4.922, p = 0.0003$			$F_{(5.46)} = 1.338, p = 0.265$		
Multiple R^2 ($AdjR^2$)	0.061 (0.013)			0.057 (0.040)			0.1239 (0.098)			0.126 (0.032)		
Is the sample size sufficient? (Power-analysis)	No			Yes			Yes			Yes		

Bold text indicates a statistically significant predictor (p-value < 0.05).

TABLE 6 Multiple linear regression analysis for the study variables predicting cognitive flexibility from the senior kindergarten group to third school grade.

Model coefficients	Model 1 5–6 y. o.			Model 2 6–7 y. o.			Model 3 7–8 y.o.			Model 4 9–10 y.o.		
	β	*SE*	*p*	*β*	*SE*	*p*	*β*	*SE*	*p*	*β*	*SE*	*p*
Intercept	10.66	4.48	0.019	12.60	3.22	0.000	8.650	3.53	0.015	27.43	19.1	0.159
Sex	1.914	0.55	**0.000**	0.334	0.31	0.278	0.019	0.52	0.970	−1.56	1.1	0.164
Age	0.051	0.07	0.455	0.085	0.04	**0.039**	0.039	0.04	0.273	−0.11	0.17	0.504
Raven	0.093	0.04	**0.02**	0.084	0.02	**0.000**	0.051	0.03	0.111	0.02	0.08	0.837
Type DD usage	0.507	0.40	0.212	0.189	0.22	0.393	−0.289	0.30	0.344	0.89	0.71	0.216
Frequency DD usage	0.135	0.20	0.494	0.010	0.26	0.968	−1.045	0.25	**0.000**	−0.14	0.57	0.808
F-statistic (p-value)	$F_{(5.101)} = 3.965, p = 0.002524$			$F_{(5.286)} = 4.567, p = 0.0005044$			$F_{(5.174)} = 4.223, p = 0.001199$			$F_{(5.46)} = 0.8103, p = 0.5484$		
Multiple R^2 ($AdjR^2$)	0.164 (0.123)			0.074 (0.058)			0.1082 (0.082)			0.080 (−0.018)		
Is the sample size sufficient? (Power-analysis)	Yes			Yes			Yes			Yes		

Bold text indicates a statistically significant predictor (p-value < 0.05).

2022; Veraksa et al., 2022). In the current study, we suggest DD usage as a factor for studying the impact of digital devices on child EF. This factor was considered in terms of the cultural–historical activity perspective as one of the psychological means that mediate human activities and communication. This view on DD has been already proven to be admissible by other authors working within the cultural–historical perspective (Vojskunsky, 2005; Nechaev and Durneva, 2016; Rubtsova, 2019a,b).

The findings of the present study show that a change in the type of DD usage takes place as children grow older. In kindergarten, most participants use DDs as entertainment, which agrees with results in other studies (Nechaev and Durneva, 2016; Papadakis et al., 2018; Gözüm and Kandir, 2021; Nikolaeva and Isachenkova, 2022; Veraksa et al., 2022). By the third grade, the number of children who use the DD as a psychological means increases. This corresponds to the change of leading activity from playing to learning from preschool to primary school age (Elkonin, 1999; Sivrikova et al., 2020; Zain et al., 2022). The main hypothesis of the present study was that DD usage as a psychological means is associated with a higher EF skill level than when DDs are used for entertainment. Sixteen multiple regression models were constructed separately for each of the four EF skills and for all four groups under study. In the models, the "type of DD usage" (as a means or for entertainment) and "frequency of DD usage" (rarely, every day, and very often) were used as predictors. The individual characteristics of the participants were also considered covariates. As a result, only one model for inhibition found statistical significance for the "type of DD usage." Consistent with this fact, the 9–10-year-old children using gadgets as a means have inhibition scores higher than those who use DD as entertainment. In any other case, this factor was not significant. The hypothesis was not confirmed. When it comes to the frequency of DD usage (an equivalent of the screen time factor), this factor was significant in four cases. The more often children aged 7–8 years use digital devices, the worse their verbal working memory, inhibition, and cognitive flexibility develop. Furthermore, the more often the

children 6–7 years old use gadgets, the worse their verbal working memory develops. Thus, the factor of frequency of DD usage can appear to be quite productive for the study of executive functions in the context of children's digital device exposure. However, it is worth paying attention to the trend toward statistical significance for the differences between average values of EF skills. It is interesting to note that, in 10 out of 16 cases (four EF skills across four test groups), the average values of EF skills for the "means" group exceeded those for the "entertainment" group. However, at the age of 6–7 years, the children using gadgets as a means have higher scores in the executive functions of visual working memory, verbal working memory, inhibition, and cognitive flexibility. The children of 7–8 years also had higher scores in both visual and verbal working memory. The children aged 9–10 years also demonstrated higher scores across all executive functions. Such a tendency was not found for children aged 5–6 years.

Even though only in three out of sixteen cases the "means" group showed significantly higher results in executive functions, the presence of the trend toward statistical significance for differences between average values of EF skills is still important. This pattern of results is consistent with that of the previous research (Veraksa et al., 2022). It is also consistent with the theoretical assumption that the means modify the structure and features of the mental function's activity (Luria, 1928; Vygotsky, 1982).

The results obtained can be analyzed from the point of view of cultural–historical perspective as follows. For example, it has been shown that children aged 9–10 years using DD as a means have better inhibition scores (according to regression models considering individual characteristics of participants). Inhibition was assessed using a task where the child needed to name the figures oppositely to what the child really sees. In other words, the child had to switch from the physical plane to the mental one. Thus, while performing the inhibition task, the child acts in accordance with the internal mental plan and not under the influence of a motive coming from a physical object (he calls the square a circle, although the image of the square seems to motivate the child to say "square"). Consequently, the children who cope with this task well have a better ability to switch from the material plane to the mental one, and it is voluntariness, according to the concept of Vygotsky (1966). At the same time, the studies showed that many digital games do not include shifting to the mental plane but make the child act mainly in accordance with the material one (Veraksa et al., 2022). This probably leads to the fact that children who spend a lot of time playing digital games have little experience in shifting to the mental plane (which can be acquired during role-playing games, communication with others, etc.). The role-playing game combines necessary conditions for the development of voluntary behavior—increasing motivation and awareness of one's behavior. Elkonin noted that the rule is incorporated into the role during the game and the child monitors and regulates his behavior to comply with this rule (Elkonin, 2006). Thus, the participation in a game situation is a springboard for the development of voluntary behavior. At the same time, communication allows the child to gain experience with speech signs' usage. According to Vygotsky, the use of speech signs is the most important means of mediation (Vygotsky, 1983). Thus, children who interact with gadgets very often have less experience in live communication and participation in role-playing games, which increases the risk of incomplete voluntary behavior development. The opposite is also true: children who communicate more often and take part more often in role-playing games develop the ability to voluntarily switch to the mental plane more effectively. There is a dual affective plan in a role-playing game: the child experiences the pleasure of restraining direct impulses, subordinating his behavior to the meaning of what is happening in the game situation and to the role taken (Vygotsky, 1966). The restraining of impulses is inhibitory control.

In our view, there are three compelling explanations for our findings. First, the negative result (insignificance of differences between groups and therefore, the insignificance of the "type of DD usage" factor in most regression models) may have resulted from a lack of statistical power—type II error. The power analysis comparing the "means" group and the "entertainment" group showed a maximum power of 68% in all 16 comparisons, which supports the aforementioned assumption. It is not enough to completely reject the hypothesis that there are differences between the children who displayed different types of DD usage (Cohen, 1962). The sample size of the "means" group was not large enough to show a significant effect according to the results of power analysis. The size of the "entertainment" group was satisfactory. The point is that it is difficult to recruit a considerable number of children who use gadgets mainly as a psychological means to regulate their own or someone's else behavior but not mainly for entertainment. A more typical pattern of activity for children of this age is entertainment. Second, in addition to the insufficient sample size, a negative result may arise from the interview design. Factors such as "type" and "frequency" of DD usage were obtained according to the parent's reports (for the children of 5–6 years of age) and according to the child's reports (for the 6–7, 7–8, and 9–10-year-olds). Thus, a discrepancy may exist between the reported and the actual DD usage. The subjective assessment of screen time and type of digital activity can often differ from the actual digital activity of children (Gentile et al., 2012; Nikitina and Rytova, 2019). Third, we cautiously assumed that it is better to use the type-predictor for older ages than for the younger ages corresponding to kindergarten and early primary school. This predictor is not so predictive for studying the characteristics of young children's development. That is because DD usage for anything other than entertainment generally does not apply to the lives and interests of young children (according to the results, up to 60% of the kindergarten children use DD for entertainment). Play activity is the leading type of activity at this age (Elkonin, 1999). This is confirmed by the lower number of children using the DD as a means in kindergarten in our study (up to 10%). However, we assumed that the type-predictor will be significant for older ages at the end of primary school and beyond. In our study, this factor turned out to be significant only in the oldest group of 9–10-year-olds (closer to the end of primary school). The representative number of children using DD as a means should already be large enough by this age, due to a fundamental change in the children's activities from playing to learning and to the constantly increasing need for self-regulation of daily routine in order to become less dependent on parents (Sarsekeyeva et al., 2016). Indeed, this study demonstrated that, the number of children using DD as a means significantly increases

with age (7.4% for the 5–6-year-old children and 38% for the 9–10-year-old children). We assume that children older than 9–10 years of age use DD as a means more often than those who are younger, and therefore, the type-predictor will be more appropriate for this age group. For example, when it comes to preschoolers, playing with social roles or digital games organized in the format of an online game with social roles should be organized in the preschooler's leisure time (Solovieva and Quintanar, 2021). Playing with social roles is important for preschool development since this is the leading activity at this age (Elkonin, 1999). Therefore, it is important not only to assess the fact of using digital devices but also to control the features of normative child development. The present study considered the children's intellectual development (Raven test) and the parental educational level. However, it may be worth monitoring other aspects that determine the normative development of a child of this age period as far as possible.

The trend toward the statistical significance of differences between mean values for some EF skills was displayed. Thus, the children using DD as a means showed higher EF skills. Despite the lack of significance in the analyzed cases, the presence of the aforementioned trend might prove the application of the cultural–historical perspective to the research on child development in the digital era when DDs have become an important psychological means for self-regulation. Hence, it is crucial to determine the age interval as to when the type-predictor might be most applicable. This proves the actuality of the results of our study. It must be considered that the contemporary digital era is quite different from pre-digital times when the cultural–historical perspective evolved. First, DD usage as a psychological means entails a partial transition to a new type of externalization. In particular, the actions, which used to be completely internalized before, have partially moved to the DDs' area of responsibility (Falikman, 2021). Second, digital devices supplant playing with social roles more and more, while their developmental potential is still considered crucial for the preschool age in terms of the cultural–historical perspective of the pre-digital era (Smirnova and Sokolova, 2013; Hakkarainen and Bredikyte, 2020; Zulkifli et al., 2021; Yudina, 2022). Considering all the aforementioned factors, we suggest that the application of the cultural–historical perspective elaborated during the pre-digital era requires to be revised in contemporary digital times.

5. Limitations

The current study is based on data from children's and parent's reports on digital device usage, which could result in inaccuracy in the assessment of children's digital activity. Furthermore, a longitudinal design is required to draw reliable conclusions about the relationship between voluntariness and digital device usage. Despite these limitations, the results suggest some theoretical and practical implications.

6. Conclusion

In the current study, the type of DD usage as a psychological means or as entertainment was suggested to be considered as a factor for studying the impact of digital devices on child voluntariness. The voluntary behavior was evaluated using the level of executive functioning development. The hypothesis under study was that DD usage as a psychological means is associated with higher executive functioning scores acquired by children from kindergarten (5–6 years old) to mid-primary school (9–10 years old) age. "The type of digital devices usage" (as a psychological means or for entertainment) and "the frequency of digital devices usage" predictors were tested. The "frequency of digital device usage" predictor proved its statistical significance for verbal working memory, inhibition, and cognitive flexibility at 7–8 years, and for verbal working memory at 6–7 years. The higher the frequency, the lower the score for these executive functions. The type-predictor proved to be significant only for inhibition at 9–10 years. Children with DD usage as a means show an inhibition score higher than those who use DD as entertainment. However, type-predictor revealed no significance for other executive functions. We explained this result as follows: it is not productive to attribute the DD activity of a child of 5–10 years of age to one of the two categories—as a psychological means or for entertainment—because of the very small percentage of children who use gadgets as a means at this age. The number of children using DDs as a means increases significantly by the end of primary school. This is a consequence of the leading type of child activity changing from playing to learning, as well as to the increasing need of the child to engage in voluntary behavior without parental control. The type-predictor is thought to be more applicable in the studies of the voluntariness–DD exposure relationship involving children in the final grade of primary school and older. We hope that the current study will stimulate further investigation in this important research area.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Ethics Committee of the Faculty of Psychology at Lomonosov Moscow State University (approval no: 2018/54). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

AS conceived, conceptualized, designed the study, gathered, and analyzed the data. MG acquired resources. AS, EC, and MG drafted the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY
Yulia Solovieva,
Meritorious Autonomous University of Puebla, Mexico

REVIEWED BY
Yolanda Rosas Rivera,
National Pedagogic University, Mexico
Daniel Rosas,
Faculty of Higher Studies Zaragoza, National Autonomous University of Mexico, Mexico

*CORRESPONDENCE
SoJung Seo
✉ seosojun@khu.ac.kr

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Toddler–teacher interaction and teachers' sensitivity as predictors of toddler's development during COVID-19: Stability or change over time

SoJung Seo* and JiYeon Song

Department of Child & Family Studies, Kyung Hee University, Seoul, Korea

This study examined the stability and change patterns among toddlers' interactions with their teachers, teachers' sensitivity, and toddlers' development during the COVID-19 pandemic and the three plausible paths were tested to identify which of the study variables affected the development of toddlers in subsequent periods over time. The subjects of this study were 63 toddlers and 6 head teachers who attended a subsidized child care center, located in Kyunggi province, Korea. In order to carry out the research objectives, a non-experimental survey research design was undertaken, and the qualitative data was obtained via on-site observations by trained researchers. With regard to continuity and change patterns among the study variables toddlers who had been actively involved in initiating their verbal interactions with teachers showed more verbal interactions with their teachers even after 4 months passed. Also, it was found that the early (T1) social disposition of toddlers and the behavioral interaction that toddlers had initiated with teachers revealed a significant effect, supporting each of the three models, which are simultaneous, cumulative, and complex paths. The main results of this research support the contention that the interaction patterns vary by contexts of subject, time, and history, indicating that it would be useful to understand new competencies required for teachers within the context of the multi-faceted ramifications of the pandemic on toddler development.

KEYWORDS

toddler–teacher interaction, toddlers' development, COVID-19, teacher's sensitivity, early childhood education

Introduction

As of November 2022, the number of COVID-19 infections globally exceeded 6.1 billion (World Health Organization, 2022) and Korea is no exception, showing that over 24 million cases have been reported in South Korea to date (Korea Disease Control and Prevention Agency, 2022). As this worldwide crisis turned into a prolonged pandemic, people responded properly with various social distancing guidelines, such as wearing a mask and following recommendations for home-based work over the past 3 years.

However, it has been expected that the extended crisis of COVID-19 would have several direct or indirect impacts on a multi-faceted society in general, and specifically in the arena of Early Childhood Education and Care (ECEC). The concern centers on the potential challenges

and limitations that young children face and deal with in their daily routine, implying that young children who are in the blind spot of care are the most vulnerable to psychological and behavioral development than any other life cycle due to the unprecedented changes associated with COVID-19 (Bhutta et al., 2017; Benner and Mistry, 2020; United Nations, 2020; Green et al., 2021).

In line with the challenges and changes associated with ECEC and addressed herein, most ECEC facilities were closed temporarily and emergency care was only implemented for young children and their families in need based upon social distancing guidelines mandated from the Korean government when the COVID-19 situation worsened. As a result, the rate of enrollment in ECEC facilities after the outbreak of COVID-19 dramatically declined from 88.5 to 44.5%, as compared to that of previous year of 2020 in Korea (Korean Ministry of Health and Welfare, 2021). Also, outdoor and large group activities were limited and the opportunities to interact with teachers or peers decreased during this pandemic period of COVID-19. Thus, the contention that these immediate and robust changes that young children faced in their daily routine may have hindered them in developing social relationships with significant others (teachers and peers) has become highlighted and convincing enough to trigger not only the need for a new ECEC system but also a consideration of the appropriate role of teachers in the post-COVID-19 period (NAEYC, 2020).

The impact of COVID-19 on toddlers from a life-span perspective

To date, there has been a near void in the related research on the direct or indirect impacts of COVID-19 on young children, though some empirical studies have been burgeoning to explore potential links between the robust changes related to the social distancing measures of COVID-19 and early development among young children in ECEC settings. One of the research endeavors that need to be addressed is rooted in the notion of the life-span perspective which is a theoretical approach to grasp the multiple influences of the daily ecological context as well as the larger societal and broader socio-historical context. Delineated from Elder's life course theory (Elder, 1998), it focuses on the simultaneous or potential multi-faceted impact of socio-historical events (e.g., COVID-19) through the lives of individuals depending on their current developmental stage. From this point of view, it is advisable to employ this life-span perspective to fully understand the impact of ECEC settings on young children in their daily routine during COVID-19 as a significant socio-historical event.

In line with the life-span perspective, the scant existing research has shown contradictory findings about the impact of COVID-19 on young children. On the one hand, the restrictive social distancing guidelines with no outdoor activities exacerbated the use of digital media by young children by allowing them to spend much more time with it (Jiao et al., 2020). In support of Jiao et al.'s (2020) findings, Gupta and Jawanda (2020) also found that decreased physical activity has negatively affected various developmental areas, such as lowered immunity, reduced change to experience socialization, and increased aggressive behaviors in young children. Furthermore, it is important to address the research evidence that toddlers wearing a mask initiated interactions less frequently with peers than when not wearing a mask (Green et al., 2021). From neurobehavioral and social aspects, they were more likely to interrupt psychological stability (United Nations, 2020).

On the other hand, a few studies revealed the positive effects of COVID-19 on young children who have been cared for by non-maternal caregivers or teachers in ECEC settings during the pandemic period. Bredeveien (2020) found that dense individual interactions with a young child-teacher ratio per class, which dramatically decreased due to the drop in the ECEC facility enrollment rate during the pandemic, improved the quality of center-based childcare settings. As Handal (2020) asserted, the immediate and robust changes due to the COVID-19 resulted in a turning point of the structural characteristics of the ECEC field, enhancing the ECEC quality to some extent.

In the same vein, recent research by Seo and Song (2021) found similar patterns in young children's initiation to interact with their teachers as an active social agent, as compared with those observed before the COVID-19 outbreak (Song and Seo, 2021). From a developmental perspective, there were no negative effects of COVID-19 on the levels of developmental outcomes of gross and fine motor development as well communication ability of infants (aged 12 months old), as compared with those test results before the COVID-19 pandemic (Imboden et al., 2021). This finding, in particular, needs to be examined more deeply for possible diverse paths that may mitigate or accelerate the negative impacts of the pandemic along the early developmental trajectory of young children (Benner and Mistry, 2020).

Toddlers' outcomes as related to historical events in developmental trajectories

As Bhutta et al. (2017) asserted, young children are most vulnerable to multiple stressors (e.g., COVID-19), and young children's development could have been substantially affected within the nested contexts of the pandemic. The claim by Bhutta et al. (2017) is also supported by the findings from a previous study by Sprang and Silman (2013) who addressed the plausible linked mechanism between internal and external factors surrounding young children. Specifically, behavior problems in children increased shortly after the outbreak of the global SARS epidemic, and academic achievement had noticeably declined after the Great Recession (Sprang and Silman, 2013). The effects of certain historical events, such as SARS, 9/11, or COVID-19, may be considered as a critical turning point in the developmental trajectory of a child. Furthermore, the effects of teacher–infant interactions within the ECEC contexts needs to be specifically investigated as a positive factor that buffers the developmental risk of young children with low socio-economic status (SES) characteristics (Prime et al., 2020; Imboden et al., 2021).

Coupled with the effects of historical events on child development over time, in recent decades research findings have generally agreed that early childhood is a critical time for providing a variety of developmental appropriate stimuli through continuous, quality interactions with primary caregivers (Seo et al., 2018). It is widely accepted that ECEC quality cannot exceed the quality of the teachers who provide both the education and care for young children (Seo et al., 2016). In the midst of this discussion, a great deal of attention and support from the research arena have centered on the role of

teachers' sensitivity within the context of their interactions with young children in ECEC settings.

One noteworthy finding is the longitudinal study by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) which found that infants' interactions with their teachers at the age of 24 months predicted social development at the age of 3 years (NICHD Early Child Care Research Network, 1996). Also, cognitive and language development improved later in life if toddlers experienced sensitive interactions with their teachers (Klein and Feldman, 2007), and language development was noticeably improved when the teacher provided the verbal model and emotional support tailored to toddlers' developmental needs (Cadima et al., 2010).

Teachers' interaction and sensitivity in ECEC during the pandemic

It is striking that the claim from the most recent study by Davies et al. (2021) is that teachers' sensitivity to their interactions with young children played a significant role in language development and executive function among young children (aged 8–36 months old) in ECEC settings. On the continuum of findings obtained from western studies, several Korean studies have found that teachers with higher levels of sensitivity tended to interact with their young children in more responsive, reflective, and related ways and that, in turn, positively affected young children's cognitive and language development compared to their counterparts who had interactions with teachers with lower levels of sensitivity.

However, a few studies cited earlier took an approach of focusing on the concurrent effects of teachers' interactions with their young children, and research endeavors need to explore various pathways about how teachers' interactions with young children might predict early or later development in young children. It is necessary to examine the effects of a time lapse on young children's developmental outcomes.

This study was guided by the pioneering research of Bornstein and Tamis-Lemonda (1990) who proposed three potential models of young children's development through the relationship between the mother and infant. The first model suggests the lasting ripple effect from the way in which the caregiver initially interacts with the infant, even after a time lapse. The second model assumes the concurrent view that the caregiver interaction has an immediate effect on the infant. The last model highlights both immediate and long-term effects of mothers' interactions with infants because mothers' early and later interaction patterns work in more complex and intertwined ways, affecting how infants interact with their mothers as well. Thus, taken into account the possible three models of Bornstein and Tamis-Lemonda (1990), it would be meaningful to lend empirical support to explore overarching research questions of interest in this study about early development among young children who experienced the socio-historical event of the pandemic COVID-19. Furthermore, multi-faceted circumstances associated with COVID-19 would affect the teacher-child interaction in ECEC settings.

To discuss interaction patterns between teachers and young children, this important issue will be centered on the premise that it is necessary to understand the traits of interaction within the context of the teacher-child relationship in nature. Grounded in Sameroff's transactional theory (Sameroff and Mackenzie, 2003), researchers have explored the plausible links between traits of child (e.g., child's age, temperament) and those of social contexts (e.g., caregivers, non-maternal infant care) and found an explanation of how each of the traits interplay with developmental outcomes in young children.

This notion by Sameroff's transactional theory is in line with the compelling research evidence that has been accumulated over the past decades to take into account the concepts of stability and changes over time. The concept of stability in caregiving refers to the consistency of an individual's behavior over time. Furthermore, continuity or change means the consistency of the whole group's behavioral pattern (Bornstein and Tamis-LeMonda, 1990). Intuitively, during the period of the pandemic crisis, the interaction patterns might change or persist as a function of traits related to covariates of teacher-infant interactions. Thus, this proposition needs to be empirically supported or tested from a longitudinal perspective within the Asian context of ECEC.

To date, the very few western studies that have been conducted with significant evidence have found the frequency of interaction attempts of toddlers with their teacher was 18% of the observation duration at 1 year, but it was only 6% at the age of three, showing a change in the interaction pattern with the teacher decreasing as the child's age increased [NICHD Early Child Care Research Network, 1998; HHS (US Department of Health and Human Services, National Institute of Child Health and Human Development), 2006]. For teachers of Korean studies, the frequency of their interactions with toddlers decreased over time, while the types of teachers' interactions with infants maintained stability during the observation period (Ha and Seo, 2011; Seo and Song, 2021).

Taken as a whole, a life-course perspective and transactional theory approach discussed herein are of great necessary to guide this study as it has been challenging to comprehend the dynamic interaction process and track the developmental trajectory for young children due to long-lasting concerns about the pandemic crisis. However, researchers are very limited to enter the caring field of ECEC during the COVID-19 pandemic to conduct qualitative research, such as in-depth observations in nature. Thus, it is important to examine the factors influencing teacher-toddler interactions over time in the midst of social controversy about how the quality of teacher-child interaction improves living in a contact-free society as a "new normal." This may be inferred as seeing a new paradigm in the related research during the socio-historical period of COVID-19.

Purposes of the study

To fill gaps in the related research discussed so far, the primary research purpose was to examine the potential factors that could enhance the development of toddlers by observing the dynamic interaction patterns between teachers and toddlers during free play time at the center-based ECEC settings in Korea. Furthermore, it focused on how the levels of teachers' sensitivity affected those patterns of interactions over time. Inspired and guided by the previous study by Bornstein and Tamis-LeMonda (1990), both concurrent and cumulative effects of teachers' early interaction with toddlers were investigated in terms of stability and change across two time points (Time 1 vs. Time 2, with a four-month interval) in the unique context of COVID-19. This approach will help researchers or practitioners comprehend the new competencies required for young children to reach their fullest potentials living in different daily routines.

Research hypotheses

To meet the primary purposes of this study, three research hypotheses were developed and tested:

> *H1:* Toddlers' initial experiences (Time 1), including interaction with a teacher and teacher's sensitivity, could predict the later development (Time 2) and have a long-lasting effect.

Based on the findings that a toddler and teacher's initial interaction acts as a positive factor that buffers the later developmental risk of toddlers with low SES characteristics (Prime et al., 2020), it is plausible to expect a consistent effect over time on toddler development.

> *H2*: Toddlers' initial experiences (Time 1), including interaction with a teacher and teacher's sensitivity, could have an immediate effect one toddles' development simultaneously.

Given that toddlers wear a mask all day in early child education and care settings and interact with peers or teachers through their eyes with their mouths being covered, it would be difficult to comprehend other intentions and induce the stability or change patterns of toddler's development immediately. Therefore, we expected the main variables' concurrent impacts on the toddler's development.

> *H3:* Toddlers' initial (Time 1) and later experience (Time 2), including interaction with a teacher and teacher's sensitivity at each time, could affect the toddler's development cumulatively.

According to life-span theory (Benner and Mistry, 2020), socio-historical events such as the COVID-19 pandemic could drive a toddler's development depending on life span not only during the same period but also over time in the complex interaction context. Therefore, H3 assumes that a toddler's development would be affected by related variables at both the initial (Time 1) and later time period (Time 2).

Methods

Research design

In order to carry out the research objectives, a non-experimental survey research design was undertaken. Also, the qualitative data was obtained *via* on-site observations by trained researchers. To some extent, this study was semi-longitudinal in nature in that it was designed to examine the impact of socio-historical event of COVID-19 on the interactions between toddlers and teachers over time.

Participants

The study participants were 63 toddlers aged 2–3 years old and their six teachers in a childcare setting located in Gyeong-gi Province in South Korea. To examine the variables that affected toddlers' development during the COVID-19 pandemic, this study's aims and procedures were explained on paper to the mothers, who then signed an informed consent form. At Time 1, the 63 toddlers (37 boys, 26 girls) and their six teachers were observed in their class. The toddlers' mean age was 40.5 months ($SD = 8.46$). A total of 66.6% of the toddlers were two-years-old ($n = 42$), whereas 33.4% of the toddlers were three-years-old ($n = 21$), respectively. The toddlers' mean level activity of temperament was 3.94 ($SD = 0.55$), emotionality was 2.76 ($SD = 0.70$), and sociability was 3.57 ($SD = 0.46$). The toddlers' physical development score was 27.22 ($SD = 2.20$), language/cognitive score was 36.78 ($SD = 3.90$), and sociality score was 33.24 ($SD = 2.97$). Two of the teachers had 2–3 years of college education or less (33.3%), and four of them had a four-year university education or an advanced degree (66.7%). Fifty percent of teachers ($n = 3$) had less than 10 years of teaching experience and 50% of teachers ($n = 3$) had more than 10 years.

After 4 months, 35 toddlers and 4 teachers participated in a dyadic interaction in the same childcare center at Time 2; 28 toddlers were not included because of home-based rearing or difficulty in completing all observation sessions due to the rapid spread of COVID-19. The specific descriptive information on toddler and teacher characteristics is presented in Table 1.

Measures

Toddler development. Mothers measured the toddler's development at home using the K-CDI (Korea version of the Child Development Inventory), which was based on the M-CDI (Minnesota Child Development Inventory: Ireton and Thwing, 1972) and standardized by Kim and Shin (2006) with Korean children. The K-CDI consists of eight dimensions and a total of 270 ~ 300 items: sociability, self-care behavior, gross motor, fine motor, expressive vocabulary, comprehensive vocabulary, letters, numbers. Each item regarding what toddlers could or could not do was rated with three points, with 1 = yes, 2 = no, and 3 = no response. For the present study, these subscales of K-CDI were classified into three dimensions: sociability, physical ability, and language/cognitive ability.

Toddler–teacher interaction

To observe the interaction of toddlers with their teachers in a childcare center, the Observational Record of the Caregiving Environment (ORCE) of NICHD Early Child Care Research Network (1996) was used, which had been employed in the study of Seo and Song (2021). The ORCE consists of four motivations (shown in Table 2): physical or physiological, emotional, conflict mediation, and play participation. Two types of toddlers' interaction behavior were rated: (1) verbal (voice initiation, naming, response, question, request, and in or out of contextual conversation); and (2) behavioral interaction (attention, behavior, imitation, acting on demand, pointing to, nodding, body contact, and laughing/smiles).

Teachers' sensitivity

The level of teachers' sensitivity was collected through the same observation tool of the ORCE scale (NICHD Early Child Care Research Network, 1996) which including interactions that teachers initiated to toddlers. We conceptualized interactions that a teacher initiated to toddlers as an aspect of a larger construct of teachers' sensitivity. The sensitivity of a teacher was organized in four dimensions (shown in Table 3): (a) verbal sensitivity that instructs or provides questions and requests; (b) emotional sensitivity that responds positively, such as expressing emotional/affectionate expressions and praising the toddler's behavior; (c) developmental stimulus that leads to the upper outcome for cognitive, language, and

TABLE 1 Descriptive statistics for study subjects.

Variable			*N*	%	*M* (SD)
Toddlers (*n* = 63)	Gender	Male	37	58.7	
		Female	26	41.3	
	Age				40.50 months (8.46)
		2-year-old (28 ~ 38 months)	42	66.6	
		3-year-old (39 ~ 51 months)	21	33.4	
	Temperament	Activity			3.94(0.55)
		Emotionality			2.76(0.70)
		Sociability			3.57(0.46)
	Development	Physical			27.22(2.20)
		Language/ Cognitive			36.78(3.90)
		Sociality			33.24(2.97)
		Total			39.48(3.35)
Teachers (*n* = 6)	Education	2–3 years college	2	33.3	
		4-year Univ.	4	66.7	
	Teaching Experience				9.9 months (102.04)
		Less than 10 years	3	50.0	
		More than 10 years	3	50.0	

social development of toddlers; and (d) behavior control that includes restricting toddlers' behaviors and the physical environment.

For the present study, the following data were used in the analyses, except for the teachers' sensitivity of behavior control and positive response due to the low frequency and negative meaning. Data were collected by trained three observers, who during training had reached agreement at around 85%.

Procedure

The main variables of this study were assessed through Time 1 and Time 2, respectively. Prior to the main survey at Time 1, a preliminary survey was conducted to explore timely research methods for COVID-19. Regarding the suitability and understanding of the measurement tool, the content validity was verified by one professor of child studies and three experts with childcare experience who are currently in the doctoral program of the graduate school. Also, observers were composed of three graduate doctoral students who received reliability training for six toddlers from 28 to 51 months and two teachers in the childcare center. It was conducted three times until the inter-observer reliability was 85% or higher.

In the first study, S childcare center in Gyeong-gi Province of South Korea was selected as a research institute. The first study was conducted from November 2020 to January 2021 and consent forms for research participation were sent to the mothers, who completed the toddlers' development and temperament questionnaire. There were 63 toddlers and six teachers who participated to explore the overall characteristics of the toddler's trial interaction and the teacher's sensitivity to the toddler's needs and the development in the free play time situation. Three trained observers observed and recorded the toddlers' interactive behaviors and teachers' sensitivities.

However, due to the reoccurring COVID-19 crisis, the observation method was modified to use non-face-to-face observation using a body cam as well as face-to-face observation. Toddler–teacher interaction and teachers' sensitivity were recorded and analyzed for a total of 160 min in four sessions of 40 min per toddler during morning/afternoon playtime for 63 children aged 28–51 months and six homeroom teachers.

Toddlers' interactions with teachers were assessed at 40 min per toddler for a total of four times through the free-play time, excluding morning or afternoon lunch, snacks, and outdoor and large group activities. The entire data collection through observation was conducted both through a non–face -to-face method using a body camera and face-to-face by considering social distancing and safety guidelines. All observations were made by three graduate students who had been trained regularly on the measure until achieving at least 85% reliability.

The second study was conducted 4 months after the end of the first study (May to July 2021). Of the 63 toddlers in the primary study, the final 35 toddlers were selected for the secondary study, excluding 28 infants who did not complete the fourth observation period due to family childcare or personal circumstances. The observation method, observation items, and mother-reported questionnaire items were the same as those of the primary study. Moreover, the influence of the major variables predicting toddlers' development at Time 2 was assessed by examining the stability and change trends of the interaction and teacher sensitivity in the previous period (Time 1) and the post-time period (Time 2).

Analysis approach

Our primary aims were, first, to describe the study variables (toddler's development, interaction with teacher, teachers' sensitivity) and differences according to the characteristics of toddlers (gender, age, and temperament) through a *Mann–Whitney U* or *F* test. In addition, we examined those patterns of change by a *Wilcoxon signed rank test* and stability by a *Spearman rank correlation* across the two time periods (Time 1 and Time 2) for each quality measure. Finally, *stepwise regression* with two-way interaction between toddlers' interaction and teachers' sensitivity was performed to identify the potential effect of the study variables on the toddlers' development over time.

Results

Preliminary findings

Descriptive information on toddler's development, interaction with a teacher, and teacher's sensitivity is presented in Table 4. As a result of examining the overall interaction motives that toddlers initiated to the teacher, the physical/physiological and play

TABLE 2 The definition of toddler–teacher interaction.

		Subscales	Content
Motivation		Physical/physiological	Interaction attempted by the teacher in response to the toddler's instinctive needs
		Emotional	Interaction that toddlers attempt to feel psychological stability from the teacher
		Conflict mediation	Interaction attempted to elicit teacher intervention when toddlers have peer conflicts
		Play participation	Interaction that toddlers try to interact with the teacher for play
Type	Verbal	Voice initiation	Imitate the teacher's utterance
		Naming	Refer to objects or places such as toys and books
		Response	Respond verbally to the teacher's questions
		Question	Ask questions to the teacher to induce the teacher's verbal response
		Request	Asks the teacher for his/her needs or requirements
		In or out of contextual conversation	Talk to the teacher about own thoughts, experiences, situations or related stories
	Behavioral	Attention	Focus attention on the teacher's words for at least 5 s.
		Behavior imitation	Imitate the teacher's behavior
		Acting on demand	Act according to what the teacher asked a toddler to say.
		Pointing to	Point to objects or places such as toys or books.
		Nodding at	Nod head in a positive response to the teacher's words
		Body contact	Make physical contact with the teacher.
		Laughing/smiling	Smile as a positive response to the teacher.

TABLE 3 The definitions of sensitivity of teachers.

	Subscales	Content
Verbal	Direct	Give toddlers general routine instructions
	Ask	Ask questions about the toddler's behavior and related situations
	Request	Ask the toddler for help
Emotional	Express emotions/affections	Express of emotional or affectionate behaviors to toddlers (e.g., "pretty," "I love you," petting, hugging)
	Response to the toddler's behavior (positive or negative)	Express negative verbal expression of toddler's behavior (e.g., threatening, reacting hostilely, scolding, criticizing, yelling) or positively (speaking affectionately, praising)
Developmental stimulus	Provide developmental stimulation	Support the toddler's developmental stimuli (cognitive, linguistic, social) by providing instructions, questions, requests and elaborate explanations
Behavioral control	Restrict toddler's behavior	Restrict behavior by physically separating or moving the toddler (i.e., physical separation, time-out)
	Restrict physical environment	Limit the physical environment around the toddler (i.e., removing toys, no access)
	Show negative/physical behaviors	Negative physical behavior toward the toddler

participation motive appeared most frequently while emotional and conflict mediation were observed with low frequency. Therefore, this study preceded with a focus on the two interaction motives (participation in play and physical/physiological motive).

As a result, no differences were found in the main variables across the toddlers' gender. Three-year-old toddlers showed higher language/cognitive development ($z = -2.69$, $p < 0.05$) and overall development ($z = -2.22$, $p < 0.05$) than two-year-old toddlers. Otherwise, two-year-old toddlers tried to interact more actively with their teachers verbally ($z = -3.51$, $p < 0.001$) and behaviorally ($z = -2.18$, $p<.05$) than three-year-old toddlers. Also, teachers interacted more verbally ($z = -2.60$, $p < 0.01$) and provided developmental stimulation ($z = -2.02$, $p < 0.05$) with the two-year-old toddlers. Toddlers who had higher sociability of temperament had upper socio-emotional development than toddlers with high emotionality ($F = 5.99$, $p < 0.01$). Finally, toddlers with high activity temperament had more frequent communication by physical and physiological demands than toddlers with emotionality and sociability temperament ($F = 3.32$, $p < 0.05$) and induced higher sensitivity of teachers of providing developmental stimulation to them ($F = 8.16$, $p < 0.05$).

Stability and Changes Time 1 to Time 2.

In order to examine the stability and change over time, descriptive statistics for toddlers' interaction and teachers' sensitivity were

TABLE 4 Descriptive characteristics and tests of differences for study variables.

		Gender			Age			Temperament			
		Boy (n =37)	Girl (n =26)	t or z	2-year-olds (n =42)	3-year-olds (n =21)	t or z	Activity (n=14)	Emotionality (n=14)	Sociability (n=35)	F
		M(SD)			*M(SD)*			*M(SD)*			
Toddlers' development	Physical	59.50(8.11)	60.13(6.49)		57.00(6.84)	61.62(7.26)	−0.19	56.57(3.77)	57.90(5.22)	61.15(8.29)	1.25
	Sicio-emotional	65.95(12.99)	64.33(17.91)	0.31	66.64(14.66)	64.33(15.26)	0.44	64.14(14.11)	47.00(23.15)	69.57(10.18)	5.99**
	Language/ Cognitive	56.66(8.26)	57.75(8.04)	−0.39	53.00(5.63)	59.88(8.37)	−2.69*	52.68(7.88)	59.75(7.06)	57.91(8.12)	0.24
	Total	53.68(11.91)	52.76(11.60)	−0.37	48.94(10.66)	57.00(11.36)	−2.22*	50.43(8.92)	55.83(13.18)	53.08(12.25)	0.34
Toddler–teacher interaction	Motive										
	Physical/ Physiological	1.66(0.92)	1.16(0.77)	−1.72	3.00(3.61)	0.37(0.63)	−0.37	3.50(4.57)	1.55(3.19)	0.76(1.14)	3.32*
	Play participation	12.38(9.91)	11.73(11.63)	−0.43	16.45(11.44)	6.11(2.92)	−2.25*	17.00(11.88)	11.20(9.42)	7.98(7.15)	3.04
	Type										
	Verbal	2.14(1.75)	4.07(4.27)	−0.68	4.91(3.61)	1.55(1.84)	−3.51***	4.39(4.81)	5.35(4.25)	1.92(1.53)	3.13
	Behavioral	3.95(2.42)	5.42(3.39)	−1.20	5.86(3.03)	3.73(2.58)	−2.18*	4.71(3.19)	5.80(3.13)	4.27(2.86)	1.52
Teachers' sensitivity	Verbal	5.93(4.69)	5.43(6.01)	−0.63	9.93(5.96)	2.86(3.22)	−2.60**	8.36(5.00)	7.90(7.98)	4.39(5.10)	3.92
	Emotional	2.55(2.98)	1.40(1.92)	−1.31	2.32(2.21)	1.24(1.72)	−0.79	2.00(1.55)	2.20(2.71)	1.46(1.97)	1.28
	Development stimulation	3.68(3.31)	2.50(2.71)	−1.01	5.89(5.34)	1.17(1.42)	−2.02*	5.79(4.29)	5.30(7.54)	1.74(2.74)	8.16*
	Total	12.15(9.08)	9.30(9.77)	−1.04	15.07(9.74)	8.17(8.17)	−0.64	14.93(7.82)	12.80(10.37)	9.30(9.49)	2.44

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. $n = 63$.

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conducted between Time 1 and Time 2. As shown in Table 5, behavioral interaction ($z = -2.07$, $p < 0.05$) by physical/physiological motivation ($z = -4.95$, $p < 0.001$) at Time 2 exhibited a statistically significant decrease when compared to Time 1. It was also found that a toddler's verbal interaction with a teacher occurred simultaneously, as observed by both stability ($r_s = 0.49$, $p < 0.05$) and change ($z = -3.27$, $p < 0.01$). With respect to teachers' sensitivity, the overall score ($z = -2.65$, $p < 0.01$) and developmental stimulus ($z = -1.98$, $p < 0.05$) indicated a decrease at Time 2.

Regression predicting toddlers' development

To conduct the regression analysis, a Spearman correlation was conducted to examine the predictive relationships between physical and language/cognitive development at Time 2 and relevant variables (toddler–teacher interaction and teachers' sensitivity), measured at each period. The physical development of the toddler at Time 2 was positively related to the age of the toddler ($r_s = 0.45$, $p < 0.01$) and sociable temperament ($r_s = 0.45$, $p < 0.01$) at Time 1. However, emotional temperament ($r_s = -0.39$, $p < 0.05$), verbal interaction of toddler with a teacher at Time 1 ($r_s = -0.38$, $p < 0.05$), the behavioral interaction of toddlers ($r_s = -0.43$, $p < 0.05$), and teachers' emotional sensitivity ($r_s = -0.40$, $p < 0.05$) were associated negatively with the toddlers' physical development at Time 2. In addition, the language/cognitive development at Time 2 had a negative relation to the motivation for play participation ($r_s = -0.34$, $p < 0.05$), verbal interaction ($r_s = -0.37$, $p < 0.05$), and teachers' verbal sensitivity ($r_s = -0.43$, $p < 0.05$) at Time 1. Indeed, there was a negative relationship with emotional ($r_s = -0.48$, $p < 0.01$) and developmental stimulation of teacher sensitivity ($r_s = -0.41$, $p < 0.05$) at the same period. These results highlighted a significant correlation between the toddlers' development and relevant factors at each time.

Therefore, in this study, three hypotheses were established according to the model based on the method established by Bornstein and Tamis-LeMonda (1990): (1) the effect of toddler–interaction and teachers' sensitivity at Time 1 on toddlers' development at Time 2 (Model 1); (2) the effect of the above related variables at the same time (Time 2) on toddler development (Model 2); and (3) the composite effect of toddler–teacher interaction and teachers' sensitivity in Time 1 and Time 2 on toddlers' development in Time 2 cumulatively (Model 3).

Only variables that have been reported as statistically related to toddler's development at T2 physical and language/cognitive development were further investigated. These were entered at each time as independent variables in the multiple regression analyses of the stepwise model selection method to examine predictors of toddlers' physical and language/cognitive development at Time 2. As indicated in Table 6, significant predictors of toddlers' physical development at T2 included the following and accounted for 28% of all variances ($F = 6.15$, $p < 0.01$): Toddlers' behavior interaction with teachers at T2 ($\beta = -0.32$, $p < 0.05$) and sociable temperament at T1 ($\beta = 0.37$, $p < 0.05$). In addition, toddlers' language/cognitive development at T2 was predicted by the following and accounted for 36% of all variables ($F = 9.10$, $p < 0.01$): the toddler's verbal interaction with a teacher ($\beta = -0.44$, $p < 0.01$) at T1, emotional sensitivity of teacher at T2 ($\beta = -2.20$, $p < 0.05$), and the two-way interaction between toddlers' interaction at T1 and teachers' emotional sensitivity at T2 ($\beta = -0.46$, $p < 0.05$). This result indicates that the emotional sensitivity of T2 teachers regulates when the verbal interaction of toddlers to the teacher affects the language/cognitive development of T2.

Based on these results, it was found that the physical development of Time 2 is explained by "Model 3" (T1 social temperament and T2 toddlers' behavioral interaction → T2 toddlers' physical development). In addition, the language/cognitive development of Time 2 was also described as "Model 3″ (T1 toddlers' verbal interaction, T2 teachers' emotional sensitivity → T2 toddlers' language/cognitive development).

Figure 1 explains the pattern of the two-way interaction by a simple slope test recommended by Aiken and West (1991). It indicates 1 *SD* above and below the sample mean for high and low toddlers' verbal interaction and teacher's emotional sensitivity. The test revealed that the association between toddlers' verbal interaction at T1 and teachers' language/cognitive development at T2 was significant for toddlers with low teachers' emotional sensitivity (simple slope: $\beta = -0.54$, $t = -2.86$, $p < 0.05$) but not for toddlers with high teachers' emotional sensitivity. These results suggest that the differences in the language/cognitive development in T2 were larger in toddlers who initiated verbal interactions with teachers at T1 according to the emotional sensitivity of the teacher at T2.

TABLE 5 Stability and changes on study variables over time.

			Stability (r_s) T1–T2	M (range)		Change (z) T1–T2
				Time 1	Time 2	
Toddler–teacher interaction	Motive	Physical/Physiological	−0.18	1.44(0–3.50)	0.23(0–1.88)	−4.95*
		Play participation	0.22	4.36(0–16.38)	4.61(0–14.50)	−0.43
	Type	Verbal	0.49**	5.27(4.74)	2.93(3.15)	−3.27**
		Behavioral	0.18	7.59(8.08)	4.58(2.92)	−2.07*
Teachers' sensitivity	Verbal		0.02	5.71(5.22)	3.69(2.92)	−1.82
	Emotional		0.05	2.06(2.61)	2.41(2.14)	−0.81
	Development stimulation		0.07	3.17(3.08)	2.06(1.54)	−1.98*
	Total		0.10	13.34(14.28)	4.38(3.69)	−2.65**

*$p < 0.05$, **$p < 0.01$. $n = 35$.

TABLE 6 Regression analysis for study variables predicting toddlers' development at T2.

		R^2	$\triangle R^2$	F	B
Time 2 Physical	(Overall model)	0.28	0.23	6.15**	
	Social temperament T1 (Model 1)				0.37*
	Toddlers' behavioral interaction with teachers T2 (Model 2)				−0.32*
Time 2 Language / Cognitive	(Overall model)	0.36	0.32	9.10**	
	Toddlers' verbal interaction with teachers T1 (Model 1)				−0.44**
	Teachers' emotional sensitivity T2 (Model 2)				−2.20*
	Toddlers' verbal interaction with teachers T1 × teachers' emotional sensitivity T2 (Model 3)				−0.46*

*$p < 0.05$, **$p < 0.01$. $n = 35$.

Discussion

The purpose of this study was to examine the potential pathways to toddlers' physical and language/cognitive development over time that toddlers might experience simultaneously or cumulatively in such a historical event including the current pandemic of COVID-19 based on the life-cycle theory.

As shown in the preliminary results, there were differences in the main variables of interest by child' age and temperament, but not by his or her gender. First and foremost, a group of three-years old toddlers showed a higher level of language or cognitive development than that of 2 years old ones, as expected. This is in support of the contention from previous studies that as a child grows older, his or her receptive and expressive vocabulary increases as well (Lee and Lee, 2016; Kim and Kim, 2019). Also, temperamentally active toddlers with physical/physiological motives were more likely to be active in order to interact with their teachers, and that could be interpreted to support the argument that infants with a high level of large and small muscle development have strong demands for voluntary behavior and actively move their body, and they tend to express the discomfort they feel by wearing a mask as a positive emotion (Moon and Yi, 2018).

A couple of notes need to be addressed to discuss a distinct pattern between the two groups by a child' age and temperament in the teacher's interaction with toddlers. First and foremost, it was observed that a tendency has emerged for teachers to interact in a different and directive way to control toddlers' behaviors for their health, hygiene and safety due to the changes in the basic routine that toddlers and teachers face after the onset of COVID-19 outbreak (An et al., 2018). Specifically, teachers were more likely to exert immediate verbal controls to the toddlers of 3 years old in order to minimize physical contacts with their peers than the 2 years old toddlers. But, for the toddlers of age of two, teachers were more likely to respond appropriately to their temperamental needs than those of the 3 years old. It could be possible to discuss that distinct finding between the two age groups in that a type of physical activities were strictly restricted in ECEC as a preventive measure of COVID-19 infection and most of play activities were static in nature, such as block-stacking and scissoring a piece of paper, thus improving fine motor skills in the toddlers of this study.

Given that researchers have consistently shed light on the physical or structural dimension related to quality of childcare, the current study confirms the argument that a high ratio of infants to teachers inhibits teachers' interactions with infants, which is not conducive to positive development in young children (Le et al., 2015; Pessanha et al., 2017). Taken as a whole, it is necessary to examine in-depth the physical elements of childcare facilities in order to improve the overall quality of child care and its impacts on child development.

In terms of the second hypothesis of the current study that toddler–teacher interaction and teacher sensitivity level could be maintained or changed over 4 months in time, the verbal interactions that toddlers had initiated with teachers showed stability even after time passed. In other words, toddlers who had been actively involved in initiating their verbal interactions with teachers during playtime showed more verbal interactions with their teachers even after 4 months passed. Delineated from Sameroff's exchange theory (Sameroff, 2009), this result is in line with the findings from previous studies that parent–child relationships have dynamic characteristics of exchanging influences over time rather than at a specific point in time. For example, the behavior of 10-month toddlers imitating their mother's voice increased over time (Markodimitraki and Kalpidou, 2021), and the level of vocabulary in 18-month toddlers predicted that of 24 months of age in toddlers later (Suttora and Salerni, 2011). Expanding this result obtained from the family context to that of daily routines in ECEC, the patterns of interaction between toddlers and teachers reflect the mechanism that shares social and emotional shared meanings and integrates dynamic elements in nature.

Meanwhile, the finding pertaining to the decreased change in physical, physiological, verbal, and behavioral interactions among toddlers after a 4 months lapse supports the research by Ha and Seo (2011) who found that positive interactions, such as asking questions to teachers or imitating teachers' behaviors from 12 to 30 months, decreased rapidly over time. In accordance teachers also showed a decrease in their levels of sensitivity that may induce developmental stimulation for toddlers at Time 2, as compared to those observed earlier at Time1. There are inconsistent findings over the teachers' sensitivity as a child grow older. On the one hand, teachers could more easily grasp toddlers' signals for communication and meet their needs by responding verbally as toddlers improve their levels of language, cognition, and physical development over time (Deynoot-Schaub and Riksen-Walraven, 2008). On the other hand, it is expected that older toddlers are more likely to interact with their peers than teachers from a perspective of peer scaffolding during free play (Shin, 2009; Pessanha et al., 2017). Thus, the interaction patterns vary by contexts of subject, time and history, it would be necessary to understand the multi-faceted impacts of the pandemic on toddler development.

In this study the third hypothesis was tested to investigate how the toddlers who have experienced a certain social and historical event of COVID-19 interact with the nested environments and that, in turn,

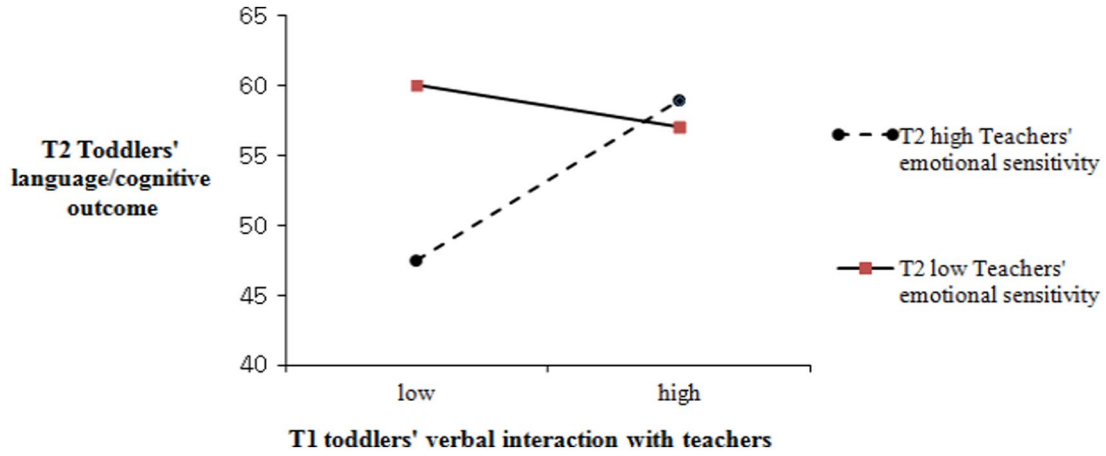

FIGURE 1
Two-way interaction for T1 toddlers' verbal interaction with teachers and T2 high teachers' emotional sensitivity predicting language/cognitive development at T2.

affects both the concurrent and predictive outcomes in toddlers. To process this, the current study employed the three developmental paths, suggested by Bornsteem and Tamis-lemonda (1990) from the perspective of Life Cycle Theory (Elder and Shanahan, 2007), which assumes that the everyday context experienced by the interaction subject can be internalized and cause a turning point in the development trajectory. The focused areas to track the development path in this study were only the physical and language/cognitive development of toddlers. As rapid brain development occurs in the early stages of life, the speed of information transfer between cells increases, and the coordination of eyes and hands and motor skills improves to acquire appropriate social skills for each development trajectory and expand interaction targets, thus it is assumed that toddler physical and language/cognitive development can be clearly observed, as compared to other areas of social and emotional development, which is a psychological factor of toddlers and is relatively more stable after a short time lapse (Benner and Mistry, 2020).

Based on the three paths presented by Bornstein and Tamis-lemonda (1990), the paths of major variables affecting the physical development of toddlers in subsequent periods (T2) over 4 months were explored. As a result, it was found that the early (T1) social disposition of toddlers and the behavioral interaction that toddlers had initiated with teachers revealed a significant effect, supporting both models 1, 2, and 3 respectively, which are simultaneous, cumulative, and complex paths, and discussed in detail as follows. On the one hand, toddlers with high social temperament characteristics in the early stages of their lives are likely to actively attempt nonverbal interactions, such as reaching out to catch interesting playgrounds or attempting collaboration with teachers (e.g., staring). This is consistent with the results of several recent previous studies (Longobardi et al., 2014; Cho, 2018) that revealed that as physical autonomy increases, more people and objects are observed and participated in physical activities. Furthermore, it can be inferred that toddlers with high social temperament had abundant opportunities to gradually improve physical development, such as sitting and walking, to try to interact with others in a way appropriate to their developmental characteristics over time and to utilize social context clues.

On the other hand, the level of physical development of toddlers was predicted to be higher for toddlers who attempted less behavioral interaction with teachers at the same time (T2). This is inconsistent with the findings of Liszkowski and Tomasello (2011), who reported that the interaction intention becomes clear in the late 1st year of age and has a positive effect on toddler development by attempting to interact in the form of nonverbal movements such as pointing to objects. However, in the late second year of the study, as toddler autonomy increases, peer participation increases more than teacher interaction, and in this process, we support the research results of Recchia and Shin (2012) and Cho (2018), which reported the characteristic of gradually transferring nonverbal movements to rich verbal expressions.

Also, it is noteworthy to address the paradigm shift in ECEC centers implemented during the pandemic period to support the results related to the negative effects of behavioral interactions in toddlers on simultaneous physical development. To prevent COVID-19 infection, as large groups and outdoor activities were entirely banned in ECEC, and static play activities in the form of small groups were recommended, toddlers frequently interacted with peers or teachers in the form of small groups in the classroom. Therefore, it can be assumed that the delicate play that requires small muscle exercise skills, such as stacking blocks, engaging in role plays, or using scissors, which are centered on small groups has also affected the physical development of toddlers.

Next, it was found that the verbal interaction of early (T1) toddlers and the sensitivity of contemporary (T2) teachers negatively affect the language/cognitive development of contemporary toddlers, respectively, which can be seen as supporting all three hypotheses assuming continuous, simultaneous, and cumulative influence. Specifically, in the case of toddlers who try less verbal interaction with teachers in the early stages of observation, the result of higher language/cognitive development after 4 months is the result of supporting Hypothesis 1, which suggests continuous influence, and can be examined in the same context as a study by Cho (2018), who revealed changes in the pattern of interaction motivation by teachers as a child's age increases. In other words, in the early stages of toddlers, toddlers try to interact with their teachers to meet needs for cognitive

and emotional motivation by asking for help to express their emotions, but the patterns for toddlers' interaction motivation to interact with teachers change in order to facilitate their levels of engagement in play with peers. Therefore, toddlers who try less verbal interaction with teachers in the early stages of observation show a higher level of language development, thus enabling them to communicate verbally with peers at their early age.

Furthermore, the low emotional sensitivity of teachers at the same time supports Hypothesis 2, which emphasizes immediate effects by predicting the language/cognitive development of toddlers at a higher level. Until now, the importance of responsive sensitivity of teachers has centered on the issue of quality of ECEC, and been universally agreed upon in the academic arena (Seo et al., 2016). Unlike previous studies, which consistently have found that the emotional sensitivity of teachers experienced by toddlers had a positive effect on acceptance, expression, self-regulation, and cognitive development at the age of two (Cadima et al., 2010; Kim and Kim, 2019; Davies et al., 2021), the current study revealed teachers in ECEC settings focused their interactions with children to provide tailored services to coordinate toddlers' words and actions, mainly on issues related to safety, healthy, and hygiene (An et al., 2018). In that process, toddlers with a high level of language/cognitive development were more able to initiate verbal interactions with their peers in order to expand the scope of social relationship formation, while toddlers with lower levels of language development experience with difficulty to express a variety of emotions in relationships with peers (Han, 2021). Therefore, in order to motivate toddlers to participate in play with their peers, teachers ought to be required to create a positive atmosphere where teachers could react sensitively to toddlers in needs or express affection at individual levels.

In a support of the Model 3, the linguistic interactions initiated by toddlers with teachers in T1 and the emotional sensitivity of teachers in T2 showed interaction effects, predicting the language/cognitive development of toddlers at the same time (T2). Given that the emotional sensitivity of teachers at T2 would play a moderating role in the relation between the linguistic interactions of toddlers at T1 and the language/cognitive development at Time 2, the claim for interpreting this fining needs to be provided with caution in that teachers did not react sensitively to or tune-in to the emotional needs of toddlers in the process of attempting verbal interactions with toddlers under the COVID-19 circumstances. Interestingly, if the emotional sensitivity of the teacher at Time 2 and the frequency of verbal interaction attempted by toddlers at Time 1 are low, then it will have the most positive effect on the language/cognitive development of the toddler at Time 2. Under the COVID-19 circumstances, toddlers and teachers ought to wear their masks all day long, and it was limited to interact verbally with toddlers, teachers found an option or alternative to catch non-verbal clues including gestures, facial expressions, and body signs from toddlers in order to meet the needs of toddlers in more adaptive ways.

As expected, for the toddlers who had frequent interactions with teachers (both verbally and non-verbally) in the early period (T1), their levels of language or cognitive development were found to be high at the later period (T2), regardless of the levels of teachers' emotional sensitivity at the same time (T2). In the social context where toddlers belong to, they experience a variety of communication opportunities by imitating the teacher's verbal expression (Jung and Kim, 2015). Also, it is in line with the research by Kirk et al. (2013) who found that the close interactions initiated by toddlers with teachers at the very early age, which were coordinated or tuned-in by sensitive teachers to meet the needs of toddlers had a positive effect on their vocabulary development at a later period. Thus, this study supports the premise from the transaction theory and during the COVID-19 period in general, and the teachers' sensitivity not only to the diverse needs of young children, but also to mandatory regulations in the historical and social contexts.

In sum, the above discussion suggests that sensitive interactions with teachers experienced early in life can have a major impact on the development of post-toddler periods (Blewitt et al., 2020), and that teachers' emotional support appropriate for individual toddlers' development levels and characteristics can serve as a driving force for toddler development. Therefore, the socio-historical change of COVID-19 suggests that in order to provide developmental support to toddlers as a required competency for teachers in the childcare field, they should recognize the importance of early and cumulative experiences and respond sensitively for toddlers to grow as active communicators according to the development trajectory.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

SJS was contributed as both the primary investigator and corresponding author for this research. JYS was contributed as co-investigator to assist collecting and analyzing the data for this research. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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EDITED BY
Yulia Solovieva,
Meritorious Autonomous University of Puebla, Mexico

REVIEWED BY
Margarita Gavrilova,
Lomonosov Moscow State University, Russia
Gustavo Cunha de Araujo,
Federal University of North Tocantins (UFNT), Brazil

*CORRESPONDENCE
Tiia Tulviste
✉ tiia.tulviste@ut.ee

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Longitudinal links between maternal directives, children's engagement in family conversations, and child linguistic skills

Tiia Tulviste * and Anni Tamm

Department of Psychology, University of Tartu, Tartu, Estonia

Background: Research on mother–child verbal interaction is largely inspired by Vygotsky. The results align with his view that children acquire language and culture-specific ways of using language through actively participating in daily conversations with adults. Supporting Vygotsky's concept of the Zone of Proximal Development, the facilitative features of such conversations have been found to depend on age, the level of the child's language skills, and the interactional context. Most previous studies in the field have been conducted in English-speaking Western families with a focus on the first years of children's lives. As Estonian middle-class mothers have been found to put greater emphasis on controlling children than mothers from other cultural contexts, we included the frequency of using directives as one of the features of mothers' speech that might have an impact on child language development.

Aim: Accordingly, the current study explored the relative impact of various aspects of mother–child interaction (e.g., mothers' vocabulary diversity, use of attentional and behavioral directives, wh-questions, and the amount of children's talk) on children's language skills using data collected from Estonian middle-class families at two timepoints, 1 year apart. As a novel approach to this topic, the study also examined the correlation between mothers' input features and children's participation in the parent–child conversation.

Method: A total of 87 children aged 3;0 and 4;0 and their mothers participated in the study. We observed the mother–child interactions during a semistructured videotaped game played at home. Mothers reported their children's language skills *via* the ECDI-III. Children's language comprehension and production were measured using the examiner-administered NRDLS.

Results and conclusion: Although the results showed somewhat differential effects of various aspects of mothers' speech on different measures of child language skills at two timepoints, the diversity of mothers' speech was positively, and mothers' frequent use of directives negatively related to children's language skills. At both ages, the diversity of mothers' speech predicted the amount of children's verbal contribution to conversations. The findings will be discussed in light of Vygotskian and his followers' theoretical views and theories about child language development.

KEYWORDS

talk input, CDI-III, language comprehension, language production, directives, vocabulary diversity, children's contribution

1. Introduction

The current study assessed various features of mothers' input during mother–child play interaction to determine which aspects of input have the greatest impact on children's verbal participation in these conversations, both in the present and over time, as well as on their language skills at ages 3;0 and 4;0. Much research on child language acquisition and development has been inspired by, and the results are in line with, Vygotsky's (1978) views that children acquire language and culture-specific ways of its use through active participation in early daily conversations with adults.

1.1. Facilitative features of parent speech

Although some variability in child language development is rooted in heritability (Stromswold, 2001), communicative exchanges with adults are important for children to acquire language. Since the book by Snow and Ferguson (1977) speech directed to language-learning children has received much scholarly attention. Studies have specified which kind of parent–child conversation plays a vital role in promoting child language skills. Much emphasis is placed on the quantity of adult speech (often measured as word tokens) directed at the language-learning child (Hart and Risley, 1995; Huttenlocher et al., 2010; Zauche et al., 2017), as well as on the quality of the language input, often measured as vocabulary diversity and sophistication (Huttenlocher et al., 2010; Rowe, 2012; Rowe and Snow, 2020). As Vygotsky (1978) proposed, children acquire the linguistic forms their parents use in daily conversations (Huttenlocher et al., 2010). Children who experience less verbal interaction face an increased risk of developing poorer language skills. Over the last few decades, studies have provided strong evidence that interactivity—engaging children in back-and-forth conversations—is the key feature that supports child language learning rather than being exposed to language (Romeo et al., 2018).

Supporting Vygotsky's (1978) concept of the Zone of Proximal Development (ZPD), the facilitative features of adult input have been found to depend on children's age and level of language skills (Rowe and Snow, 2020; Anderson et al., 2021). The language level of the child rather than the child's age also determines how much parental speech is directed to children (Dailey and Bergelson, 2022). Moreover, research has revealed somewhat differential effects of various aspects of parental speech at different child ages. The amount of adult language input during the second year of life, the use of diverse and sophisticated vocabulary during the third year of life, and the use of decontextualized language such as narratives and explanations during the fourth year of life have been posited to play an important role in children's future language skills (Huttenlocher et al., 2010; Rowe, 2012).

Additionally, wh-questions (e.g., who, what, when, where, and why questions) are found to be a useful type of input for fostering toddlers' language learning (Rowe et al., 2017). Unlike other types of questions (e.g., yes-no questions), wh-questions allow children to provide more than one possible answer and elicit more verbal participation in conversations. Wh-questions are also linguistically and cognitively more challenging, as they elicit more syntactically complex responses (Rowe et al., 2017).

1.2. Mixed effects of directives

Not all features of parental talk that may relate to children's language development have been assessed in previous studies. For example, the effect of parental use of directives on children's early language learning is a less examined aspect of parent talk compared to features such as the number of word tokens, word types, and asking wh-questions. At the same time, parents differ in their communicative intent to control or converse with their children (McDonald and Pien, 1982; Hoff-Ginsberg, 1991; Tulviste, 2019a). Conversation-eliciting utterances are positively related to children's language development, whereas developmental associations between different types of verbal control and language skills are not well known (Pine, 1992; Flynn and Masur, 2007; Rantalainen et al., 2022). In many studies, the directive conversational style of parents has been associated with children's poorer language skills (Hampson and Nelson, 1993; Hart and Risley, 1995), but the direction of the effect remains unclear. Due to directives being easily understandable, parents use them to make their speech more easily understandable to children with poor language skills. Parental speech contains fewer directives when children become older and are more able to manage tasks independently (Pan et al., 1996; Tulviste, 2019a). Moreover, parents' directiveness and functions have been found to differ across interactional contexts, being higher in toy play than in some other contexts (Hoff-Ginsberg, 1991; Yont et al., 2003).

Vygotsky (1978, 2012) explained how children acquire language and learn to contribute to conversations through participating in social interactions: social (i.e., interindividual) processes are the source of individual internal (i.e., intraindividual) processes (Wertsch, 1985). Unlike conversation-eliciting utterances such as wh-questions, directives may reduce a child's engagement in adult–child conversations and, in turn, be linked to poorer language skills as they discourage children from practicing their language skills. Moreover, a high level of parental control might decrease children's intrinsic motivation (Deci et al., 1993). Therefore, it could be that children of mothers who use directives more frequently participate less actively in conversations and, as a result, develop poorer language skills than children of mothers who frequently engage their children in conversations. By providing children the experience of talking more with the aim of conversing with their children rather than controlling their behavior or attention, parents can scaffold children's ability to actively and verbally participate in conversations and engage others in conversations. Children can learn the pragmatic meaning of language from their mothers: is it a social tool to share information, or is it a tool to control and regulate other people's attention and behavior? Similarly, it is likely that from early on, it is through everyday parent–child conversations at home that children implicitly learn how much talk is expected of them in conversations and how to participate in such conversations. It is likely that individual differences in talkativeness also have a genetic basis (Stromswold, 2001), but the quantity and quality of parental input also play a role in explaining the variability in how much children

talk during conversations. Mothers who talk more tend to have more talkative children. It is known that parents talk more to infants who have just begun to talk and to toddlers with higher language skills (Dailey and Bergelson, 2022).

1.3. Cultural variation in parent–child communication

Despite a growing understanding of the relative importance of language-promoting features of talk, much of this knowledge is still derived from research conducted primarily on English-speaking Western, mostly American, middle-class families (Tulviste, 2019b). Little is known about the extent to which the facilitative features of parent talk are culture-specific. However, evidence from other cultural and linguistic contexts is necessary to check the generalizability of previous findings. A wide cultural range exists in family interaction patterns: how common adults' one-to-one dyadic conversations with children are, the number of words children hear, how directive parents are, and how much children are involved in conversations (see Tulviste, 2019b). Differences in the use of language in children with diverse cultural backgrounds have been attributed to the culture-specific patterns of such conversations. There are likely some cultural differences in what features of mother–child interaction foster a child's language learning the most. For example, it is unclear which input features should support children in cultures where talkativeness is generally less highly valued and control of children is more highly valued.

Furthermore, there is considerable evidence that some aspects of parental input and children's language development are linked to the child's gender and maternal SES. Girls have been found to have better language skills than boys of the same age (Fenson et al., 2007; Eriksson et al., 2012). There are conflicting results about whether parents speak differently to girls versus boys (Leaper and Smith, 2004). According to some studies, girls receive larger language input and hear more questions and repetitions, but fewer directives and attention-getters, than boys (Clearfield and Nelson, 2006). Similarly, an Estonian study with LENA-generated estimates found that 4;0 old girls heard more speech than boys. However, the boys' environment was noisier (Tulviste and Tamm, 2021). Other studies have reported no differences in the quantity and quality of parental speech based on a child's gender (see Leaper and Smith, 2004; Rantalainen et al., 2022).

Parents with higher levels of education (a core component of SES) have been found to engage in speech patterns that more strongly promote children's language development. They have been found to talk more with their children and use a greater variety of words with fewer directives (Heath, 1983; Hart and Risley, 1995; Hoff, 2006; Fernald et al., 2013; Rowe, 2018). SES-related differences in children's language development have already been found among 18-month-old children (Fernald et al., 2013).

Thus, the crucial role of parental talk in children's language learning is consistently validated in studies. To better understand the mechanisms underlying language development, studies with more features of parent talk that may matter are still needed to provide more information about which specific features of adult–child interaction are developmentally appropriate for children of different ages and in children with other cultural backgrounds.

1.4. The present study

The current study aimed to determine the extent to which different aspects of maternal speech (vocabulary diversity, the frequency of using attentional and behavioral directives, and wh-questions) contribute to children's language skills and conversational contributions to mother–child play interactions at children ages 3;0 and 4;0 years.

As a novel approach to this topic, we focused on the extent to which the features of mothers' talk facilitate children's language skills and their contribution to conversations, i.e., to how talkative the children are. The diversity of mothers' vocabulary was calculated as the number of produced word types per minute and children's verbal contribution to conversations—talkativeness—as tokens per minute told by children. These two spontaneous speech measures (i.e., types and tokens) were derived from the same mother–child conversation during a joint toy play. It is known from prior studies that tokens and types are strongly associated. Talkative parents tend to produce speech that is more varied in terms of vocabulary. Considering that parents' vocabulary diversity rather than input quantity has been found to predict children's language learning in toddlers and preschoolers (Rowe, 2012; Anderson et al., 2021), we focused on the use of different words by mothers.

Unlike many other studies on this topic, parental attentional and behavioral directives were included as features of mothers' talk that might affect concurrent and future language development. To our knowledge, to date, no studies have directly examined the relative importance of maternal directiveness for children's language skills. Estonian middle-class mothers of toddlers and teenagers tend to use more directives and fewer conversation-eliciting utterances than, for example, Swedish and US mothers (Junefelt and Tulviste, 1997; Tulviste et al., 2003). Moreover, directives in the form of imperatives are very common in the Estonian language, and the frequent use of imperatives when speaking in Estonian is not perceived to be as unpolite as it is, for example, in Swedish, especially when directives are mitigated by adding "please" or "honey" (Metslang, 2004). Despite greater parental verbal control and other peculiarities of the Estonian language, Estonian children do not differ from children with other cultural backgrounds in linguistic skills (Eriksson et al., 2012; Kuvač-Kraljević et al., 2021). Estonian parents' conversational intent to frequently control children's attention and behavior might be reflected in the finding that Estonian 4-year-old children were less active conversation partners during the past event talk than their Swedish counterparts, as they answered their mothers' questions rather than spoke on their own initiative (Tulviste et al., 2016). Thus, in the current study, we included more items (the frequency of using attentional and behavioral directives) among the measures of mothers' input talk than previously, addressing not only children's language skills as outcome measures but also their contribution to conversations.

Children's language skills were measured using two assessment tools. Language comprehension and production were assessed using the examiner-administered standardized New Reynell Developmental Language Scales (NRDLS, Edwards et al., 2011). Similar to most prior studies, we also used parental reports of a child's communicative abilities—the Estonian version of the CDI III (E-CDI-III, Tulviste and Schults, 2020). Most research to date

has focused on the effects of the quality and quantity of parent talk on variability in children's vocabulary during the first 3 years of life. The present study was conducted with 3–4-year-old children. At this age, not only the variety of words but also the acquisition of other aspects of language, such as the variety of syntactic structures, pronunciation, etc., are good indicators of language acquisition. Hence, we focused on more general language abilities and used the total score of the E-CDI III instead of the vocabulary score. The assessment tools used in the study allowed us to examine how differences in mothers' input reflect in children's language knowledge (i.e., comprehension scores) and language use (i.e., language production scores and the parent-reported E-CDI-III total score).

This study aimed to examine the relationship between various aspects of mothers' input and children's language skills and participation in conversation at two time points when the children were 3;0 and 4;0 years old. According to Vygotsky (1978), scaffolding (i.e., regulating children's behavior and providing guidance and feedback) in the ZPD—the split between the actual skill level and the level that the child achieves with the help of the adult's guidance and regulation—is highly relevant when children are learning a new skill. Scaffolding decreases as children's skills develop, and they are gradually more and more able to perform tasks independently (Vygotsky, 1978). At age 3;0, children begin to play collaboratively with other people and become more verbally involved in mother–child interactions. Thus, it is likely that mothers' input differs at two time points. At age 3;0, children might require more regulations from their mothers *via* directives for joint play with toys.

Similarly, their need for mothers' wh-questions for engaging in mother-child joint play interaction might be higher 1 year later when these skills have grown. Moreover, children's language and conversational skills are higher at age 4;0. Thus, attentional and behavioral directives might have a greater negative effect, while wh-questions have a greater positive effect at age 3;0 compared to age 4;0.

Another aim of this study was to investigate the longitudinal links between mothers' input features in children aged 3;0 and child outcomes at 4;0 years. By relying on Vygotskian theory (Vygotsky, 1978), we hypothesized that children whose parents elicited conversations from them more frequently by asking wh-questions learned the importance of their verbal participation in family conversations. As they age by 1 year, these children are more communicative and show higher language and conversational skills than children whose mothers asked fewer questions and were more concerned with regulating their attention or behavior through directives. While exploring the predictors of children's developmental outcomes, we were also interested in whether the findings hold even after controlling for the same skills 1 year earlier.

The research questions of the study are as follows:

1. How similar are the predictors of children's language skills and contribution to conversations at two-time points—at age 3;0 and 4;0—when controlling for the child's age and maternal education?
2. To what extent are children's language skills at Wave 2 predicted by the features of mothers' talk input and children's contribution to conversations at Wave 1, controlling for the child's previous language skills, gender, and mother's education?

2. Materials and methods

2.1. Participants

The sample consisted of 105 mother-child dyads at Wave 1 and 87 dyads at Wave 2. The children were, on average, 3;0 years old (*M*age = 35.77 months, SD = 0.84 months; 60 females and 45 males) at Wave 1 and 4;0 years old (*M*age = 48.31, SD = 0.61 months) at Wave 2. The inclusion criteria for the study required that children be around 36 months old, that both mothers and children be Estonian speakers, and that the children have no serious health or language problems. For maternal education, there were two categories: those with at least a university education, i.e., a bachelor's degree (58%), and those with less than a university education (42%).

2.2. Procedure

The children's families were first contacted close to the children's third birthday. Children were video recorded in their homes in semistructured toy play interactions with their mothers. The mothers were given a bag containing kitchen and doctor toys and asked to play with their children as they normally would. No time restrictions were set for their joint play. A research assistant administered the NRDLS to each child during the next visit to the children's home. At Wave 1, we collected the family's background information.

2.3. Measures

Mother–child play interactions were transcribed using the Computerized Language Analysis (CLAN) program (MacWhinney, 2000). *Word tokens* (i.e., the number of words used by the child) and *word types* (i.e., the number of different words used by the mother) were taken from the automated computer analyses of the transcripts by the CHAN program. Because the length of the play sessions differed, we used the number of word types per minute to measure mothers' diversity of vocabulary and the number of word tokens per minute as a measure of children's contribution to conversations, i.e., their talkativeness.

2.3.1. The coding of play interactions

We coded mothers' directives and wh-questions. All directives—utterances used to give verbal directives to the child—were identified and divided into two categories depending on whether the mother aimed to control the children's attention or behavior. The utterances that involved giving commands or permission, requesting or encouraging desirable action, or preventing the child from acting (e.g., "*Put the cup on the table!*") were categorized as behavioral directives. The utterances used to get the child's attention (e.g., *Listen carefully*!" and "*Look, I put*

it here!") or calling the toddler's name (e.g., "*Marleen*!") were categorized as attentional directives. The wh-questions referred to the questions beginning with who, what, when, where, and why (e.g., "*What should we do this morning?*" and "*What happened to her?*"). All repetitions were coded.

Mother–child interaction transcripts were coded by a research assistant. Another research assistant coded 20% of the transcripts to assess interrater reliability. The inter-rater reliability was measured by Kappa and ranged from 0.81 to 0.91.

2.3.2. Children's linguistic skills

2.3.2.1. Estonian CDI-III

The ECDI-III (Tulviste and Schults, 2020) is the Estonian adaptation of the CDI-III developed for Swedish by Eriksson (2017) and consists of (1) *the level of communication* – a general evaluation of a child's language complexity (max = 6); (2) *a 100-item vocabulary* list that contains food words, body words, mental words, and emotion words. For each word, the parent was asked to indicate whether the child says the word (max = 100); (3) *ECDI-III scores for grammar* consist of grammar usage and sentence complexity sections. The grammar usage section asks parents to indicate for seven items whether the child has never used it, used it several times, or used it on a daily basis (max = 34). The sentence complexity section contained 10 pairs of sentences, including simple and complex sentences. The parent was asked to indicate for each pair if the child currently uses the simple one, alternates between simple and complex ones, or uses a more complex one (max = 20); (4) *the metalinguistic awareness section* (phonological and orthographic awareness, max = 7); and (5) *the pronunciation section* (max = 7). The scores of all subscales were summed (max = 154).

2.3.2.2. The New Reynell Developmental Language Scales (Edwards et al., 2011)

We used the most recent version of the well-known language test—the Reynell Developmental Language Scales—to assess the child's comprehension and production of single words (nouns and verbs) and simple and complex sentences. The comprehension scale of the NRDLS consists of 72 items, and the production scale consists of 64 items. In the Estonian version, there is the same number of items as in the original English version, but some items in the pronouns, complex sentences, and grammatical judgment sections have been changed because the Estonian language differs from English. The norming of the Estonian version of the NRDLS has not been finished (and published). There are preliminary norms for 3–4-year-old children based on 255 children aged 34–50 months. In the present study, Cronbach's alpha was used to assess the internal consistency of the items within the scales. These were 0.93 for the comprehension scale and 0.96 for the production scale. There was a high correlation between the two scales; $r = 0.772$ at age 3;0 and $r = 0.868$ at age 4;0.

To estimate the relative importance of variables pointed out in previous studies as central in predicting variability in children's early language skills, we used generalized linear models. We used children's gender, mothers' education, vocabulary diversity (i.e., word types per minute), frequency of using attentional and behavioral directives, and wh-questions as predictors of children's concurrent linguistic skills (i.e., CDI total score, comprehension, production, and talkativeness). The child's talkativeness (i.e., tokens per minute) was added as a predictor in models where CDI total score, comprehension, and production were the dependent variables. Two spontaneous maternal speech measures—word tokens and word types—were strongly associated with each other ($r = 0.794$, $p < 0.001$, at Wave 1, and $r = 0.746$, $p < 0.001$ at Wave 2). Moreover, prior research has also shown that during the third year of life, the diversity of input starts to play a larger role than the amount of input (Rowe, 2012). When investigating longitudinal predictors of children's language skills, we added the same language skills measured 1 year earlier among the predictors outlined earlier.

3. Results

3.1. Descriptive statistics

The mean scores for the study variables at two waves when children were around 3;0 and 4;0 are presented in Table 1. As shown in Table 1, the frequency of wh-questions asked by mothers was the only measure of interest that did not differ between the

TABLE 1 Descriptive statistics: means and standard deviations of the mother–child interaction variables and children's language skills.

	Wave 1		Wave 2			
	M	SD	*M*	SD	*p*	Cohen's *d*
Child						
CDI total	79.35	26.32	110.07	20.92	<0.0001	−1.87
Comprehension	49.31	11.02	58.07	12.34	<0.0001	−0.72
Production	32.45	11.02	58.05	12.34	<0.0001	−1.07
Talkativeness	18.76	8.84	21.73	10.80	0.013	−0.27
Mother						
Behavioural directives	2.14	1.15	0.98	0.62	<0.0001	1.02
Attentional directives	1.43	0.64	1.86	1.38	0.004	−0.32
Wh-questions	2.57	1.54	2.64	1.42	*ns*	−0.06
Vocabulary diversity	19.86	6.36	22.38	5.94	<0.0001	−0.43

ns, insignificant differences between Wave 1 and Wave 2 scores according to paired samples t-tests. Means and standard deviations of all interaction variables are per min.

two waves. In comparison with Wave 1, the frequency of mothers' use of behavioral directives decreased significantly ($p < 0.0001$), whereas the frequency of producing attentional directives increased ($p < 0.01$), and the diversity of mothers' vocabulary increased ($p < 0.0001$) at Wave 2. Children's talkativeness (i.e., tokens produced per minute) during play interaction increased ($p < 0.05$), as well as all three scores of their linguistic skills ($p < 0.0001$). At Wave 1, boys had lower production scores and contributed less to conversations than girls. At Wave 2, mothers used behavioral directives more frequently with boys. Children of more educated mothers scored higher on all language measures at both waves (except the E-CDI III Total score at Wave 2). They contributed more to conversations, and their mothers' vocabulary diversity was greater than that of children whose mothers had lower levels of education.

Tables 2, 3 present concurrent predictors and Table 4 presents longitudinal predictors of children's language comprehension and production, CDI total score, and talkativeness.

3.1.1. Concurrent predictors of child outcome measures

At Wave 1, CDI total scores were positively related to children's talkativeness, mothers' vocabulary diversity, and less frequent use of behavioral directives. Higher scores on comprehension scales were associated with mothers' larger vocabulary diversity and less frequent use of behavioral directives. Higher scores on the production scale were related to being a girl, mothers' higher education, and bigger vocabulary diversity. Children's talkativeness was related to higher maternal education, a larger vocabulary diversity, and the less frequent use of behavioral directives.

At Wave 2, CDI total scores were positively related to the diversity of mothers' vocabulary and the less frequent use of behavioral and attentional directives. Comprehension scores were positively related to mothers' higher education, diversity of vocabulary, and less frequent use of attentional directives. Production scores were positively related to being a girl, mothers' more frequent use of wh-questions, a bigger diversity of vocabulary, and less frequent use of attentional directives. Talkativeness was positively related to a larger diversity of mothers' vocabulary.

3.2. Longitudinal predictors of children's outcome measures

It is evident from Table 4 that the child's E-CDI III Total Score at 4;0 years was predicted by the mothers' use of a more diverse vocabulary and a lower frequency of using behavioral directives 1 year earlier. When we included the E-CDI III Total Score at 3;0 years in the model, only the CDI Total Score and the lower frequency of using behavioral directives remained as significant predictors of the E-CDI III Total score at 4;0 years.

The language comprehension score at 4;0 years was predicted by mothers' higher education levels and less frequent use of behavioral directives at 3;0 years. When controlling for the comprehension score at 3;0 years, only the previous comprehension score and less frequent use of behavioral directives remained significant predictors.

The production score at 4;0 years was predicted by mothers' vocabulary diversity and less frequent use of behavioral directives a year earlier. As shown in Table 4, both remained significant predictors when the language production score from a year earlier was controlled for.

None of the variables of interest predicted children's talkativeness at 4;0 years. After controlling for children's talkativeness a year earlier, this and being a girl were significant predictors.

Thus, the frequency of using behavioral directives and vocabulary diversity at 3;0 years were the most important aspects of mothers' input that related to the child's subsequent language skills.

4. Discussion

The study examined concurrent and longitudinal associations between the features of the mother's talk input, children's verbal contributions to play interaction, and their language skills.

Using the data collected at two-time points 1 year apart at 3;0 and 4;0 years, we found a significant increase in all children's language skills that were measured, as well as in their verbal contributions to play interactions. Changes were also observable in mothers' ways of talking with children (except in the frequency of asking wh-questions). The finding that mothers' vocabulary diversity and children's language skills significantly increased during one year is congruent with studies reporting that parents use more diverse language with language-advanced children (Dailey and Bergelson, 2022). The results also indicated that mothers directed children's behavior significantly less and attention significantly more at children aged 4;0 years than they did 1 year earlier. There was some support for previous studies suggesting that girls have better language skills than boys and that parents converse differently with girls and boys (Leaper and Smith, 2004; Clearfield and Nelson, 2006; Fenson et al., 2007; Eriksson et al., 2012). Namely, girls scored higher on the language production scale, and their verbal contribution to conversations was bigger at age 3;0. Mothers used behavioral directives more frequently with boys at age 4;0. Mothers' education was linked to many of the variables central to the study, despite the relatively high educational level of the mothers participating in our study. Specifically, children of more educated mothers received higher scores on all language measures (except the E-CDI III Total score at Wave 2), they contributed more to conversations, and their mothers' vocabulary diversity was greater than that of children with lower-educated mothers. Thus, the findings are in line with many previous studies (see Hoff, 2006).

4.1. Concurrent predictors of developmental outcomes at ages 3;0 and 4;0

Previous studies have pointed to the age-specificity of features of parent input that matter the most in early language development (Huttenlocher et al., 2010; Rowe, 2012). Based on these studies, we compared the predictors of children's outcomes at two-time points. For children aged 3;0, mothers' higher education predicted their children's greater production scores and talkativeness, whereas at age 4;0, their higher comprehension scores. None of the outcome measures were predicted by the frequency of asking wh-questions

TABLE 2 Predictors of children's language skills and talkativeness at Wave 1.

	CDI		Comprehension		Production		Talkativeness	
	B (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*
Children								
Boys (ref. girls)	0.84 (5.16)	ns	−0.45 (1.93)	ns	−6.18 (2.52)	0.014	−1.66 (1.61)	ns
Talkativeness	0.67 (0.33)	0.045	0.13 (0.13)	ns	0.14 (0.16)	ns	–	
Mothers								
Lower education (ref. higher)	−6.70 (5.75)	ns	−3.05 (2.14)	ns	−6.64 (2.78)	0.017	−5.33 (1.75)	0.002
Behavioral directiveness	−7.00 (2.69)	0.009	−3.48 (1.17)	<0.001	−4.43 (1.34)	<0.001	−1.65 (0.81)	0.041
Attentional directiveness	−3.59 (4.65)	ns	0.81 (1.74)	ns	2.34 (2.27)	ns	−2.35 (1.41)	ns
Wh-questions	0.90 (1.65)	ns	−0.46 (0.60)	ns	0.21 (0.79)	ns	−0.75 (0.51)	ns
Vocabulary diversity	1.66 (0.49)	<0.001	0.79(0.19)	<0.001	0.94(0.25)	<0.001	0.42(0.15)	0.004
Pearson x^2/df	1.10		1.10		1.10		1.08	

TABLE 3 Predictors of children's language skills and talkativeness at Wave 2.

	CDI		Comprehension		Production		Talkativeness	
	B (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*
Children								
Boys (ref. girls)	−1.90 (4.78)	ns	−3.16 (1.64)	ns	−6.23 (2.31)	0.007	4.02 (2.32)	ns
Talkativeness	−0.09 (0.23)	ns	−0.05 (0.08)	ns	0.02 (0.11)	ns	–	
Mothers								
Lower education (ref. higher)	−1.60 (4.83)	ns	−4.55 (1.69)	0.007	−4.39 (2.38)	ns	−3.08 (2.41)	ns
Behavioral directives	−8.92 (3.82)	0.019	−1.26 (1.36)	ns	−1.08 (1.91)	ns	−3.15 (1.91)	ns
Attentional directives	−6.20 (1.64)	<0.001	−2.33 (0.59)	<0.001	−3.17 (0.83)	<0.001	−1.24 (0.83)	ns
Wh-questions	3.01 (1.56)	ns	0.45 (0.56)	ns	1.66 (0.78)	0.034	−1.42 (0.78)	ns
Vocabulary diversity	1.10 (0.43)	0.010	0.55 (0.15)	<0.001	0.57(0.21)	0.006	0.54 (0.20)	0.008
Pearson x^2/df	1.13		1.11		1.11		1.09	

by the mothers, except language production scores at Wave 2. At the same time, the mothers' speech with their children, which contained a more varied vocabulary, was a significant predictor of all language scores at both waves and the children's verbal contribution to play interaction.

An important finding of our study was that the frequent use of behavior directives was a significant negative predictor of all four outcome measures at Wave 1 and continued to be negatively linked to mother-reported language scores at Wave 2. At age 4;0, the frequent use of attentional directives predicted poor outcomes (except for children's talkativeness). Thus, the study sheds light on the different roles of maternal attentional and behavioral directives in a child's language development at different times. Interpreting the findings in light of the Vygotskian theory of ZPD (Vygotsky, 1978), a reason that behavioral directives play such a big negative role in predicting younger children's language skills might be the 3-year-olds' limited abilities of cooperative play. Moreover, the toys provided by the experimenter were new to them, and likely because of that, more behavioral directives were required to guide the children's play activities. Mothers' use of behavioral directives twice as much with younger children supports the presumption. A year later, children seemed to need mothers' directives to keep their attentional focus on ongoing play rather than guidance on how to play with their mothers and new toys.

Similarly, a lack of change in the frequency of asking wh-questions may indicate that as children become older and more communicative, they do not need mothers' encouragement through wh-questions to engage in conversations. The findings that wh-questions did not predict the amount of talk contributed by children at 3;0 and 4;0 did not support our suggestion. It is worth noting that at Wave 1, the amount of children's contribution to conversations did predict their parent-reported language skills but not the scores on the standardized test. It is possible that more talkative children look like they have better language skills, and mothers tend to overestimate their skills. On the contrary, it may also be that talkative children have good language skills, and their mothers' estimates on the E-CDI-III are more accurate as they know better which words and grammatical constructs children already produce. Moreover, children who talk more with their mothers might be less talkative with an unknown research assistant who is administering the test. As a result, their language skills are underestimated by the standardized assessment.

At age 3;0, children's talkativeness was predicted by their mothers' higher education level, larger vocabulary diversity, and lower frequency of using behavior directives. At age 4;0, only

TABLE 4 Longitudinal predictors of children's language skills and talkativeness at Wave 2.

	CDI W2		Comprehension W2		Production W2		Talkativeness W2	
	B (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*
Model 1								
Children								
Boys (ref. girls)	−1.13 (4.51)	ns	−0.14 (2.52)	ns	−3.25 (2.60)	ns	3.72 (2.39)	ns
Talkativeness W1	0.34 (0.29)	ns	0.07 (0.17)	ns	0.04 (0.17)	ns	–	
Mothers								
Lower education (ref. higher)	−1.55 (5.03)	ns	−8.08 (2.81)	0.004	−5.97 (2.90)	0.039	−3.88 (2.64)	ns
Behavioral directives W1	−9.09 (2.28)	<0.001	−3.46 (1.27)	0.006	−4.78 (1.30)	<0.001	−1.66 (1.17)	ns
Attentional directives W1	−0.61 (4.01)	ns	1.34 (2.23)	ns	−0.07 (2.30)	ns	0.43 (2.07)	ns
Wh-questions W1	2.14 (1.34)	ns	0.18 (0.78)	ns	0.75 (0.81)	ns	−0.80 (0.75)	ns
Vocabulary diversity W1	1.01 (0.41)	0.014	0.37 (0.23)	ns	0.84 (0.24)	<0.001	0.29(0.21)	ns
Pearson x^2/df	1.13		1.11		1.11		1.09	
Model 2								
Children								
Boys (ref. girls)	3.14 (3.06)	ns	1.03 (2.53)	ns	−0.64 (2.54)	ns	4.76 (2.29)	0.038
Talkativeness W1	−0.07 (0.20)	ns	−0.01 (0.18)	ns	0.01 (0.17)	ns	0.45 (0.15)	0.003
CDI W1	0.52 (0.07)	<0.001						
Comprehension W1			0.37 (0.14)	0.007				
Production W1					0.31 (0.10)	0.002		
Mothers								
Lower education (ref. higher)	2.20 (3.36)	ns	−7.15 (2.78)	0.010	−3.85 (2.80)	ns	−1.45 (2.63)	ns
Behavioral directives W1	−4.67 (1.69)	0.006	−2.11 (1.46)	ns	−3.02 (1.41)	0.032	−0.85 (1.14)	ns
Attentional directives W1	−0.29 (2.77)	ns	0.48 (2.29)	ns	−0.91 (2.26)	ns	1.73 (2.01)	ns
Wh- questions W1	0.20 (0.91)	ns	0.30 (0.77)	ns	0.43 (0.76)	ns	−0.62 (0.71)	ns
Vocabulary diversity W1	0.22 (0.30)	ns	0.09 (0.27)	ns	0.52 (0.26)	0.041	0.11 (0.21)	ns
Pearson x^2/df	1.15		1.13		1.13		1.11	

vocabulary diversity mattered. Language comprehension scores at age 3;0 were predicted by mothers' vocabulary diversity and a lower frequency of using behavioral directives. At age 4, language comprehension scores were predicted by mothers' higher educational level, greater vocabulary diversity and less frequent use of behavioral directives. Language production scores at age 3;0 were predicted by being a girl, having a mother with a higher educational level, having a more diverse vocabulary, and using behavioral directives less frequently. At age 4;0 being a girl, and mothers' diverse vocabulary, a lower frequency of using attentional directives, and asking wh-questions were significant predictors of productive language scores. Mother-reported language skills at Wave 1 were predicted by being more talkative and mothers' vocabulary diversity and reduced use of behavioral directives, and at Wave 2, by mothers' vocabulary diversity and reduced use of attentional and behavioral directives.

Thus, although the results showed somewhat differential effects of various aspects of mothers' speech and background factors on the child's concurrent language skills at two-time points, all concurrent language scores were positively predicted by mothers' vocabulary diversity and negatively predicted by mothers' frequent use of directives. The predictors of concurrent outcomes at two waves differed with regard to which directives mattered: a higher frequency of mothers' behavioral directives was a negative predictor at age 3;0, whereas a higher frequency of attentional directives at age 4;0.

4.2. Longitudinal predictors of developmental outcomes

The second objective of the study was to investigate to what extent children's language skills at Wave 2 were predicted by the features of mothers' talk input and children's talkativeness measured 1 year earlier, controlling for children's gender and mothers' education. We were also interested in whether the findings held when the same language scores from 1 year earlier were entered as predictors. The results indicated that mother-reported language scores and language production scores on the standardized test at age 4;0 were positively predicted by mothers' earlier vocabulary diversity and negatively predicted by their earlier use of behavioral directives. When controlling for the same language scores 1 year earlier, the pattern of the results remained

the same in the model that predicted language production. Mothers' vocabulary diversity at age 3;0 did not remain a significant predictor of later mother-reported language skills when controlling for the same language scores 1 year earlier. Better language comprehension scores at age 4;0 were predicted by the mother's higher education and less frequent use of behavioral directives 1 year earlier. When previous comprehension scores were counted, only these scores and mothers' education remained significant predictors.

Given that plenty of recent research on child language acquisition highlights the importance of children's verbal participation in conversations, we were interested in finding out which features of earlier input predict a bigger verbal contribution to mother-child play interactions 1 year later. We expected that parental control of the child's behavior by means of directives would likely lead children to concentrate on play activities rather than verbal exchanges and, thus, not support language development. At the same time, one might think that mothers' use of open-ended questions facilitates children's ability to verbally participate in conversations and results in better language skills over time. Our longitudinal results showed that none of the variables measured 1 year earlier mattered in predicting how talkative children were at age 4;0. When statistically controlling for children's earlier talk production, only these scores and being a girl were significant predictors. It is likely that talkativeness is more heritable than language skills and is less affected by the features of talk input.

4.3. Factors that matter the most in future language and conversational skills

The study addressed the question of which variables measured at age 3;0 affect children's subsequent language skills the most. Our study advances the literature by revealing that all earlier outcome measures central to the study (i.e., mother-reported language scores and directly measured language comprehension and production scores) were important predictors of the same developmental outcomes measured 1 year later. The findings correspond to the results of many previous studies showing that language development during the first years of a child's life plays a crucial role in later language proficiency (Hart and Risley, 1995; Rescorla, 2009; Golinkoff et al., 2019). After statistically controlling for the same outcome measure 1 year earlier, many other predictors did not remain significant. For example, although the frequency of using behavioral directives a year earlier was a significant negative predictor of all subsequent language outcomes central to the study, after controlling for the same language scores at Wave 1, they remained a significant predictor of language production scores and mother-reported language skills (except language comprehension scores). However, the finding is consistent with those of studies indicating that the frequent use of directives is a risk factor in language development (see Hoff, 2006).

In contrast, vocabulary diversity in maternal input at Wave 1 related positively to future language production scores and mother-reported language skills. However, when controlling for the same language skills at Wave 1, vocabulary diversity remained a significant predictor of later production scores. Various words have been proven to be a crucial feature of parental talk input that matters in a child's language development during the third year of life (Rowe, 2012). Our findings are consistent with those of previous studies and add to the literature regarding the beneficial effects of vocabulary diversity on language learning also in slightly older children—around their third and fourth birthdays.

Based on recent theoretical views that children's active participation in social interactions supports their language development, one might expect that talkativeness promotes the development of language skills over time. Our data did not support the presumption, as talkativeness did not emerge as a predictor of any future language skills. Wh-questions are commonly assumed to be related to children's better language skills (Rowe et al., 2017). There was no support for the idea that children whose mothers promoted 3-year-old children's conversations by more frequent use of wh-questions were more talkative 1 year later or that they had better language skills. Longitudinal analysis indicated that gender was a significant predictor only for children's talkativeness and only when children's previous contribution to the conversation was counted for. The results also did not confirm that mothers' education is a significant predictor of subsequent language and communication abilities (Fernald et al., 2013). Education-related differences did appear only in future comprehension scores, and mothers' educational level remained an important predictor of language comprehension even after controlling for previous scores on the comprehension scale.

4.4. Limitations of the study

A limitation is that the study was done with a constrained age range of children and only in Estonia. Researchers working in line with Vygotskian ideas pay a lot of attention to the developmental context in which children grow up. It is known that parents of different cultural backgrounds vary greatly in how they talk with their children, and Estonian middle-class mothers have put much more emphasis on verbal control of their children. In families with other cultural backgrounds where fewer directives are used during play interactions, negative associations between mothers' directives and children's concurrent and future language skills might be not as strong. The current study focused only on mothers' input during play interaction, but the daily social context of children at ages 3;0 and 4;0 includes many different conversational partners, including fathers and other family members, kindergarten teachers, and other people outside the family. Research in other cultural and linguistic contexts and across various interaction contexts is necessary to check the generalizability of our findings. It is unclear if the language predictors that matter the most during the studied period are the same when children grow older.

5. Conclusion

Despite these limitations, the study advanced previous studies in the field. Most prior studies have addressed vocabulary development in infants and toddlers. The current study with slightly older children and its focus on more general language skills added to the literature the knowledge that each language skill of interest (i.e., mother-reported language skills, language

comprehension, and production measured using a standardized language test), as well as children's contribution to conversations, has a somewhat different combination of predictors. However, mothers' diverse vocabulary is a positive predictor of concurrent and future language skills, whereas the frequent use of directives is a risk factor for language development. The results support the view that the features that foster children's language learning the most depend on concrete developmental outcomes and the age/language skills of the child.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Research Ethics Committee of the University of Tartu. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

TT wrote the manuscript and made substantial contributions to the conception and design of the work. TT and AT interpreted the results, and organized and participated in data collection. AT carried out the statistical data analyses and made the language correction. Both authors provided approval for publication of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY
Aleksander Veraksa,
Lomonosov Moscow State University, Russia

REVIEWED BY
Loredana Sundberg Cerrato,
Nuance Communications, United States
Tania Stoltz,
Federal University of Paraná, Brazil
Elena Chichinina,
Lomonosov Moscow State University, Russia

*CORRESPONDENCE
Leonardo Daniel Rivera Valdez
✉ leonardo.riv.val@gmail.com

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A proposal for monitoring the process of internalization following Galperin's conception

Leonardo Daniel Rivera Valdez*, Vicente Arturo López Cortés and Marco Antonio García Flores

Facultad de Psicología, Benemérita Universidad Autónoma de Puebla, Puebla, Mexico

Since the era of Piaget and Vygotsky, private speech (PS) has been widely discussed, but in recent years, the avenues for its study have greatly expanded. In this study, we explored the use of a recoding scheme for PS inspired by the studies of Pyotr Galperin. A coding scheme for social speech, PS, and the lack of speech, as the form of action (FA) has been proposed (i.e., external social speech, external audible speech, inaudible speech, and mental FA when no speech was produced). An exploratory study was conducted to elucidate the appropriateness of the coding scheme, both ontogenetically and during tasks. The results showed that both the coding scheme by type of speech and FA were adequate for differentiating ontogenetically between children. However, only the coding schemes of the FA were appropriate for differentiating between children as a function of their performance (i.e., time and scores) in a Tower of London task. Moreover, Galperin's scheme was more suitable when there was redundancy in performance between those with audible and inaudible external speech.

KEYWORDS

private speech, internalization, activity theory, cultural-historical psychology, developmental psychology

Introduction: Vygotsky and the internalization process

The process of internalizing speech was deeply studied and theorized by Vygotsky (2012). He proposed that private speech (PS) was an intermediate step between social speech and inner speech, but he also attributed it a role in self-regulating activity. For him regulation first occurred due to the influence of adults in social speech and later transferred to self-regulation because of PS. Finally, the regulation became internalized in inner speech.

This conception of PS was aligned with his general notion that functions appear two times in development: first in the social space and then in the internal or mental space (Vygotsky, 2012). Such conceptions have been deeply influential in studying the process of the genesis of self-regulation in preschool children (see Winsler, 2009).

One of the most influential coding schemes for studying this process of internalization was proposed by Berk (1986). In this coding scheme, one first needs to separate the utterances produced by the child in the condition selected by the experimenter (e.g., play) according to temporal and semantic criteria (Winsler et al., 2005). Then, one divides the speech according to whether it is social or PS. Social speech is coded when there is physical or visual contact, when the context refers to someone or something that was said, or when it is temporarily related to the speech of another individual. Everything else is considered PS. Further, PS is classified as follows: (1) level 1 if PS (PS1) is irrelevant to the task, word play or repetition, emotional expression irrelevant to the task, or

commentaries to absent or imaginary characters; (2) level 2 if PS (PS2) is relevant to the task, describes the child's own activity, is self-guided commentary, is a self-answered question, or is an emotional expression relevant to the task; and (3) level 3 of PS (PS3) if PS is externalized inner speech relevant to the task (e.g., verbal murmurs, whispers, and lip and tongue movements).

To elicit this kind of speech, many conditions have been used, such as naturalistic settings, social settings, free play, planning tasks, constructive tasks, memory tasks, and response inhibition tasks (Berk, 1992; Fernyhough and Fradley, 2005; Winsler et al., 2005; Fernyhough and Meins, 2009; Winsler, 2009). The common denominator is that the task is significant and aligned with the level of development such that it is significantly challenging.

Such a scheme has been highly fruitful not only in studying the process of internalization but also in examining its relationship with other cognitive functions or investigating PS in atypically developing populations (please refer to Winsler, 2009). This scheme has been used to study PS across the lifespan (Berk, 1992; Winsler, 2009). The study on PS in the specific language impairment population (Lidstone et al., 2012) has been productive in studying PS in the ADHD and ASD populations (Winsler et al., 2007). For studying microgenetic (Benigno et al., 2011) and transversal relations between PS and executive functioning (Fernyhough and Fradley, 2005; Alarcón-Rubio et al., 2014; Thibodeaux et al., 2019) as well as the ontogenetic relation between PS and theory of mind (Fernyhough and Meins, 2009; Rivera, 2023), Berk's coding scheme has been highly fruitful. However, it is important to note that Berk's coding scheme is not the only coding scheme (please refer to Winsler et al., 2005) available for studying the internalization process of the self-regulation function.

Galperin's notion of internalization

Galperin was a member of the Kharkov school of pyschology that was headed by Leontiev and where other important psychologists such as Vygotsky, Luria, Bozhovich, and Zaporozhets worked. He integrated the ideas of internalization of Vygotsky (2012) with the developments of object-centered activity developed by Leontiev (1981). He developed a formative method to study the internalization process (Galperin, 2021). Such a procedure was called the stage-by-stage formation of mental actions. Moreover, such a procedure allowed Galperin to study the formation of mental actions in connection with object-centered activity at the material/materialized level (i.e., actions with concrete objects or their representations), thus informing, in a controlled way, of the stages in the formation of actions.

According to Galperin, an action traverses multiple qualitative changes or forms of action (FA): material/materialized, externalized social speech, silent external speech, and mental FAs (Galperin, 1967, 1992, 2021). At the material/materialized level, people interact with the material supports needed to solve a particular problem. These can include real objects, graphic representations, and, most of the time (in the context of the experiments), an orientation card that helps the learner solve the problem. After this level was accomplished, the next stage (externalized social speech) consisted of the interaction between the learner and the teacher, where they resolved the problem in collaboration, but especially because the teacher oriented the learner in the space problem (e.g., asking for the steps, correcting him, etc.). Later, the learner would orient himself/herself in the problem space using his/her own speech, which would gradually become more and more abbreviated. Finally, the motor aspect of speech would disappear entirely. At this level, Galperin (2009) suggested that, at this point, the learner would operate at the level of meaning or "pure thought," which he referred to as the mental form of action.

In this study, we indicate that his internalization stages could be implemented in the studies of PS. We also propose a new coding scheme for PS using the internalization forms of action: material/materialized, externalized social speech, silent external speech, and mental.

However, we recommend retaining the PS coding based on Vygotsky (e.g., such as Berk's) but reclassifying it for continued use. This coding scheme can still be useful for ontogenetical purposes, discourse analysis, and content analysis of the utterances, among others, and shedding light on the transitional process from external, inaudible speech form to mental form. Galperin's proposed forms of internalization include material/materialized, externalized social speech, silent external speech, and mental forms of action. We suggest incorporating the specificity of the literature on the types of PS into Galperin's scheme. We also propose recoding the PS of children to incorporate Galperin's notions of internalization.

The classification is proposed as follows: (1) material/materialized when the concrete objects or their representations are used to solve a task; (2) external social speech when the majority of the utterances are of the social type; (3) audible external speech when the majority of the utterances are of the PS2 type; (4) inaudible external speech when the majority of the utterances are of the PS3 type; and (5) or mental when there is one or no event of speech at all while resolving tasks. This classification would add even more specificity to Galperin's conception since he did not consider audible external speech as others have (Berk, 1986; Winsler, 2009: Winsler et al., 2005) and would shed some light on the complex process of passing from audible external speech to a mental form of action.

Because of the previous considerations, an exploratory analysis was performed to discern if the proposed re-coding by the FA is an appropriate categorization for studying the process of internalization across the preschool years. Does the classification of the FA distinguish between different preschool children (e.g., first and second grade of preschool)? Is this classification better in some respects to other kinds of classification of private speech?

TABLE 1 Descriptive statistics of private speech.

	Grade	Social speech	PS1	PS2	PS3
Mean	Preschool 1	18.9	0.833	3.42	0.0833
	Preschool 2	6.37	0.00	1.70	2.57
	Preschool 3	1.47	0.0625	2.16	2.06
Standard deviation	Preschool 1	12.7	1.86	2.76	0.408
	Preschool 2	8.69	0.00	2.77	2.54
	Preschool 3	2.98	0.354	2.92	2.12

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Is the reclassification by FA redundant, or does it present new information compared to other classifications?

Methodology

Participants

Participants from a previous study that were recruited from the preschools "Jardín de Niños General Lázaro Cárdenas del Río" and "Jardín de Niños Salvador Díaz Mirón" in the state of Tlaxcala, Mexico were included in the study if they did not have previous antecedents of a neurological condition or a learning problem reported by their teachers. Consent was obtained from their parents, and, the children and their parents were free to withdraw from participation in the study at any time during the study. Of the 91 children, four left the study, and one was discontinued because his teacher said that the kid was receiving language therapy. The sample consisted of a total of 86 participants: 24 of them were from the first grade of preschool (boys = 9 and girls = 15; mean age = 4 years, SD = 0.257; range: 3.50–4.33 years); 30 from the second grade of preschool (boys = 13 and girls = 17; mean age = 5.02 years, SD = 0.311; range: 4.58–5.41 years); and 32 from the third grade of preschool (boys = 14 and girls = 18; mean age = 5.98 years, SD = 0.279; range: 5.58–6.75 years).

TABLE 2 Descriptive statistics of degree of internalization (DI).

	Grade	DI
N	Preschool 1	24
	Preschool 2	30
	Preschool 3	32
Missing	Preschool 1	0
	Preschool 2	0
	Preschool 3	0
Mean	Preschool 1	0.262
	Preschool 2	2.19
	Preschool 3	3.09
Standard deviation	Preschool 1	0.207
	Preschool 2	2.07
	Preschool 3	2.07

Procedure

Consent was obtained from the guardian of every child. First, the participants were led to a quiet room provided by the school (e.g., the empty playroom) where different toys for make-believe play were provided (in the case of the play condition). The children

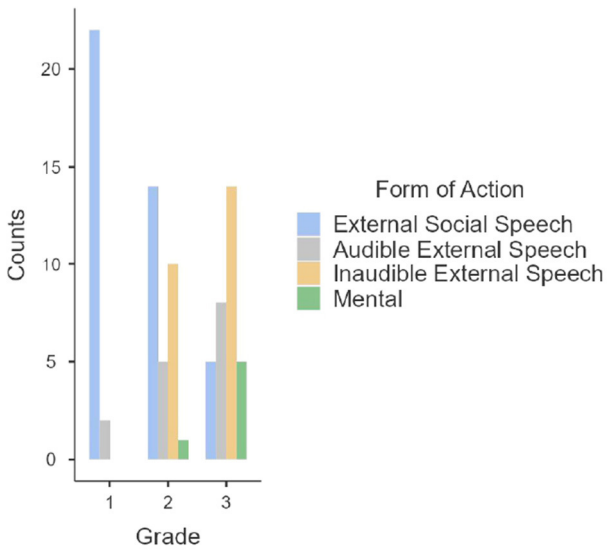

FIGURE 1
Frequencies of the forms of action.

TABLE 3 Frequencies of FA.

FA	Grade	Frequencies	% of total	Cumulative %
External social speech	Preschool 1	22	25.6%	25.6%
	Preschool 2	14	16.3%	41.9%
	Preschool 3	5	5.8%	47.7%
Audible external speech	Preschool 1	2	2.3%	50.0%
	Preschool 2	5	5.8%	55.8%
	Preschool 3	8	9.3%	65.1%
Inaudible external speech	Preschool 1	0	0.0%	65.1%
	Preschool 2	10	11.6%	76.7%
	Preschool 3	14	16.3%	93.0%
Mental	Preschool 1	0	0.0%	93.0%
	Preschool 2	1	1.2%	94.2%
	Preschool 3	5	5.8%	100.0%

then either performed the free play condition in groups of four or performed the ToL task individually. Subsequently, the children received theory of mind tasks as part of a parallel study. Those in preschool 1 took the theory mind task on another day, and those of preschool 2 and 3 on the same day. Finally, after completing the tasks, the children received a gift and sweets that were delivered as a group.

Private speech coding

We adopted the proposal of Fernyhough and Meins (2009) where videotaped sessions were divided into utterances according to Bakthin's unit of analysis. In this study, the limits of an utterance were demarcated temporarily and semantically, temporarily by units of 2 s of difference, and semantically by changes in the theme of the utterance. Once this was accomplished, utterances were divided according to whether they were social or private, according to Winsler et al. (2005). An utterance was considered social if: (1) visual contact occurred between the participant and another person for at least 2 s while the utterance was produced; (2) contact (e.g., physical, sight, etc.) occurred between the participant and another person for at least 2 s while the utterance was produced; (3) content involved the content of the previous utterance of another person or mentioned them explicitly; and (4) temporarily, the utterance followed, in a time-lapse of <2 s, the previous utterance of another person. All the other utterances that did not fulfill these conditions were considered PS.

Second, PS utterances were coded following Berk (1986)'s classification: (1) level 1 if PS (PS1) is irrelevant to the task, word play or repetition, emotional expression irrelevant to the task, or commentaries to absent or imaginary characters; level 2 if PS (PS2) was relevant to the task, described the child's own activity and were self-guided commentaries, were self-answered questions, or were emotional expressions relevant to the task; Finally, level 3 of PS (PS3) was coded if externalized inner speech was relevant to the task (e.g., verbal murmurs, whispers, and lip and tongue movements). Finally, a degree of internalization measure was computed by summing the amounts of PS2 and PS3 and dividing it by the amount of time (in minutes) when such utterances were coded (i.e., $\frac{Total\ PS2 + Total\ PS3}{Total\ Time\ (min)}$; Fernyhough and Meins, 2009; Winsler, 2009).

TABLE 4 *Post-hoc* tests—degree of internalization as a function of grade.

				95% Confidence interval	
		psi-hat	*p*	Lower	Upper
1	2	−1.52	0.002	−2.51	−0.540
1	3	−2.85	<0.001	−4.08	−1.608
2	3	−1.32	0.035	−2.83	0.186

1, preschool 1; 2, preschool 2; 3, preschool 3.

Form of action

The recoding scheme for the PS was realized, as stated above in the section above. Material/materialized form was omitted since it was impossible to evaluate such a form in free play or Tower of London conditions. Thus, coding form was stated as external social speech, audible external speech, inaudible external speech, or mental form as a function of the predominant PS types (i.e., social, PS2, PS3, or none). Therefore, if a participant had a frequency of five in PS3, but a frequency of seven in PS2, the audible external speech FA was assigned. When a conflict occurred, such as when PS2 and

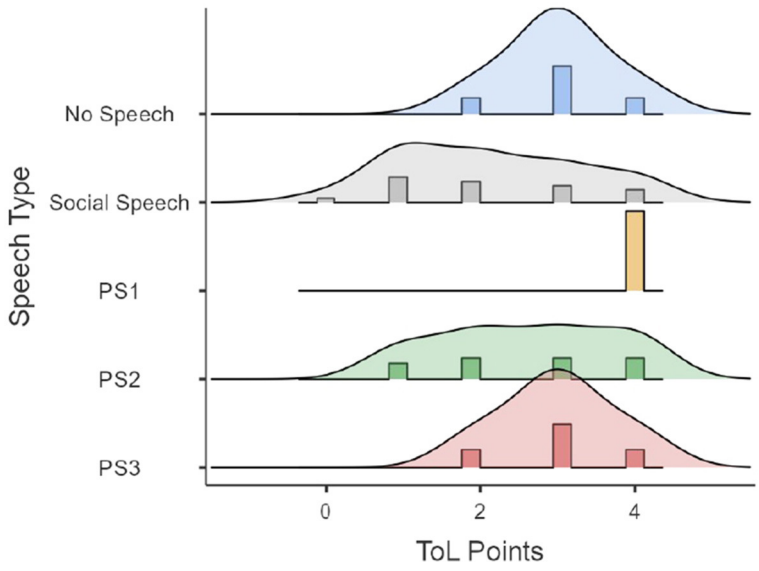

FIGURE 2
ToL points as a function of speech type.

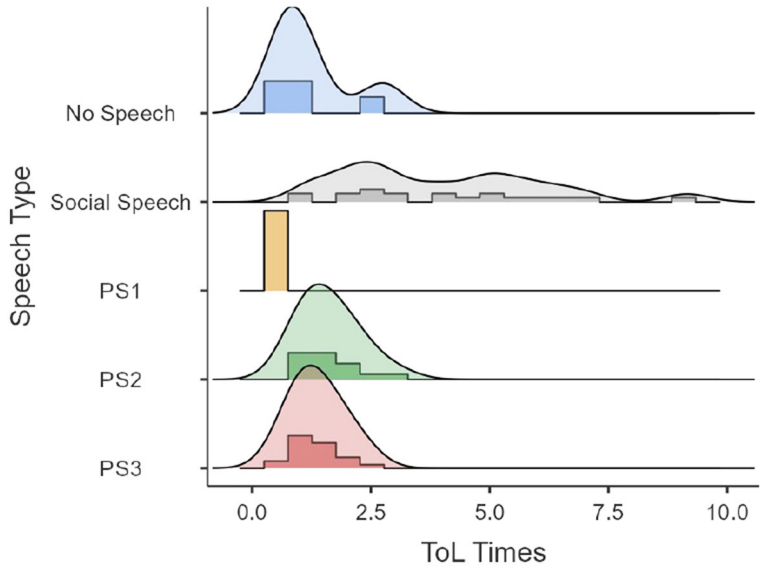

FIGURE 3
ToL times as a function of speech type.

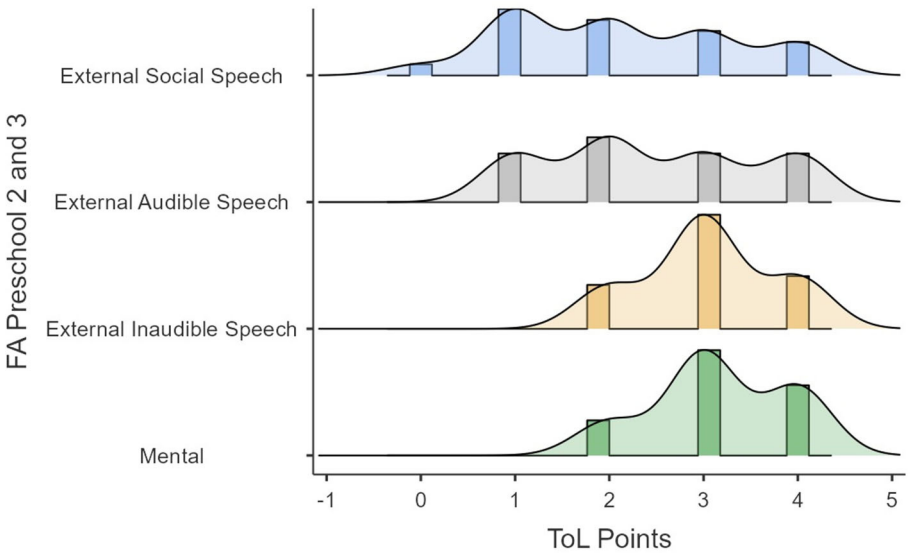

FIGURE 4
ToL points as a function of FA.

PS3 were equal, a less internalized form of action was adopted (i.e., PS2).

Free play

Since the group of first-graders was very young, we followed Fernyhough and Meins (2009) suggestions of recording free play sessions in groups of four kids for a maximum of 16 min. Two cameras were positioned in a silent room provided by the schools. Their speech was coded following the abovementioned coding schemas.

Tower of London

Following Fernyhough and Fradley (2005), we applied the Tower of London (ToL) to the second and third grades of preschool

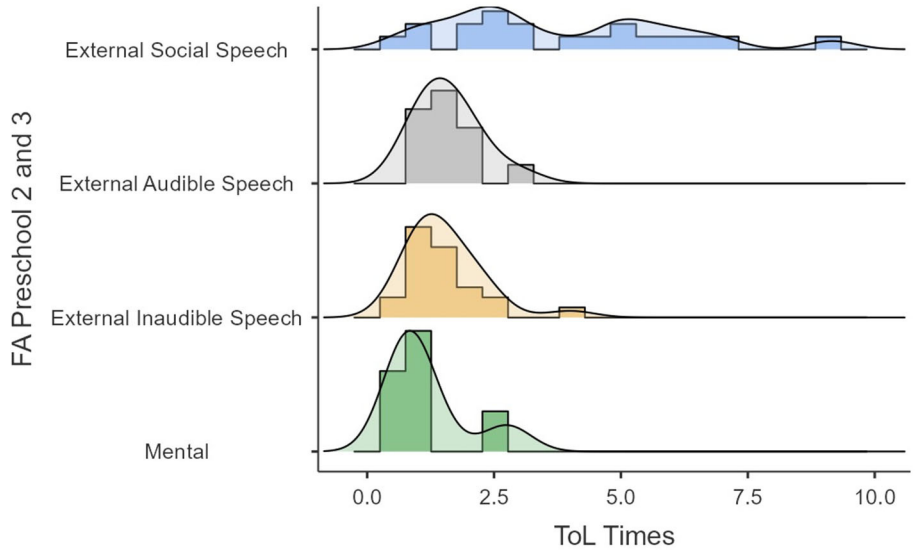

FIGURE 5
ToL times as a function of FA.

TABLE 5 Pairwise comparisons—ToL times as a function of speech type.

		W	*p*
No speech	Social speech	3.92	0.044
No speech	PS1	−2.07	0.586
No speech	PS2	2.22	0.515
No speech	PS3	1.59	0.793
Social speech	PS1	−2.33	0.467
Social speech	PS2	−5.28	0.002
Social speech	PS3	−6.55	<0.001
PS1	PS2	2.30	0.479
PS1	PS3	2.35	0.459
PS2	PS3	−1.69	0.756

TABLE 6 *Post-hoc* tests—ToL scores of preschool 2 and 3 as a function of FA.

				95% Confidence interval	
		psi-hat	*p*	Lower	Upper
1	2	−0.444	0.653	−2.09	1.20580
1	3	−1.063	0.050	−2.12	−0.00933
1	4	−1.250	0.112	−2.74	0.23738
2	3	−0.618	0.653	−2.20	0.96016
2	4	−0.806	0.653	−2.60	0.98538
3	4	−0.188	0.653	−1.66	1.28227

1, External social speech; 2, external audible speech; 3, external inaudible speech; 4, Mental.

to elicit their PS. The ToL consists of three pegs and three rings of different colors (e.g., blue, red, and green), one copy for the participant and another for the researcher to model the target of the trial. The experimenter told the participant, "That they need to make sure that their toy looks equal to this one (the model)," presenting them with four different levels (i.e., 2, 3, 4, and 5 moves) of the task. Further, participants were told some rules: (1) they should use one hand only; (2) they cannot move more than one piece at a time; and (3) they cannot leave the pieces on the table and then move another piece, they should place the piece first on the pegs, and then they can move another one. Finally, children are told that "Some children like to talk out loud when they resolve this task, if you want you can talk. While you play, you can talk and say what you want" to encourage children to talk, otherwise they may not talk even if that is helpful for them. The session was recorded and coded as specified before.

Results

In Tables 1–3 descriptive statistics of PS, degree of internalization and FA in the preschool grades are presented. Figure 1 presents a graphic of the amount of FA according to the preschool grade. Descriptive statistics showed that children from preschool 1 tend to have a lower degree of internalization than children from preschool 2 and 3. The results showed that preschool 1 only has external social speech FA, while children in preschool 2 have external social speech as the dominant form but also have inaudible external speech, audible external speech, and in last place mental FA; finally, preschool 3 children have as a dominant FA inaudible external speech, audible external speech, mental, and lastly they have external social speech. Therefore, in was not until

children reached preschool 3 that inaudible external speech as a dominant form.

Differences in degree of internalization across preschool grades

ANOVA analyses were performed following Wilcox (2017), who recommended the use of trimmed means for incrementing the power of the analyses (for some computational and implementation details, see Mair and Wilcox, 2020; Love and Mair, 2022). The analyses revealed that there were significant differences between preschool groups ($F = 25.1$, $p < 0.001$). *Post-hoc* analyses were conducted (see Table 4), and it was found that the first grade of preschool had a lower degree of internalization than the second grade ($\hat{\psi} = -1.52, p = 0.002$); that the first grade had a lower degree of internalization than the third grade ($\hat{\psi} = -2.85, p < 0.001$); and that second grade had a lower degree of internalization than the third grade ($\hat{\psi} = -1.32, p = 0.035$).

TABLE 7 *Post-hoc* tests—ToL times of preschool 2 and 3 as a function of FA.

				95% Confidence interval	
		psi-hat	*p*	Lower	Upper
1	2	2.107	0.013	0.320	3.895
1	3	2.225	0.010	0.448	4.003
1	4	2.723	0.003	0.936	4.511
2	3	0.118	0.588	−0.507	0.743
2	4	0.616	0.068	−0.117	1.350
3	4	0.498	0.083	−0.189	1.185

1, External social speech; 2, external audible speech; 3, external inaudible speech; 4, Mental.

Differences in performance as a function of speech type and FA

First, performances of time and ToL points as a function of speech type (i.e., the dominant type for each participant) are presented in Figures 2, 3. Figures 2, 3 show that a lack of speech events is not classifiable with the private speech coding scheme. Figure 2 shows that ToL points as a function of speech type are widely distributed as a function of the speech type and are uninformative. Figure 3 shows that ToL times seem to be widely distributed when the speech type is social but reduced when the speech is more internalized (i.e., PS1, PS2, and PS3).

Second, Figures 4, 5 show the differences in times and ToL points as a function of the FA. Figure 4 shows that, as the process of internalization progresses, the dispersion of the ToL scores becomes smaller, and scores tend to be on the higher end. While Figure 5 shows that, as the internalization progresses, the dispersion of times of execution in ToL becomes smaller, especially when FA passes from external social speech to external audible speech.

An analysis of ANOVA for the type of speech with trimmed means was not possible; thus, classical non-parametric tests were performed (i.e., Kruskal–Wallis test). No significant difference was found for ToL points as a function of speech type ($\chi^2 = 8.90$, df = 4, $p = 0.064$), while a significant difference was found for time ($\chi^2 = 29.3$, df = 4, $p < 0.001$). Pairwise comparisons (see Table 5) showed that participants with social speech took more time resolving the ToL than those with PS2 ($W = -5.28$, $p = 0.002$) and PS3 ($W = -6.55$, $p < 0.001$) types of speech but not more time than those with PS1 type ($W = -2.33$, $p = 0.467$). Those with PS1 type did not

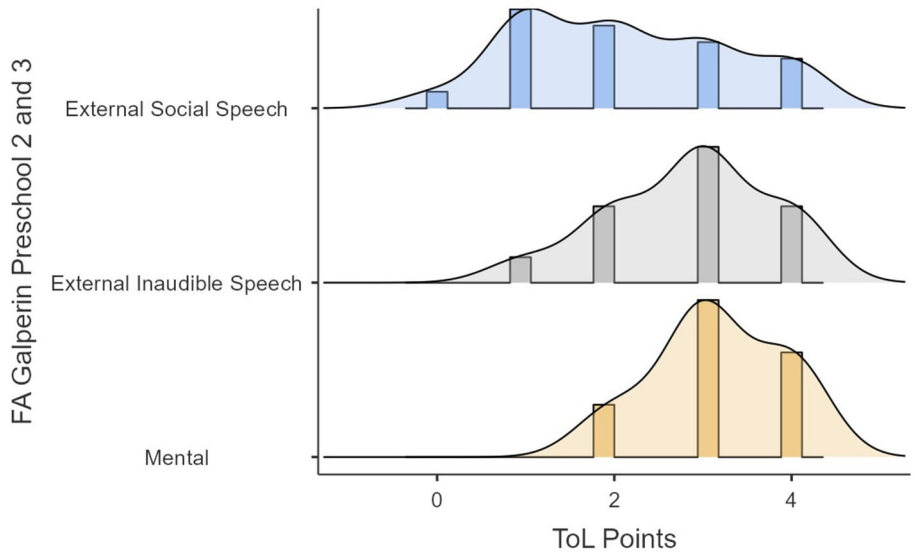

FIGURE 6
ToL points as a function of FA.

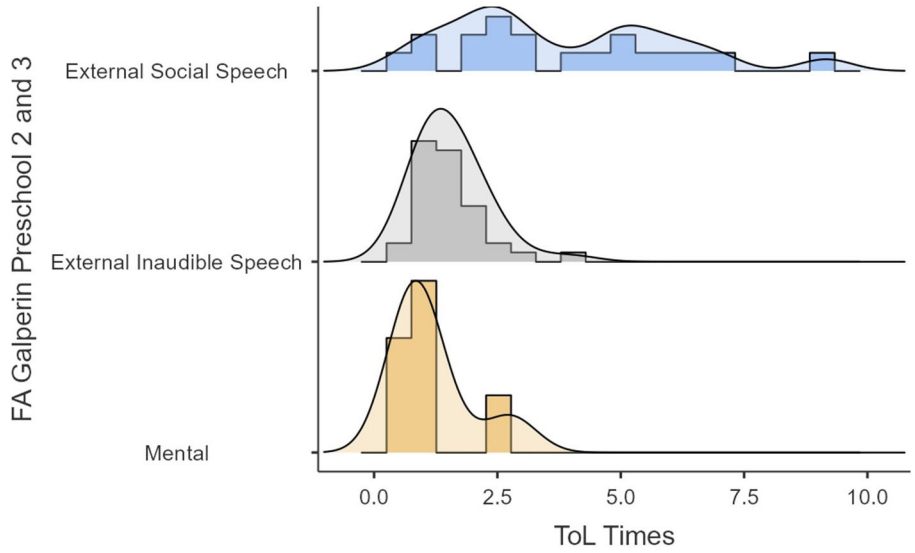

FIGURE 7
ToL times as a function of FA.

differ from those with PS2 (W = 2.30, $p = 0.479$) or PS3 (W = 2.35, $p = 0.459$) types. Moreover, those with PS2 type did not differ from those with PS3 type (W = −1.69, $p = 0.756$). Finally, those with a lack of speech showed faster executions than those with social speech (W = 3.92, $p = 0.044$), but no difference from those with PS1 (W = −2.07, $p = 0.586$), PS2 (W = 2.22, $p = 0.515$), or PS3 (W = 1.59, 0.793) types.

The ANOVA analyses indicated a significant difference in the score of the ToL ($F = 3.34$, $p = 0.053$). The *post-hoc* analyses (see Table 6) showed that children with an external social speech FA showed lower scores in ToL than those with an inaudible external speech FA ($\hat{\psi} = -1.063$, $p = 0.050$). However, they did not differ from those with an audible external speech FA ($\hat{\psi} = -0.444$, $p = 0.653$) or a mental FA ($\hat{\psi} = -1.250$, $p = 0.112$). Further, those with an audible external speech FA did not differ from those with an inaudible external speech FA ($\hat{\psi} = -0.618$, p=0.653) or a mental FA ($\hat{\psi} = -0.806$, $p = 0.653$). Finally, the group that had an inaudible external speech FA did not differ significantly from those with a mental FA ($\hat{\psi} = -0.188$, $p = 0.653$).

The ANOVA analysis of time in function of the FA was also significant ($F = 7.82$, $p = 0.002$). The *post-hoc* analyses (see Table 7) showed that those with an external social speech FA consumed a significant amount of time to resolve the ToL task than those with an audible external speech FA ($\hat{\psi} = 2.107$, $p = 0.013$), those with an inaudible external speech FA ($\hat{\psi} = 2.225$, $p = 0.010$), or those with a mental FA ($\hat{\psi} = 2.723$, $p = 0.003$). However, those with an audible external speech FA did not differ significantly from those with an inaudible external speech FA ($\hat{\psi} = 0.118$, $p = 0.588$) or a mental FA ($\hat{\psi} = 0.616$, $p = 0.068$). Finally, those with an inaudible speech FA did not differ from those with a mental FA ($\hat{\psi} = 0.498$, $p = 0.083$).

Differences in performance as a function of FA according to Galperin's categories of internalization

The previous analyses showed redundancy between audible and inaudible external speech that the mental FA showed a tendency toward significance, and that the type of speech tended to be a variable that did not capture the differences in performance well. Because of these, the same analyses were reproduced but with Galperin's categories of internalization. This indicates that we did not consider the differences between audible external speech and inaudible external speech to oneself. Figures 6, 7 show the performances in time and points in the ToL as a function of FA (i.e., external social speech, inaudible external speech, and mental). Figures 6, 7 show how the variance of the times and scores in ToL tend to be lower as the internalization process progresses.

Significant differences were found in ToL scores ($F = 4.15$, $p = 0.045$). In concrete terms, *post-hoc* analyses showed (please refer to Table 8) that those with an external social speech FA had lower scores than those with an external inaudible speech ($\hat{\psi} = -0.870$, $p = 0.049$) or a mental FA ($\hat{\psi} = -1.250$, $p = 0.049$). However, there was no difference in performance between those with an external inaudible and a mental FA ($\hat{\psi} = -0.380$, $p = 0.370$).

Finally, the ANOVA analysis showed a significant difference in times for the ToL task as a function of the FA ($F = 11.7$, $p = 0.002$). The *post-hoc* analyses (see Table 9) showed those with an external social speech were slower at solving the ToL task than those with an external inaudible speech ($\hat{\psi} = 2.194$, $p = 0.005$) and a mental FA ($\hat{\psi} = 2.723$, $p = 0.001$). Moreover, the participants with externally inaudible speech were slower than those with a mental FA ($\hat{\psi} = 0.530$, $p = 0.029$).

TABLE 8 *Post-hoc* tests of ToL scores with respect to Galperin's coding scheme in preschool 2 and 3.

				95% Confidence interval	
		psi-hat	*p*	Lower	Upper
External social speech	External inaudible speech	−0.870	0.049	−1.80	0.0588
External social speech	Mental	−1.250	0.049	−2.56	0.0622
External inaudible speech	Mental	−0.380	0.370	−1.66	0.8976

TABLE 9 *Post-hoc* tests of time in the ToL with respect to Galperin's coding scheme in preschool 2 and 3.

				95% Confidence interval	
		psi-hat	*p*	Lower	Upper
External social speech	External inaudible speech	2.194	0.005	0.6180	3.77
External social speech	Mental	2.723	0.001	1.1312	4.32
External inaudible speech	Mental	0.530	0.029	−0.0622	1.12

Discussion

The results showed that the degree of internalization was increasing significantly across preschool grades, which is consistent with previous results in the literature (Fernyhough and Meins, 2009; Winsler, 2009). Further, the findings revealed that speech type was not a satisfactory category for studying the changes in performance across ages. Some types of speech were not effective in determining the performance of the task. Categorization by speech type was not able to show differences in scores, but it did show that those with predominantly PS2 and PS3 types were faster than those with social speech. Nonetheless, the degree of internalization was important for differentiating the children at different ages. Therefore, it is an important marker of the ontogenetic development of children.

The categories of speech presented us with the problem of what to do with the cases where kids tend not to talk. This was especially true for older children, but when we collected data, it was clear that even some younger kids seemed to have little to no speech. Because of that, it was critical to consider other aspects, such as the relationship between performance and lack of speech. The latter point is important since many kids may not want to talk even if prompted to do so, as suggested by Fernyhough and Fradley (2005). This could be for many reasons, such as unfamiliarity with the researcher, embarrassment, cultural reasons (e.g., that you should not talk to strangers), and anxiety about tests.

Further, FA coding schemes solved the problem of the unclassifiable lack of speech and also showed to be effective in identifying differences between participants even without the consideration of the material/materialized in this study; older children tended to have inaudible external speech and audible external speech FA while younger children had mainly external social speech. FA classification showed that children with FA that signaled a more internalized action had better performances in time and scores during ToL tasks. The last point was especially clear when we considered the coding scheme of Galperin himself rather than our own, in which we attempted to consider the more subtle forms of PS in the literature (see Winsler et al., 2005; Winsler, 2009). Galperin's account ignored the differences between PS relevant to the task and those not and seemed to ignore the subtleties between audible and non-audible external speech. Ignoring such subtleties seemed correct when we were concerned with the performance in the ToL task (i.e., time and score). Our coding scheme was not effective in determining changes in scores and only revealed that those with external social speech had lower scores than those with inaudible external speech. Galperin's approach, on the contrary, revealed that those with external social speech had lower scores than those with inaudible external speech and mental FA. Then, when we considered the time of execution, our approach determined that those with an external social speech FA took longer to solve the ToL task than those with an external audible, inaudible, or mental FA. However, Galperin's account found that both (i.e., external inaudible speech and mental FA) consumed less time to resolve the ToL task and that those with a mental FA resolved faster than those with an external inaudible form of action.

The last point is consistent with Galperin's approach. He proposed that, in the last stages of internalization, one of the specific changes that occur is automatization of action. This is consistent with the fact that the main difference between mental and inaudible external speech is in time but not in scores of ToL (Galperin, 2021).

Therefore, our results suggest that classifications based on the internalization of actions are a more suitable scheme for classifying the internalization process than speech-type classifications, at least when performance is an issue. This does not imply that such schemes are not useful. On the contrary, we believe that such classification schemes may be useful when the content of the speech is relevant or when the subtleties of PS are of interest. We also believe that the degree of internalization markers is an important quantitative measure for making ontogenetic claims about the internalization process. Nonetheless, we believe that the categories of the FA may be more useful when we want to consider changes in performance since it seems that further subdivisions of speech are redundant for performance (i.e., scores and time). These categorizations would be of great use in neuropsychological neurorehabilitation, where the monitoring of the process is crucial, and the focus is on performance during microgenetic processes.

One concern that the reader may have, as some reviewers pointed out, is that Galperin's approach is normally associated

with such formative experiments. This is study is not one of those studies. We agree with them, Galperin is specially associated with that, and that aspect should not be ignored but embraced since it is a very rich description of how to form an action. Nonetheless, we believe that Galperin's intentions were broader. His purpose was to describe the process of internalization broadly, and he found in such a formative method a fruitful way to approach the problem in a controlled manner (Arievitch and Van der Veer, 1995). Because of that, the study of how to apply his categories to ontogeny is valid, and it is in need of more research. However, as we mentioned earlier, we believe that such a process is going to be useful, and is going to be fruitful in such contexts where formation of actions is needed (e.g., neuropsychological rehabilitation; see Engeness and Lund, 2020). For such purposes, we believe that our coding scheme is going to be very useful since it provides a systematic way of studying such formative processes.

The limitations of the study are clear. Since it was only an exploratory study, no clear answers on the topic can be made presently. However, it will be a task of the future to explore the utility of these classifications in other practical cases, especially in the neuropsychological rehabilitative and pedagogical processes.

Conclusion

This exploratory study successfully showed that PS recoding is a valuable addition to the study of internalization. Coding by the FA proved to be effective in distinguishing between children of different ages and levels of internalization. Further, this coding scheme was useful for differentiating between children according to their time and score performances, which is contrary to the type of speech classification. The latter was not sensitive and was inadequate for those children who performed better but did not speak. As mentioned, this re-coding scheme seems promising for studies that need to monitor the changes in performance as a function of time, teaching, and a rehabilitation process. Future studies will clarify the utility of these coding schemes.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Facultad de Psicología BUAP. Written infor med consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

LR conceived the initial idea, recollected, transcribed and analyzed the data, and wrote the manuscript. LR and VL discussed and reviewed the theory, methodology, and the final manuscript. VL and MG gathered the resources for publishing and obtained the location for gathering data. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY
Yulia Solovieva,
Meritorious Autonomous University of Puebla, Mexico

REVIEWED BY
Claudia Ximena González-Moreno,
Pontifical Javierian University, Colombia
Carla Anauate,
São Paulo State University, Brazil

*CORRESPONDENCE
Daria Bukhalenkova
✉ d.bukhalenkova@inbox.ru

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Active screen time and imagination in 5–6-years-old children

Daria Bukhalenkova[1]* and Olga Almazova[2]

[1]Department of Educational Psychology and Pedagogy, Faculty of Psychology, Lomonosov Moscow State University, Moscow, Russia, [2]Department of Developmental Psychology, Faculty of Psychology, Lomonosov Moscow State University, Moscow, Russia

This research focused on the connection between such factors of the active screen time of preschoolers as the time spent playing computer games and parental participation in children's computer games on imagination in 5–6 years old children. The mothers of 772 children were asked to fill out questionnaires where they described how their children interact with gadgets. 371 of these children also participated in the test that assessed productive imagination using complete the drawing task (such parameters as flexibility, originality, elaboration were assessed). As a result of the study, no relationship was found between imagination and the time spent by preschoolers playing computer games. At the same time, this study revealed significant relationships between imagination and the characteristics of parental participation in the gadgets' usage by preschoolers. The research showed that imagination flexibility scores are significantly higher in children who use gadgets with siblings or peers than in those who often play alone or with an adult.

KEYWORDS

preschool age, imagination, creativity, flexibility, originality, elaboration

1. Introduction

One of the most important aspects of cognitive development in preschool age is imagination, which is significant for the children's further successful development and learning (Vygotsky, 1984; Lubart, 1999; Alfonso-Benlliure et al., 2013; Calvert, 2015; Gajda et al., 2016; Chen et al., 2020; Bayanova and Khamatvaleeva, 2022). At preschool age, imagination actively develops within the role play (Vygotsky, 1984), however in the modern world, traditional play with peers among preschoolers is supplanted and supplemented by the active use of gadgets (Singer and Singer, 2005; Calvert, 2015; Götz, 2015; Kalabina and Progackaya, 2021; Belova and Shumakova, 2022; Yudina, 2022). At the same time, some scientists adhere to the hypothesis that gadgets have a developing potential for imagination (for example, Jackson et al., 2011; Ott and Pozzi, 2012; Götz, 2015; Blanco-Herrera et al., 2019); whereas others support the opposite idea that gadgets are more likely to impoverish the imagination (e.g., Singer and Singer, 2005; Greenfield, 2009; Calvert and Valkenburg, 2013). In this regard, studying the gadgets' influence on the imagination development in preschoolers remains relevant and significant.

It is the active screen time (i.e., playing on smart electronic devices) and not the passive screen time (i.e., watching cartoons and various video content on television/tablet/mobile

phone), that seems to be the most significant in terms of the cognitive development of preschoolers (Linebarger et al., 2014; McNeill et al., 2019; Veraksa et al., 2020; Veraksa N. E. et al., 2021) and of the imagination too (Calvert, 2015). In a computer game, children have more opportunities to show initiative, activity and independence than when watching a cartoon with a predetermined plot. Such active participation in a computer game, on the one hand, trains various cognitive functions that all are interconnected with the imagination (since all mental functions develop in a systemic and interconnected manner) (Vygotsky, 1984). On the other hand, the need to choose a strategy, think over your actions and their possible consequences, find ways to solve problems in computer games stimulate children creativity and imagination. Numerous studies convincingly show the potential of popular children's computer games and specially designed computer programs (serious games) to develop creativity and imagination in children (Cassell and Ryokai, 2001; Bertolini and Nissim, 2002; Kannetis et al., 2009; Jackson et al., 2011; Ott and Pozzi, 2012; Blanco-Herrera et al., 2019; Papadakis, 2020; Rahimi and Shute, 2021; Xiong et al., 2022).

However, such educational computer programs and applications are not always available to parents because they are developed as part of research and are not always in the public domain. In addition, parents do not always know how to choose educational applications for their children and optimize play time (Broekman et al., 2016; Brito and Dias, 2020; Veraksa A. N. et al., 2021; Khokhlova et al., 2022). Thus, it is essential to study the impact that ordinary, everyday (and not created within the study) gadgets' usage by children has on their creativity. Based on all the reasons described, this research focused on the influence of such factors as the game's duration and parental participation in children's computer games on imagination in 5–6 years old children.

The results of studies of the relationship between time spent on computer games and creativity or imagination in preschoolers are quite contradictory. Some studies show no relationship between time spent on games and creativity (Hamlen, 2013), while others show a positive relationship between the two (Jackson et al., 2011). Data on the gadgets' negative impact on creativity was obtained mainly about the time spent watching TV, and not the time spent on computer games by children (Valkenburg and van der Voort, 1995; Calvert, 2015). Based on the previously obtained data on the relationship between gadgets' use and other cognitive functions (Bowers and Berland, 2013; Soldatova and Vishneva, 2019), it can be assumed that such a contradiction in the results may be due to the non-linearity of this relationship. It is likely that there is some optimal amount of time to spend playing computer games that increases the level of imagination, while the complete lack of playtime with gadgets or excessive playing time will reduce creativity scores in preschoolers.

As for the research on parent mediation in the gadgets' usage by children, these studies normally focus either on parental beliefs about the benefits or harms that can bring the usage of different computer games and applications by children, or they focus on parental educational strategies regarding the rules for using gadgets by children (Broekman et al., 2016; Palaigeorgiou and Katerina, 2017; Brito and Dias, 2020). Quite a lot of research has been devoted to this issue, and based on those specific recommendations have been formulated for parents regarding the digital devices' use by children (for example, Blum-Ross and Livingstone, 2017). At the same time, the role of the joint play of a child with an adult with gadgets at preschool age is practically not researched at all.

It is crucial to mention that one of the problems in research on creativity is that the authors define this concept and the phenomena it describes differently, and therefore use different methods to assess it (Sternberg and Lubart, 1999; Runco and Jaeger, 2012; Williams et al., 2016). This leads to additional complexity when comparing and interpreting the results of different studies on this topic. In this study, we rely on the most widespread understanding of creative imagination (i.e., creativity) in child psychology as a special ability of a person to create something objectively and/or subjectively new and at the same time corresponding to the requirements of the situation (Dyachenko, 1996; Sternberg and Lubart, 1999; Calvert, 2015).

Thus, data on the influence of such factors as the time spent playing computer games and parental participation in children's computer games on imagination are rather small and contradictory. In addition, a large number of studies on this topic are devoted to older children - schoolchildren and adolescents, and not to preschoolers (Jackson et al., 2011; Hamlen, 2013). To complement the scientific data available on this topic, the purpose of this research was to trace whether the imagination level differs in children interacting with digital devices for a different amount of time and how adults' participation in children's interactions with gadgets is correlated with their level of imagination.

2. Materials and methods

2.1. Sample

The mothers of 772 children were asked to fill out questionnaires where they described how their children interact with gadgets, among the study participants there were 390 (50.5%) boys and 382 (49.5%) girls aged 58–73 months (M = 65.3; SD = 3.99).

Of the half of those for whom the parents answered (386 children), a subsample was drawn up, in which the distribution by sex and age of children coincided with the general sample. With them, a technique to assess the imagination was carried out. The results of 15 children were excluded from the analysis due to the child's refusal to complete the task or misunderstanding of the instructions. As a result, the sample of tested children was 371, among them were 175 (47.2%) boys and 196 (52.8%) girls aged 59–71 months (M = 65.2; SD = 3.84).

2.2. Measures

To study the peculiarities of the gadgets' usage by preschoolers, a questionnaire for parents was used. The questionnaire consisted of several blocks of questions about SES, peculiarities of the family situation, peculiarities of children's use of gadgets, and peculiarities of children's behavior. In this research, 3 questions from the questionnaire about the playing computer games were analyzed. In the first two questions, parents were asked to indicate the

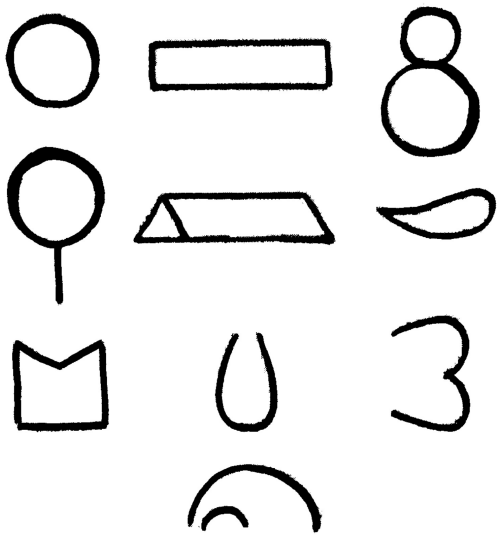

FIGURE 1
Tasks of the technique "complete the drawing" (10 figures; Dyachenko, 1996). Reproduced with permission.

number of hours and minutes that a child usually spends on electronic devices on weekdays and weekends separately, excluding the time spent watching cartoons and videos («How much time on a typical weekday/weekends does a child spend on electronic devices (computer, tablet, phone, game console), not counting the time spent watching cartoons and videos?»). The third question was "Who more often decides what games a child will play on an electronic device?" and the following 3 answers were offered to parents: (1) "More often I or other adult family members"; (2) "More often the child"; and (3) "The child does not play games on the electronic device." In the fourth question, parents were asked "With whom does the child usually spend time playing electronic devices?" - parents were offered the following answers: (1) "alone"; (2) "with brothers/sisters"; (3) "with adult family members"; (4) "the child does not play games on the electronic device"; (5) "other (please, specify)." Parents of preschool children completed the questionnaire individually.

To assess the preschoolers' imagination, the "Complete the Drawing" test was used, which is a modified version of the test by Torrance (1962) and Dyachenko (1996). It is widely used in Russia and is the most common test amongst the researchers in the field of preschool development to measure the children's imagination level.

The test included 10 cards, and each card had one figure of indefinite shape drawn on it (see Figure 1). The task of a test participant was to finish each drawn figure so that a completed image was created. The test results were evaluated according to four indicators:

(1) Images' originality–the number of the original figure inclusions in the new graphic image. An image is considered original if the initially given figure plays the role of an insignificant component (for example, a triangle is not a roof of a house, but a pencil lead with which a boy draws a picture, etc.). The total number of drawings with inclusions was calculated (maximum 10 points).

(2) Images' elaboration–the level of detail, i.e., the number of elements added by the child. This indicator reflects the child's ability to develop his/her ideas in detail. This indicator was calculated separately for each image, then the average score was calculated for all the drawings of each participant.

(3) Imagination flexibility–the number of non-repeating (in terms of content and drawing principle) images for each child. Images were considered identical, in which the initially given for the drawing figure turned into the same element (for example, a child draws the figures "circle" and "circle with a stick" like a lollipop). Thus, for this parameter, each participant could score a maximum of 10 points.

(4) Originality coefficient–the number of unique images that are different from other drawings of the same child, as well as from the drawings of other children from his/her kindergarten group, drawn on the basis of the same initially given figure (maximum 10 points).

2.3. Procedure

Each child was tested individually in a quiet and bright room of the kindergarten where he/she was studying. Tests were facilitated by a specially trained tester. Children were free to quit or refuse to participate in the research at any time as well as were explicitly asked about their desire to participate in the research.

All parents were informed about the research objectives and gave written consent for children's involvement in the study. The research was approved by the Ethics Committee of the Faculty of Psychology at Lomonosov Moscow State University (the approval No: 2022/15).

3. Results

3.1. Gadgets' use of preschoolers

Based on the data obtained, we calculated how many minutes approximately per week a child actively uses gadgets: from 0 to 1920 min (M = 555.8; SD = 681.47). Since we assumed a non-linear relationship between the time spent playing with gadgets and imagination, for further analysis, the children were divided into 3 groups, approximately equal in size, based on the frequency table: rare, medium and frequent use of gadgets (see Table 1). The number of minutes in all three selected groups differs significantly (Anova, $F = 388.393$, $p < 0.001$).

An analysis of the answers to the question about who decides more often what games a child will play on an electronic

TABLE 1 Selected groups of children with different frequency of active gadgets use.

Frequency	Range (min)	% children
Rare	Up to 210	31.1
Medium	From 210 to 570	34.6
Frequent	More than 570	34.2

TABLE 2 Means, medians and standard deviations of scores according to the "complete the drawing" method.

	M	Me	SD	Min.	Max.
Elaboration	7.66	7.00	3.170	2	21
Originality	1.25	1.00	1.205	0	6
Originality coefficient	4.40	4.00	1.756	0	9
Flexibility	9.63	10.00	0.694	6	10

TABLE 3 Differences in imagination parameters depending on who chooses the content (child or adult).

	Who chooses the content				Differences	
	Child		Adult			
	M	SD	*M*	SD	*U*	*P*
Elaboration	7.84	3.432	6.96	2.766	7633.5	0.035
Originality	1.29	1.273	1.04	1.017	8374.5	0.217
Originality coefficient	4.32	1.738	4.39	1.820	8977.5	0.762
Flexibility	9.63	9.67	9.67	0.565	9060.0	0.819

device showed that children themselves more often determine the games they will play (56.0% of answers), rather than parents (24.7% of answers). Mothers were also asked with whom a child usually watches videos and plays with. According to the data obtained, the majority of children play with a sibling or friend (37.3%) or alone (31.7%), and only 12.0% of children play with adults. At the same time, about 19.3% of children do not play with gadgets at all according to the answers given by their mothers.

3.2. Imagination of preschoolers

The results of the imagination indicators assessing of preschoolers (elaboration, originality, coefficient of originality and imagination flexibility) showed that in terms of imagination flexibility, we observed a small data scatter, showing that most children demonstrate high imagination flexibility level: the majority of participants made 9 or all (10) non-repeating (in content and drawing principle) images, when they were presented with 10 unfinished drawings within the test (see Table 2).

The Kolmogorov–Smirnov test showed that the distribution according to the imagination's different aspects was not normal, which indicates the need for further analysis with non-parametric criteria.

3.3. Preschoolers' imagination in connection with the gadgets' usage peculiarities

Firstly, we compared the imagination assessment scores in different groups of children based on the gadgets' usage peculiarities highlighted in the analysis (using the Kruskal–Wallis test for several independent samples). There were no significant differences in the imagination parameters depending on the gadget frequency use (rare, medium, frequent use).

Secondly, we have found that imagination elaboration scores were significantly higher in children who chose content themselves more often than in children whose content was chosen by adults (Mann–Whitney test, $U = 7633.5$, $p = 0.035$) (see Table 3). Also, imagination flexibility scores were significantly higher in children who used gadgets together with siblings or peers than in those who played alone ($U = 7510.0$; $p = 0.046$) or with an adult ($U = 2457.5$; $p = 0.014$) more often (see Table 4).

4. Discussion

The purpose of this study was to see if the imagination differed in with different amounts of active screen time, and how the participation of adults and peers in the interactions of children with gadgets connected with their imagination.

As a result no correlation was found between the time a child spends playing computer games and imagination indicators, which is consistent with the data of the Hamlen (2013) study, however, this data was obtained on a sample of 12-year-old children. The data generated within our study do not support the assumption that there is some optimal amount of time playing computer games that increases the imagination level, while the complete lack of play time with gadgets or excessive play time will reduce imagination level in preschoolers. This result suggests that from the imagination development in preschoolers point of view, not just the time that a child spends playing computer games is important, rather the content of child's activity via gadgets (Veraksa et al., 2022).

At the same time, our study revealed significant relationships between imagination and the characteristics of parental participation in the gadgets' usage by preschoolers. It was discovered that the drawings' elaboration level was significantly higher in children who chose the content to play with via gadgets themselves more often than in children whose content was chosen by adults. This result suggests that children who have more freedom in choosing computer games are better able to develop their ideas in detail. This finding is consistent with the theory that

TABLE 4 Differences in imagination parameters depending on with whom the child uses gadgets.

	Alone		With peers or siblings		With parents		Differences	
	M	SD	*M*	SD	*M*	SD	K-W	*p*
Elaboration	7.74	3.351	7.72	3.289	7.00	2.88	0.872	0.647
Originality	1.17	1.162	1.30	1.224	1.21	1.353	0.955	0.620
Originality coefficient	4.14	1.771	4.47	1.793	4.60	1.781	3.456	0.178
Flexibility	9.57	0.789	9.75	0.535	9.43	0.914	7.292	0.026

video game-induced positive emotions contribute to imagination in preschool age (Hutton and Sundar, 2010). This result also shows that parents are not always competent in choosing children's games in terms of their importance for the preschoolers' imagination development (Broekman et al., 2016). Probably a child's enthusiasm and interest in play is more essential in this context (Kannetis et al., 2009). If the images of computer characters are attractive, children can actively include them in their fantasies, and thus computer games can contribute to the imagination development (Götz, 2015).

According to the research results, imagination flexibility scores are significantly higher in children who use gadgets together with siblings or peers than in those who often play alone or with an adult. This result is of particular interest. It can be assumed that in a joint game with a child, an adult takes the position of an observer of the child's play, rather than acting as an equal participant in the game. At the same time, when playing with a peer or sibling, the child often has to agree with him/her on the rules for playing together or using the gadget, which trains the preschoolers' executive functions that closely related to the development of imagination and creativity (Krumm et al., 2018; Filippetti and Krumm, 2020; Veraksa et al., 2020). On the other hand, according to Vygotsky (1984), children often act out in a role-playing game the life experiences they have received and vivid impressions from the events that have happened to them. Then the impressions and emotions received in a computer game can become the basis for a joint game with peers and fantasizing, contributing to the development of children imagination (Fleer, 2022). It can also be assumed that a more active participation of adults in a children's computer games (discussing with children what is happening in a computer game, suggesting ways to solve tasks, etc.) would have a more developing effect on children imagination (Vygotsky, 1984; Strouse et al., 2013).

Speaking about the limitations of the study, it is important to note that this study did not analyze other aspects of gadgets use [for example, the role of passive screen time (Greenfield et al., 1986; McNeill et al., 2019)]; additional variables related to imagination were not taken into account [for example, personality traits and children's cognitive abilities, social and educational factors (Sternberg and Lubart, 1999; Lucchiari et al., 2019; Yildiz and Yildiz, 2021; Tvardovskaya et al., 2022)]. Also, the limitations of this study include the research methods' specifics that we have chosen. Firstly, via the "Complete the Drawing" test it is not possible to evaluate some types of activity of preschoolers, in which their imagination can also manifest itself [for example, the children's ability to make up stories (Dyachenko, 1996; Sternberg and Lubart, 1999)]. Secondly, in this study we measured the time that preschoolers spent using gadgets based on a parents' survey, and not on the observation diaries filled in by parents, which is a more reliable and secure way to measure this parameter (Calvert, 2015). However, this method requires a lot of time to be spent by parents, which reduces the likelihood of parents participating in the study and, accordingly, collecting a large amount of data. This specific approach toward the time estimation, as well as possible differences in parents' perceptions of what exactly a child is doing with the help of a gadget (playing or studying) (Calvert, 2015) can significantly affect the research results, which indicates the need for further studying of this topic and findings verification. Furthermore, a survey of parents did not allow us to find out the characteristics of the games that children play (age-appropriate or not, game type, educational component), which is also of great importance for the imagination development in preschool age (Calvert, 2015; Papadakis, 2020; Xiong et al., 2022). In the future, we plan to analyze the computer games' type and content based on interviews with children.

Therefore, the research expands the available scientific knowledge about the relationship between the gadgets' usage specifics and imagination in modern preschoolers. Based on the results obtained, it can be concluded that the amount of time that a preschooler spends playing computer games itself is not important, rather with whom and what he/she plays.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of the Faculty of Psychology at Lomonosov Moscow State University (the approval No: 2022/15). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

DB was involved in the data collection. OA verified the analytical methods and conducted the analyses. DB wrote the manuscript with critical feedback and input from OA. Both authors discussed the results and contributed to the presented idea (i.e., research questions) and the theoretical framework, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY
Yulia Solovieva,
Meritorious Autonomous University of Puebla, Mexico

REVIEWED BY
Ana Baltazar,
National Autonomous University of Mexico, Mexico
Lilia Mestas,
National Autonomous University of Mexico, Mexico

*CORRESPONDENCE
Elena Chichinina
✉ alchichini@gmail.com

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Potential impact of extra education on the development of executive functions within a year in preschool children: an exploratory research

Alexandra Dolgikh[1], Larisa Bayanova[1] and Elena Chichinina[2]*

[1]Laboratory of Childhood Psychology and Digital Socialization, Psychological Institute, Russian Academy of Education, Moscow, Russia, [2]Department of Educational Psychology and Pedagogy, Faculty of Psychology, Lomonosov Moscow State University, Moscow, Russia

Executive functions have been shown to develop through various extra classes in preschool age. But the optimal for executive functions development system of such classes has not yet been explored. The present exploratory study aimed to examine the difference in the executive functions development within a year between children attending the system of extra classes (music, choreography, art, foreign language, literacy, math, computer science, and science) twice a week for 4h in a preschool education center and children who did not take no extra classes. There were 60 children who attended extra classes and 64 children who did not take extra classes. In each group, approximately 17% were boys. The first assessment of executive functions was performed in the penultimate year of kindergarten, when the children were 5–6years old. The second was performed 1year later. The executive function level was assessed using NEPSY-II subtests "Inhibition," "Statue," "Memory for Designs," "Sentences Repetition," and "Dimensional Change Card Sort." Mothers also reported about their children's attendance in extra classes, their children's screen time, the level of maternal education, and the level of family income. The study revealed that children attending the system of the extra classes showed a higher verbal working memory development within a year than the children taking no extra classes. The obtained data plays an important role for the design of further research of the topic and for the practical recommendations for parents and teachers.

KEYWORDS

executive functions, inhibitory control, working memory, cognitive flexibility, preschool age, children, extra preschool education

1. Introduction

Executive Functions (EF) is an umbrella term for cognitive processes that underpins goal-directed behaviors, cognitive processes, and adaptive behavior in new situations (Diamond, 2013; Friedman and Miyake, 2017). EF can be divided into three interrelated components: inhibitory control (cognitive and physical), working memory (verbal and visual), and cognitive flexibility (Miyake et al., 2000). A large number of empirical results reveal that the level of EF in preschool age is a predictor of school readiness, academic performance in school (Robson et al., 2020; Kovyazina et al., 2021; Morosanova et al., 2021), and social competence (Denham et al.,

2010; Shen et al., 2020). Furthermore, the level of EF development in children is associated with physical and mental health, and social competence in adulthood (Moffitt et al., 2011; Stichter et al., 2016). A low EF level in childhood is associated with internalizing and externalizing problems, antisocial behavior, health problems, aggression, peer victimization, and depression (Robson et al., 2020). Therefore, EF are a necessary foundation for full-fledged cognitive and socio-emotional development in both childhood and adulthood (Scionti et al., 2020).

Due to the great importance of the EF in childhood, researchers study how to influence the EF development. The quality of parent–child interaction and parenting methods play an important role in promoting the development of EF in childhood. Therefore, the level of EF in children is positively related to parenting behaviors such as warmth, responsiveness, autonomy, support, scaffolding, and negatively related to parents' intrusiveness and detachment (Valcan et al., 2018).

One of the most effective ways to develop the EF of preschoolers is a game (Yogman et al., 2018). The effectiveness of this method is derived from the fact that the game is the leading activity in this age (Vygotsky, 2012). The game develops the ability to follow instructions, problem-solving skills, working memory, cognitive flexibility, and emotional, cognitive, and physical inhibitory control (Yogman et al., 2018). The game harmonizes the emotional state of the child and, in turn, creates favorable conditions for the EF development (Rosas et al., 2019).

Additionally, screen time matters when considering the EF development. It has been proven that excessive screen time is associated with a lower level of EF in preschoolers (Linebarger et al., 2014; McNeill et al., 2019). The truth is that excessive screen time can replace parent–child interaction, live play, physical activity, and the necessary amount of sleep. Consequently, it has a negative impact on the EF.

Sleep is also closely related to the development of EF. Children who do not sleep enough may have a lower level of EF (Kahn et al., 2021). Another important factor that can influence EF development is physical activity (Bai et al., 2022). So, preschoolers are recommended to engage in at least 180 min of physical activity per day to ensure normal cognitive development (McNeill et al., 2020; Veraksa et al., 2021). Physical activity itself is conducive to the EF development because it increases blood flow, general sensorimotor stimulation (van den Berg et al., 2019), and activation of brain structures, primarily the Third Functional Unit (Tvardovskaya et al., 2020), responsible for programming, regulation, and control of mental activity. At the same time, there is evidence that physical activity stimulates the EF development only if it is purposeful and specially organized—for example, if it involves sport training, dancing training, or sports games (Chang et al., 2012; Tomporowski and Pesce, 2019).

Executive function has been shown to develop through various activities in preschool education programs and classes (Rosas et al., 2019). For example, studies have shown that regular attendance of cognitive training (Röthlisberger et al., 2011), dance classes (Shen et al., 2020; Rudd et al., 2021), music classes (Chen et al., 2022), foreign language classes (Frolli et al., 2022), sports (Jarraya et al., 2019; Tvardovskaya et al., 2020), and other activities is associated with the development of EF in preschool children.

Any organized class, be it dancing, music, etc., must meet a number of requirements to contribute to the development of EF. Firstly, the EF development depends on the amount of time spent practicing, the frequency, and regularity of classes (Diamond and Ling, 2016). Secondly, the tasks that are set for the child during the classes should always be in the "zone of proximal development" (Vygotsky, 2012; Diamond and Ling, 2016). EF must always be challenged (Diamond and Ling, 2016). Thirdly, activities should support the child's motivation and promote enjoyment, self-confidence, and the development of social connections (Rosas et al., 2019). The individual characteristics of the child also play a role. Children with the poorest EF benefit the most from the activities in terms of EF development (Diamond and Ling, 2016).

Children's various activities attendance has become very popular among residents of developed countries in recent years (Wang et al., 2023). However, the optimal set of classes and the ideal schedule of such classes for the development of the EF have not yet been explored. Moreover, there is no unequivocal data on whether the attendance of extra classes is really associated with the development of the EF. In this regard, a research question was: Will attending extra classes during the year be associated with the children's EF development in comparison to the ones who do not attend extra classes? The main hypothesis of the research suggested that children attending extra classes had a higher level of EF development within a year compared to children taking no extra classes. The study considered some factors that can affect EF: screen time, mother's education level, and family income level.

Most studies with preschool children are experiments where children take part in a training of one type of activity (e.g., dance or cognitive training) for a specified period (e.g., 2 months). With this design of the study, all children attend all classes in the cycle and attend only these classes. In addition, classes are conducted by specially trained people who know about the experiment. Thus, these experiments have low ecological validity. The truth is that, in reality, children regularly miss classes, attend different types of classes, and all teachers behave differently during the class. In the present research, the requirements of ecological validity are met. All children in both groups participated in the general educational program offered by kindergartens, as do children in kindergartens in most countries of the world (Veraksa et al., 2019). Also, the children were not specially selected for participation in the study: Those children who already attended the center of extra preschool education were invited to participate, thus, reflected the real characteristics of preschoolers taking extra classes and their families.

This study compares children who do not participate in any extra classes and children who attend an extra preschool education center where classes are held twice a week for 4 h. During these 4 h, children attend a whole set of eight different classes (music, choreography, art, foreign language, literacy, math, computer science, and science) for 20 min. This exploratory study will allow to articulate the recommendations for further research in this direction.

2. Methods

2.1. Procedure

Executive Function evaluation was performed in the first half of the school year (in the fall). The first EF evaluation (T1) was performed in the penultimate year of kindergarten, when the children were

5–6 years old. The second evaluation (T2) was performed 1 year later in the last year of kindergarten, when the children were 6–7 years old. The level of EF was assets with the same measures in the first (T1) and the second (T2) evaluation. The EF evaluation included two individual meetings with each child (ca. 20 min. Each meeting). The tasks were always given to the children in the same order. EF assessments were carried out by specially trained testers. If for some reason the child did not want to continue the testing procedure, then it was stopped.

In T2, an online survey of mothers was also conducted. Mothers of children participating in T1 received a link to the questionnaire through parental chat on messengers. Completing the questionnaire took about 20 min. Not all mothers who received a link to the questionnaire completed it. Consequently, at this stage, the selection of the children took place based on their mothers' interest in participating in the study.

Before the start of the study, written informed consent was obtained from the parents. At the end of the study, each parent was individually provided with feedback on the child's EF evaluation results, and recommendations were given. Additionally, during this meeting, the parent had the opportunity to consult with a psychologist about the development of the child. This meeting was used as a motivation to participate in the study.

The study was approved by the Ethics Committee of the Lomonosov Moscow State University (approval no: 2022/23).

2.2. Sample

The sample of this study consisted of 124 typically developing children from Kazan, Krasnodar, Moscow, Perm, and Yakutsk. The mean age of the children in the last year of kindergarten (T2) was 78 months (see Table 1). All children spoke Russian without developmental delays. All children within the framework of the general program of the kindergarten attended classes aimed at cognitive, speech, physical, artistic-esthetic, and socio-communicative development (Veraksa et al., 2019).

There were two groups of participants: children attending extra preschool education center throughout the year ($n = 60$) and children who did not participate in any extra classes ($n = 64$). In each group, approximately 17% were boys, approximately 80% of the families had a medium level of income (see Table 1). There are statistically significant differences between the groups in the level of maternal education (see Table 1). Therefore, in the group of children who attended the extra preschool education center, more mothers had higher education. The average screen time of children in both groups is about 1,000–1,300 min per week. There are no statistically significant differences in screen time between the groups, but p-level is close to significant (see Table 1). In the "no extra classes" group, screen time is about 3 h per day on average (1298.86 min per week), and in the "extra classes" group it is about 2.5 h per day (1016.00 min per week).

2.2.1. "Extra classes" group

These children participate in a training, which is conducted by the extra preschool education. Classes under this training program are held twice a week for 4 h. During the 4 h, children attend various classes, each of which takes place in its classroom and lasts 20 min. The program includes the following classes: music, choreography, art, foreign language, literacy, math, computer science, and science. All of these children are also attending kindergarten and kindergarten classes.

2.2.2. "No extra classes" group

These children, as well as children from the "Extra classes" group, attend classes that are held in kindergarten (Veraksa et al., 2019). All children in kindergartens attend dance, music, physical education, drawing, and science at least twice a week. A reparatory-for-school classes (reading, writing, mathematics, etc.) children attend every day. Apart from kindergarten, these children do not attend any other extra classes.

The formation of these two groups went through several stages. First, at the T1, 180 preschoolers who attended extra preschool education center took part in the EF assessment. A year later, in T2, 72 children out of 180 took part in the reevaluation of the EF. There were also 110 children in the large longitudinal study who did not attend additional classes according to the mother's questionnaire. These children took part in the EF assessment at the same time (T1 and T2) as children who attended extra preschool education center. For each child attending the extra preschool education center, a child of the same age, sex, and screen time, with the mother of the same education level, and from a family with the same income level was selected from the 110 children who did not take extra classes. In both groups, children with maximum scores in the T1 were excluded from the sample. In the end, there were 64 and 60 children in the respective groups (17% boys). The inequality in sex distribution between the groups is because there were only 11 boys in the "extra classes" group.

2.3. Method

2.3.1. Questionnaire for mothers

The questionnaire for mothers asked about their children's attendance of any extra classes, in addition to those classes that are offered for all as part of the kindergarten program. The questions were about music, drawing, dancing, sports, math, literacy, foreign language, and classes with a neuropsychologist and a speech therapist, and other classes that mothers could indicate themselves. The following questions were asked about each type of classes:

1. What kind of activities does the child attend?
2. How many times a week does the child attend classes?
3. How long does the class last? (minutes).
4. How many years have the child been attending the classes?

In the questionnaire, there were also questions about child's screen time, maternal education level, and family income level.

2.3.2. Executive functions assessment

NEPSY-II subtest (Korkman et al., 2007) "Inhibition" was used to evaluate cognitive inhibitory control. A series of 40 figures (squares, circles, and arrows) make up this technique. The test consists of two sections: Naming (the child is asked to label the figures with the fastest speed possible) and Inhibition (reverse Naming, that is, when a square is shown, it should be labeled "a circle" and so on). Time devoted to each task, the number of mistakes, and the times of self-adjustments are recorded. These three values are converted into a combined scaled score (from 1 to 20 points) based on corresponding tables. The

TABLE 1 Differences in sex, maternal education level, family income level, age, and screen time between the groups.

		No extra classes, n=64		Extra classes, n =60		Differences	
		%		%		Chi-squared test	p-level
Sex	Boys	17.2		18.3		0.024	0.877
	Girls	82.8		81.7			
Maternal education	Secondary general education	12.3		0.0		9.141	0.027
	Secondary vocational education	31.6		11.1			
	Higher education	56.1		83.3			
	Academic degree	0.0		5.6			
Family income	Low	8.6		0.0		2.170	0.338
	Average	77.6		77.8			
	Above average	13.8		22.2			
		M	SD	M	SD	U-Mann–Whitney Test	p level
Age, 6–7 years, months		78.37	3.39	78.40	2.77	1694.500	0.806
Screen time at the age 6–7, minutes per week	Total screen time	1298.86	603.86	1016.00	516.02	341.000	0.061

combined scaled score for "Inhibition" was incorporated in the analysis.

The NEPSY-II subtest (Korkman et al., 2007) "Statue" was used to evaluate physical inhibitory control. During this task, a child has to stay immobile for 75 s without being disturbed by special sound stimulus (knocking, coughing, and a sound of a pen that fell on the floor). For each 5-s period, a child received 0–2 points for successfully following instructions (maximum number of points = 30). Such mistakes as additional movements, eye opening, and various sounds are recorded. The total score was incorporated in the analysis.

Verbal working memory was evaluated with the help of the NEPSY-II subtest (Korkman et al., 2007) "Sentences Repetition" This instrument comprises 17 sentences that progressively become more difficult to remember as the sentences expanded in length and became more grammatically intricate. Participants receive points for correctness: two points are given for each correctly repeated sentence, one point for a sentence with one or two errors, and 0 points for 3 and more errors (maximum points = 34). In this article, the analysis includes only the total score assigned for the correct repetition of sentences.

To assess visual working memory, the NEPSY-II subtest (Korkman et al., 2007) "Memory for Designs" was utilized. Participants are shown a picture with vibrant images in different cells of a field (four trials with four, six, six, and eight images). After the children have 10 s to look at the picture, it is removed and the respondents have to find the exact images of the set and place them in the appropriate cells on a blank field. The children receive two points for each correctly selected card (picking a similar card gave a child one point) and one point for accurately selecting the position of the card on the field. Moreover, if the participant places the correct card in its proper location, he or she receives two bonus points. Subsequently, the content score (maximum points = 48), location score (maximum points = 24), bonus score (maximum points = 48), and the total score (maximum points = 120) are calculated. Only the content score was examined in the article.

"Dimensional Change Card Sort" task (Zelazo, 2006) was utilized to evaluate cognitive flexibility. Three task sequences that incorporate sorting cards with the images of rabbits and boats using different rules are included in this tool. The initial sequence requires child to separate six cards by color (put red cards to one side, blue ones to the other). The following sequence requires the child to separate six cards by shape (boats and rabbits separately). In the final activity, participants are expected to be guided by a stimulus not related to color or shape (presence or absence of a black frame on the picture). Children should separate the 12 cards according to the shape or color of the object and the frame. Participants gain one point for each correctly sorted card, and those points are combined into the total score (maximum points = 24). In this article, the total score was used.

3. Results

The descriptive statistics for the measures of the executive function are presented in Table 2. In the present study, we calculated development rate of EF within a year (Δ), where Δ = EF level at 6–7 years (T1) − EF level at 5–6 years (T2). Nonparametric Mann–Whitney U-test for independent samples was used onwards because not all parameters were distributed normally. According to the Mann–Whitney U test, there is a difference between groups in verbal working memory development rate. So, children attending the extra preschool education center showed a higher verbal working memory development within a year than the children taking no extra classes

TABLE 2 Descriptive statistics for executive functions measures.

	Group	*n*	Min.	Max.	Median	Mean	SD	Skewness	SD	Kurtosis	SD
Δ Inhibition	No extra classes	54	−10	8	1.00	0.574	0.569	−0.650	0.325	0.335	0.639
	Extra classes	55	−9	6	0.00	0.218	0.421	−0.936	0.322	1.13	0.634
Δ Physical Inhibition	No extra classes	46	−16	8	0.00	0.391	0.582	−1.52	0.350	6.19	0.688
	Extra classes	42	−10	6	0.00	−0.429	0.588	−0.625	0.365	−0.0175	0.717
Δ Verbal working memory	No extra classes	62	−7	18	1.00	1.39	0.562	0.867	0.304	2.18	0.599
	Extra classes	60	−7	13	2.50	2.97	0.565	0.161	0.309	−0.0352	0.608
Δ Visual working memory	No extra classes	60	−10	17	6.00	5.43	0.731	−0.271	0.309	−0.148	0.608
	Extra classes	58	−6	24	5.00	7.07	1.01	0.717	0.314	−0.0428	0.618
Δ Cognitive flexibility	No extra classes	64	−5	7	3.00	2.45	0.321	−0.692	0.299	0.275	0.590
	Extra classes	60	−4	9	3.00	2.72	0.424	0.0729	0.309	−0.632	0.608

TABLE 3 Mann–Whitney U test for differences between mean rank of group taking attending extra preschool education center and group not taking any extra classes.

Executive functions component	Age, and Δ	No extra classes, *n* =64		Extra classes, *n*=60		U-Mann–Whitney test	*p* level
		M	SD	M	SD		
Inhibition	5–6 y. o.	10.04	3.00	10.65	3.07	1236.000	0.128
	6–7 y. o.	10.61	3.46	10.87	3.88	1340.000	0.377
	Δ	0.57	4.18	0.22	3.13	1369.500	0.482
Physical inhibition	5–6 y. o.	27.35	2.44	27.10	2.28	856.000	0.348
	6–7 y. o.	27.74	3.47	26.67	3.54	782.000	0.116
	Δ	0.39	3.95	−0.43	3.88	853.000	0.342
Verbal working memory	5–6 y. o.	15.90	4.35	20.13	3.41	781.000	0.000
	6–7 y. o.	17.29	5.28	23.10	3.81	703.000	0.000
	Δ	1.39	4.43	2.97	4.38	1433.500	0.028
Visual working memory	5–6 y. o.	33.41	6.38	36.28	3.86	1281.500	0.013
	6–7 y. o.	40.48	5.83	41.68	5.19	1528.500	0.318
	Δ	7.07	7.66	5.43	5.66	1651.500	0.633
Cognitive flexibility	5–6 y. o.	18.47	1.94	17.92	1.62	1624.000	0.133
	6–7 y. o.	20.92	2.67	20.63	2.95	1838.000	0.679
	Δ	2.45	2.57	2.58	2.93	1881.000	0.844

(see Table 3). There are also statistically significant differences between the groups in the level of verbal working memory in T1 and T2 (see Table 3). There are no other statistically significant differences between the groups in the rates of EF development (see Table 3).

4. Discussion

The study aimed to investigate the difference in EF development within a year between children attending the extra preschool education center two times a week for 4 h and children who did not take extra classes. The main hypothesis of the research suggested that children attending extra classes had a greater development rate of EF within a year, compared to children taking no extra classes. This hypothesis is confirmed in part. In the study, there is a difference between the groups in the rate of development of verbal working memory.

There is a difference between the groups not only in the rate of development of verbal working memory but also in the level of verbal working memory at the first EF assessment (T1). Children

attending the extra preschool education center initially had a higher level of verbal working memory. The difference in the initial level can be explained by the fact that only children with a high enough level of cognitive development enroll in the educational program at the center. It is shown that verbal working memory is positively associated with fluid intelligence and attentional processes (Engle, 2018; Sala and Gobet, 2020). While children with not mature enough verbal working memory, fluid intelligence, and attentional processes are not enrolled in 4-h classes (Sala and Gobet, 2020).

The difference between the groups in the development rate of verbal working memory can be explained by the features of the classes in the extra preschool education center. Since 5–7 year old children do not yet know how to read quickly, teachers give all children instructions verbally during classes. That means that the children from "extra classes" group two times a week for 4 h actively listened to what a teacher was telling them and operated on this information. Such a process stimulates the development of verbal working memory (Engle, 2018). It is important to note that in the present study, working memory was assessed using the subtest "Sentence Repetition." This tool evaluates the same processes that children use when listening to instructions – children need to keep exactly and in detail in verbal working memory what the teacher says.

Other factors in addition to extra classes may have influenced the difference between the groups on the topic of growth of verbal working memory. Therefore, the screen time was higher in the "no extra classes" group, and the level of maternal education was lower. Both these factors are associated with the development of EF (Linebarger et al., 2014; Diamond and Ling, 2016; McNeill et al., 2019). However, the absence of differences between the groups in the development rate of other components of EF except verbal working memory suggests that the difference in the development rate of verbal working memory is related precisely to the extra class attendance. Because both screen time and maternal education level are associated with the development of all components of EF, not just verbal working memory (Linebarger et al., 2014; Diamond and Ling, 2016; McNeill et al., 2019).

There are no differences between the groups in the rates of development of cognitive flexibility, visual working memory, cognitive, and physical inhibitory control. One can assume that the absence of differences in these components can be explained by the fact that all children initially had normal EF level, almost all children were from middle and high socioeconomic status families. Although extra classes give a more significant effect for children with an initially low EF level and children from low socioeconomic status families (Diamond and Ling, 2016; Zysset et al., 2018). Also, at preschool age, extra classes stimulate EF development more strongly in boys than in girls, since girls, on average, have a higher EF level at this age (Zysset et al., 2018). And in the current study, the majority of the participants were girls.

The absence of differences in all EF components except verbal working memory can be explained by the fact that the children in both groups attended in kindergarten classes every day. The kindergarten classes last for several hours a day, and the rest of the time in kindergarten children spend on play, which also contributes to the development of EF (Yogman et al., 2018; Rosas et al., 2019). That is, the children in both groups are already in an environment that is favorable for the development of EF. And perhaps the effect of extra classes twice a week is not so great compared to the influences of children's everyday kindergarten environment.

Another explanation for the absence of difference between the groups is related to the role of parents. Parents can involve children who do not take additional classes in special developmental activities at home. And vice versa, those who take additional classes may not be also engaged at home. Most likely, special developmental activities at home are less disciplined then in extra preschool education center, so there are no situations when a parent gives a lot of instructions to a child. One can assume that in this regard there are differences between the groups in verbal working memory development rate, but there are no differences in other EF components development rate. These other components are probably stimulated in both groups, one group at home and the other in the classroom.

There are many limitations of the study. First, the level of maternal education and screen time are different in the groups. Second, there is no information about classes performance characteristics and about the level of motivation of extras classes participation in the extra classes group. Third, several important factors that may influence EF development were not controlled: quality of parent–child interaction, characteristics of the learning environment in kindergarten and at home, level of physical activity.

5. Conclusion

This exploratory study allows one to draw recommendations for further research design. Further longitudinal study should continue more than 1 year. Further research should include different groups of participants: typically developing children and children with special needs, children from families with low socioeconomic status. Also, it is important to include children with an initial low, medium and high EF level and include 50% of boys. It is also crucial to monitor as much as possible factors that may affect EF development. Children taking extra classes should be under observation throughout the whole study period to evaluate the performance characteristics and motivation and attendance frequency. Moreover, to explore which type of extra classes is most effective for EF development, one should compare different training programs and classes with different duration. Also, it is possible to use other methods of EF evaluation to compare sensitivity of the subtests.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Ethics Committee of the Lomonosov Moscow State University (approval no: 2022/23). Written informed consent to

participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

LB and AD contributed to conception and design of the study. EC gathered and analyzed the data and acquired resources. LB, EC, and AD drafted the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY
Yulia Solovieva,
Meritorious Autonomous University of Puebla, Mexico

REVIEWED BY
Patricia Wiener,
Independent Researcher, La Paz, Bolivia
Luis Quintanar,
Autonomous University of Tlaxcala, Mexico

*CORRESPONDENCE
Ekaterina S. Oshchepkova
✉ oshchepkova_es@iling-ran.ru

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The longitudinal influence of the level of executive function development on children's transcriptional skills: a modern view of A. Luria's ideas

Ekaterina S. Oshchepkova[1,2]*, Arina N. Shatskaya[2] and Maria S. Kovyazina[1]

[1]Department of Educational Psychology and Pedagogy, Lomonosov Moscow State University, Moscow, Russia, [2]Psychological Institute of the Russian Academy of Education, Moscow, Russia

In the realm of Cultural-Historical Theory, A. Luria suggested writing as a model of a complex system of higher mental function, since that function is based on various psycho-physiological mechanisms, including processing of audial and visual information; and as a complex system of the frontal lobe functions of overcoming perseveration, and creation and control of the writing program. Subsequent research on these topics has shown a close association between the level of development of executive functions (EF) and writing skills. Nevertheless, the question of which parts of EF influence which aspects of writing, remains unresolved. In addition, there are few longitudinal studies of EF's influence on writing. In this article, we focus on the results of a longitudinal study of the influence of EF in children 6.3 years old on their mastery of basic writing skills at the age of 7.5. The results of regression model construction showed that all the aspects of executive functions strongly influenced the children's transcription skills, while the greatest impact on the development of the graphomotor component and spelling skills was exerted by working memory and inhibition control. These results are consistent with studies that have shown a correlation between the development of writing skills and EF. These results also confirm A. Luria's views on the importance of functions responsible for processing audial and visual information in the process of writing, and the importance of suppressing irrelevant stimuli and perseverations. Our research shows the importance of the development of EF in preschool childhood.

KEYWORDS

cultural-historical theory, writing skills, executive functions, transcriptional skills, writing development

1. Introduction

The first of Luria's works about the development of writing in children appeared in 1929. It was "Voprosy marksistkoi pedagogikii [Problems of Marxist education]. Moscow: Academy of Communist Education, 1929. Vol. 1, pp. 143–176" (cited in Luria, 1978). There he noted that "For a child to be able to write or note something, two conditions must be fulfilled. First, the child's relations with the things around him must be differentiated (…). Second, the child must be able to control his own behavior by means of these aids, in which case they already function as cues he himself invokes" (Luria, 1978).

In 1950, A. Luria's "Essays on the Psychophysiology of Writing" was published (Luria, 1950, 1978). In this work, he set the task of helping primary school teachers and specialists understand the process of writing and its organization from the standpoint of neuropsychology and psychophysiology. To do this, Luria used neuropsychological data on how writing skills are impaired when various parts of the brain are injured. Approaching writing as a higher mental function, A. Luria identified the following writing stages: (1) analysis of phonemic word content; (2) translation of highlighted phonemes into a graphic form; and (3) transformation of optical signs into necessary graphic outlines. When Luria discussed the mechanisms behind these stages, he emphasized the roles of the auditory analyzer (unlike the usual writing process), articulation, and visual organization of the writing process, as well as the importance of the frontal lobes in planning tasks and suppressing unnecessary activity and perseverations.

Further development of Luria's ideas in the school of cultural-historical psychology has revealed that writing skills, as a part of the general notion of literacy, are an important aspect of children's mental development, and a condition for successful schooling (Solovieva et al., 2021; Veraksa and Veraksa, 2021). Now Luria's followers among speech therapists and neuropsychologists continue to apply his ideas to overcome learning disabilities in children (Velichenkova et al., 2001; Akhutina, 2004).

The expanding development of electronic communication is leading to children typing on keyboards more often than writing by hand; this practice deprives them of the necessary prerequisites for developing writing skills (Mayer et al., 2020), which is becoming a greater problem of its own.

Writing as a set of rules, and the skill of capturing certain meanings in written form, requires the development of transcription skills (handwriting and spelling) (Rocha et al., 2022). Transcription skills (handwriting and spelling) may be assessed by various methods. We used methods developed by the Vygotsky-Luria school, which are currently successfully identifying children's learning disabilities (Akhutina and Pylaeva, 2012; Glozman and Plotnikova, 2021).

The connection between EF and transcription skills has been studied (Hayes and Berninger, 2014; Yeung et al., 2017). However, the question remains as to which aspects of EF influence handwriting the most, and which influence spelling. Moreover, the number of longitudinal studies dedicated to the influence of EF on transcription skills are few. This fact explains the novelty of our research: what is the connection between different aspects of children's EF and the development of their writing skills in the Russian language, as they use Cyrillic writing with its predominance of orthography and morphology in spelling (Boulware-Gooden et al., 2015).

We posed the following research questions in our study: (1) Which EF aspect has the greatest connection to the productivity of a child's graphomotor test performance; and (2) Which aspect of EF is the most connected to the level of development of spelling skills?

2. Method

Our research sample consisted of children living in Moscow. We have selected the children from 6 to 7 y.o. because we are interested first of all in the process of child's transition from preschool to school and in the changes that occur during this process. Two meetings, with an interval of approximately 1 year in-between, were conducted with them. At the first stage of the research, the children were attending kindergarten ($n = 346$, $M = 6.24$ y.o., SD = 4.15 mth), while at the second stage, the same children were attending first grade. The number of children had decreased ($n = 271$, $M = 7.5$ y.o., SD = 6.18 mth). So, the final size of the sample was 271 persons (100 boys and 171 girls). During both stages, the children's level of development of the components of executive functions was diagnosed (verbal and visual working memory, cognitive flexibility, inhibitory control). In the second stage of diagnostics, an assessment of the children's writing skills development was also conducted. According to parents' questionnaire their social cultural level was middle or high-middle. The teaching methods corresponded to a typical educational program in Russia for monolingual regions. According to this program the children begin to study written transcription only in primary school. So when the study took place, the children had been studying written transcription for 7 months.

Executive functions (EF) is a very complex concept with different approaches to it. We followed Miyake's model of EF (Miyake et al., 2000). The NEPSY-II complex (Korkman et al., 2007) was used to assess almost all aspects of the children's EF. However, the evaluation of cognitive flexibility for school students and preschoolers was conducted by different methods due to age restrictions specified by the authors. So, for younger school students, a task from NEPSY-II was used, and for preschoolers, the *"DCCS"* (Zelazo, 2006) method was applied.

Moreover, the "Raven's progressive matrices" (Raven and Court, 1998) test was applied in order to control the factors of individual differences in intellectual development. Only the children with normative cognitive development participated in further study.

The diagnosis of the children's transcription skills was conducted based on the following tests (Akhutina and Pylaeva, 2012): (a) the graphomotor test: the child is asked to write a number of alternating elements without raising their hand from the paper (the correctness of task performance is assessed); (b) the child is asked to write down their name and surname (the writing correctness is assessed); (c) the child is asked to write all the block letters they know, without repeating them (the total amount of letters written correctly without repetitions and the total number of mistakes made are assessed); (d) the child is asked to write down six syllables from dictation (the total writing correctness and the number of mistakes made are assessed); (e) the child is asked to write down three short sentences from dictation (the writing correctness, the number of words missed, the number of spelling and other mistakes – i.e., merged spelling of words and sentences, letter omission, incorrect use of upper/lower case letters, etc. -- are assessed); and (f) the child is asked to look at a number of purposefully incorrectly written words and correct the mistakes (the number of corrected words and correction mistakes made by the child are assessed).

As a final indicator, the following parameters were measured: (1) the productivity of graphomotor test performance; (2) spelling skills: and (3) the overall productivity of task performance from tests b-f above.

The data obtained was analyzed in the following way:

1. In the first testing (at 6 y.o.), we divided the sample into three groups according to the children's levels of EF development: high, average, or low. Then we calculated the correlations

between the levels of development of all EF components at 6 years of age and the levels of development of the highlighted writing skills indicators 1 year later. In particular, we analyzed the connections between the level of writing skills at the age of 7 with the level of the following parameters at the age of 6: (a) verbal and visual working memory; (b) cognitive flexibility; and (c) inhibitory control.

2. We constructed a general linear model. We chose the writing skills of the 7-year-old children as our dependent variable. As predictors, we selected the scores on all EF functions recorded at 6 years of age: audial and visual working memory; inhibitory control; and cognitive flexibility. Moreover, our model included such individual factors as gender, age (measured in months), and level of intellectual development (estimated with Raven's progressive matrices).

3. Results

3.1. Predictors of graphomotor writing skills development

3.1.1. Working memory influence

First, we compared the graphomotor test indicators among the children with low, average, and high levels of verbal and visual working memory. The results showed that the three groups differed distinctively in regard to both kinds of working memory ($F = 7.93$, $p < 0.001$ and $F = 7.75$, $p < 0.001$, accordingly). So, children with high levels of visual and verbal working memory at the age of 6 showed the highest scores in graphomotor test performance ($M = 4.15$, SD = 0.81 for visual memory, $M = 4.2$, SD = 0.76 for verbal memory), while children with low levels of working memory showed the lowest performance scores ($M = 3.59$, SD = 0.87 for visual memory, $M = 3.58$, SD = 0.89 for verbal memory). Thus, the higher the level of verbal and visual working memory development in preschool, the better the children were at performing the graphomotor test in the first grade of school.

3.1.2. Inhibitory control influence

Second, we compared the graphomotor test indicators for children age 7, who had previously (1 year ago) demonstrated low, average, and high levels of inhibitory control development. The results indicated that all three groups were distinctively different ($F = 6.55$, $p = 0.002$). Thus, the children with a low level of inhibitory control at the age of 6, showed lower levels of graphomotor test performance ($M = 3.63$, SD = 0.89), while children with higher levels of inhibitory control showed significantly better results ($M = 4.14$, SD = 0.78).

3.1.3. Connection to cognitive flexibility

The analysis showed that there was no significant difference between children with low, average, and high levels of cognitive flexibility ($F = 2.15$, $p = 0.121$).

Thus, the level of graphomotor test performance at the age of 7 was significantly associated with the level of verbal and visual working memory, as well as the inhibitory control level at the age of 6 years old. A similar association, although not as statistically significant, can be noted in regard to cognitive flexibility. The more developed these EF components were at the age of 6, the better the children were at graphomotor test performance at the age of 7. The level of writing skills development depended on the level of self-regulation while still in kindergarten.

We note that the following indicators were used in the scoring of integral spelling skills mastery: (1) the productivity of writing one's own name and surname; (2) writing alphabet letters; (3) writing syllables and sentences under dictation; and (4) the test of correction of word mistakes. We present the results obtained on each component in detail, with the results of descriptive statistics on the parameters of integral spelling skills mastery, as well as its five components (see Table 1).

Moreover, we calculated the correlations between mistakes made in all the writing tests at 7 years of age, and the level of development of all EF components prior to that, when the children were age 6. The results revealed that all significant connections between the mistakes made in all the writing tests and EF were of negative coefficients (i.e., the higher the EF indicator, the fewer mistakes the children made). However, this was not the case for the alphabet writing test ($r = 0.199$, $p = 0.002$). The most potent association was between the overall number of mistakes made in the sentences writing test and the level of verbal working memory development. The more developed the verbal working memory, the fewer mistakes the children made.

3.2. Predictors of spelling skills development

Regarding the relationship between the level of EF development at the age of 6 and spelling skills development, the following results were obtained:

3.2.1. Working memory

The results showed that the separate groups significantly differed in accordance with every type of working memory ($F = 6.38$, $p = 0.002$ and $F = 26.1$, $p < 0.001$). Thus, children with high levels of visual and verbal working memory at the age of 6 demonstrated a considerably higher level of spelling skills a year later, while children with low levels of development of these components of EF showed a lower level of spelling skills (see Figure 1).

3.2.2. Inhibitory control

It has been shown that there were significant differences between certain groups of children in this area ($F = 10.8$, $p < 0.001$). Children from the "high" inhibitory control group (at the age of 6) demonstrated a higher level of spelling skills mastery at age 7 (see Figure 2).

3.2.3. Cognitive flexibility

Significant differences between the groups with high, average, and low levels of cognitive flexibility were shown ($F = 7.61$, $p < 0.001$). A year later, the children with a high level of cognitive flexibility demonstrated a high level of spelling skills mastery, while the children with average and low levels of cognitive flexibility show those same levels of spelling skills mastery (see Figure 3).

After editing out the missing values and checking the basic assumptions for linear model construction, we found that the model is homoscedastic. Therefore, we decided to use the weighted least squares regression method. The predictors did not demonstrate

TABLE 1 Descriptive statistics on spelling skills indicators at 7–8years old.

	Integral indicator, spelling skills (%)	Name-surname	Alphabet	Syllables	Sentences	Word mistakes correction
Mean	86.1	4.77	21.3	5.74	12.1	8.16
Median	88.2	5	24	6	13	8
Standard deviation	10.9	0.471	10.6	0.799	1.88	1.78
Min	21.3	3	0	0	0	0
Max	100	5	33	6	13	10

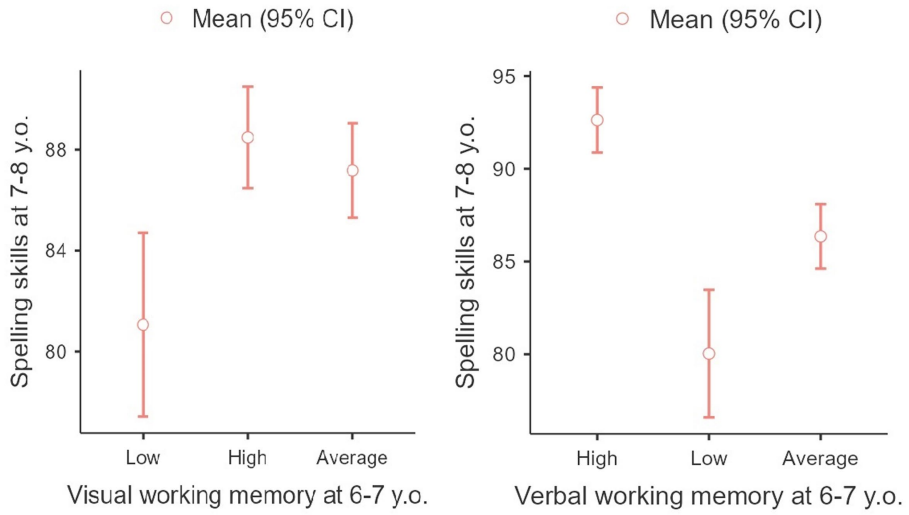

FIGURE 1
Connection between spelling skills mastery at the age of 7–8 y.o. with working memory at the age of 6–7 y.o.

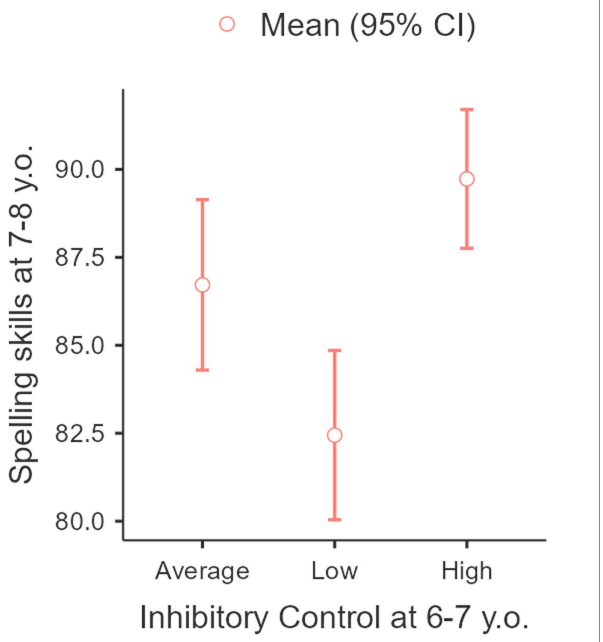

FIGURE 2
Connection between spelling skills mastery at the age of 7–8years old with inhibitory control at the age of 6–7years.

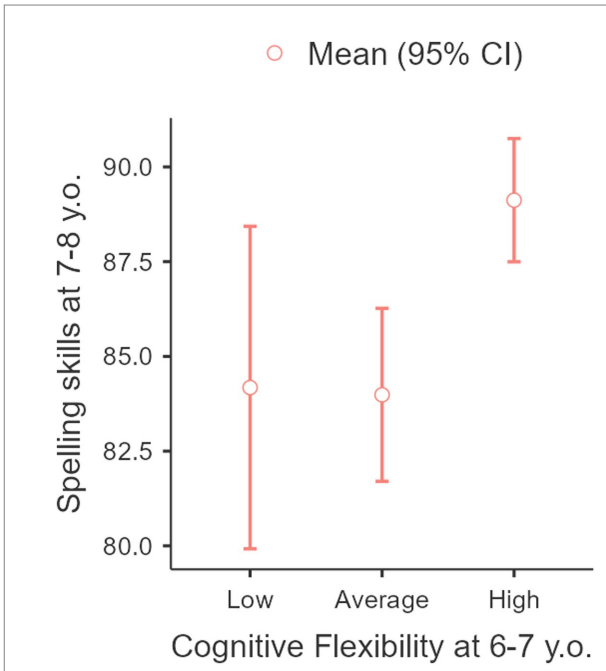

FIGURE 3
Connection between spelling skills mastery at the age of 7–8years old with cognitive flexibility at the age of 6–7years old.

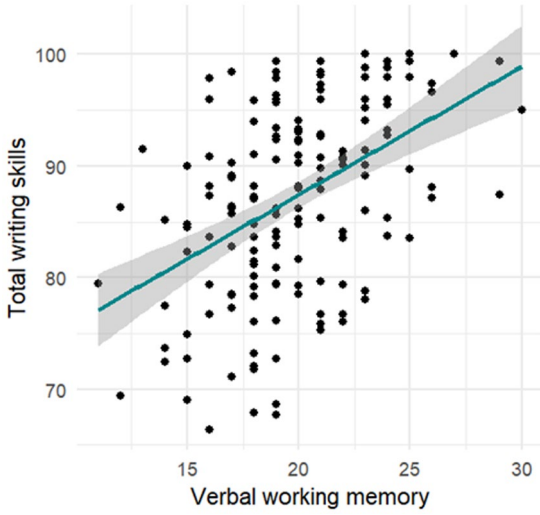

FIGURE 4
Connection between spelling skills mastery at the age of 7–8years old with audial working memory at the age of 6–7years old.

multicollinearity (VIF < =1.519). The remaining regression assumptions were also successfully checked. As a result of the stepwise removal of the non-significant predictors, the final model consisted of the following predictors: (a) the features of intellectual development; (b) inhibitory control; and (c) verbal working memory ($F = 23.32$, $p < 0.000$, Adjusted R-squared: 0.2925). After comparing the regression estimate predictors in the final model, it turned out that the most important contribution to the total spelling skills score at the age of 7 was made by the level of verbal working memory at the age of 6 (see Figure 4). The second most important impact was exerted by inhibitory control, and the third greatest by level of intellectual development.

Thus, all the components of EF at an earlier age were connected to the level of spelling skills mastery at the age of 7. However, the most important contributions were made by verbal working memory and inhibitory control.

4. Discussion and conclusion

A. Luria demonstrated that the participation of audial and visual analyzers, as well as the brain's frontal lobes, is crucial for a successful development of the writing process.

As is shown by neuro-visualization studies, verbal working memory is connected to the same brain sections as the audial analyzer, as Luria stated (Kumar et al., 2016), while visual working memory is connected to the same brain sections as the visual analyzer, as also described by Luria (Ungerleider et al., 1998). In addition, inhibitory control is connected to the brain's frontal lobes (Knyazev, 2007). This is why the data we obtained from a longitudinal population sample of normally developing children confirms the results which A. Luria found in studies of adults with brain dysfunctions.

The research also confirms the results of studies of the connection between EF and writing (Cordeiro et al., 2020) over the long run, with consideration of the specifics of writing in the Russian language.

In regard to the specific aspects of transcriptional skills, according to our research, working memory and inhibitory control influence the graphomotor skills first and foremost.

We can assume that the connection to working memory is based on the fact that good memorization of samples and instructions (visual and verbal memory) contributes to correct performance during this test. As for inhibitory control, the significant aspect of the graphomotor test is the withholding of stereotypical hand movements, as the child is trying to draw straight or tilted lines only, without interchanging them. Inhibitory control allows the child to inhibit irrelevant hand movements and continue with the correct execution of the task.

The level of spelling skills (in the first grade of school) was influenced by all the EF components in the school preparatory kindergarten group. We assume that this could be explained by how verbal memory allows the children to retain words and sentences they were given in dictation, while inhibitory control allows them to use spelling rules, instead of writing down words in the way they are heard.

To summarize, our research on a sample of children writing in a Cyrillic system with its predominance of orthography and morphology in spelling performance (Boulware-Gooden et al., 2015) has confirmed the earlier studies of the connection between executive functions and the writing process (Limpo and Olive, 2021).

Our study allows us to formulate a number of recommendations for educators, especially those preparing children for school or working to overcome learning difficulties. We can state that the development of executive functions will have a significant positive impact on the development of literacy in children.

Our study has a number of limitations. First, it was carried out on monolingual children. We assume that bilingual children will have their own characteristics in mastering transcription skills, which is associated, on the one hand, with better development of regulatory functions, and on the other hand, with possible difficulties in mastering different writing systems (for example, Latin and Cyrillic). Secondly, it included only middle and high-middle class children with normative development. It is possible that other patterns will be revealed in children with social or cognitive difficulties. Thirdly, in contrast to the studies of A. Luria, which were conducted on the basis of neurological data, our study relies on a non-clinical approach through the development of executive functions. In order to draw unambiguous conclusions, it would be good to compare the Luria's and Miyake's concepts and their contribution to the development of writing.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of the Faculty of Psychology at the Lomonosov Moscow State University (the approval no: 2021/98). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

MK was responsible for the methodological basis and understanding of the theoretical and practical significance of the research. EO was responsible for the design development, defined the diagnostic tools, and wrote the individual parts of the text of the manuscript. AS was responsible for the data collection, analysis of the received data, and wrote the individual parts of the text of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY
Yulia Solovieva,
Meritorious Autonomous University of Puebla, Mexico

REVIEWED BY
Claudia Ximena González-Moreno,
Pontifical Javeriana University, Colombia
Daniel Rosas,
National Autonomous University of Mexico, Mexico

*CORRESPONDENCE
Margarita Gavrilova
✉ gavrilovamrg@gmail.com

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Do executive function and family factors predict children's preference for trendy over classic toys? An experimental investigation

Margarita Gavrilova[1]*, Vera Sukhikh[1] and Nikolay Veresov[2]

[1]Faculty of Psychology, Lomonosov Moscow State University, Moscow, Russia, [2]School of Education Culture & Society, Monash University, Melbourne, VIC, Australia

In the last decade, global trends and social media have covered almost the entire world, including children population. The toy industry is filled with new items whose popularity has been triggered by viral publications on social networks or by popular animated films. The present experimental study is the first to (i) describe the characteristics of toy choice in the context of the spread of global trends, and (ii) examine the influence of family and individual child characteristics on the dependence on trends in toy choice. The sample consisted of N=127 children aged 3–4 years. Children had individual assessment of non-verbal intelligence main executive function skills (cognitive flexibility, working memory and inhibition control) and took part in the experiment, while their parents completed a questionnaire on family background. Analysis of children's answers about the reason for choosing a particular toy indicates uncertain motivation in choosing a trendy toy in contrast to the classic ones. It is reflected in the fact that children do not know what exactly and how they will play with it. It is revealed that boys are 1.66 times more likely to prefer the trendy toy than girls. It was also found that as inhibitory control increased, children were less dependent on tendencies to choose toys.

KEYWORDS

child psychology, cultural-historical approach, play, trendy toys, toy industry, toy preference, executive functions

1. Introduction

A toy is both an object of children's play, an object of culture, and an object of the global toy industry (Francis, 2010; Mertala et al., 2016). Although children's play and culture have relatively stable characteristics over time, the children's consumer culture been changing rapidly over the past decade. The digitalization of the toy industry leads to an instant spread of trends that are displacing more traditional children's toys (Marsh, 2017). For example, children's plays are increasingly based on the plots of popular animated films and video games (Klinger, 2007; Hinkley et al., 2018). Such animated products are entering children's playing as a result of the active marketing and commercialization of the toy industry.

From the perspective of the cultural-historical approach to the understanding of children's play, there are strong theoretical reasons to suggest that the spread and uncontrolled change of trendy toys can lead to negative consequences for children's development (Smirnova, 2015; Ryabkova et al., 2019; Veraksa et al., 2020). First, the toy is the material for framing children's play and creating imaginative situations (Elkonin, 1980, 2005; Vygotsky, 2004; Francis, 2010; Wynberg et al., 2022). As a result of increased interest in animated film and video game plots,

children actually lose the opportunity to construct a story on their own and often find it difficult to move away from the plots set by the film or game. Second, a story-rich and meaningful play promotes children's development. Play effectively trains executive function skills (Kelly et al., 2011; Fleer et al., 2019; Veraksa et al., 2020b; Vidal Carulla et al., 2021; Doebel and Lillard, 2023), emotional and social competencies (Mathieson and Banerjee, 2011; Howard et al., 2017; Colliver and Veraksa, 2021), and language skills (Nicolopoulou et al., 2015; Quinn et al., 2018). The prevalence of animated film and play plots strips children's play of essential features such as spontaneity, initiative, and freedom. Thirdly, the toy helps the child to reproduce certain situations and cultural contexts in play. That is, play is a symbolic means of understanding the surrounding world for the child (Smirnova, 2015). In recent decades children have been losing interest in reproducing real-life events and cultural themes in play (tea parties, mother–daughters, playing in a hospital). Thus, children are to some extent losing the opportunity to learn about real-life natural and social processes through play, as their attention is occupied by trendy toys.

Trendy toys are toys that become extra popular for a period of time. Over the past few years, the biggest trends in toyse were Spinner and Pop It, whose popularity has been driven by viral videos on social media. The 2022–2023 Huggy Wuggy is a new trendy toy that has gained popularity worldwide. Huggy Wuggy is not a classic harmless toy: it is a sinister monster from a survival horror game called Poppy Playtime. According to the plot of this game, a plush toy with sharp teeth singing about "hugging and killing" stalks the player to kill him. In the short period of the Huggy Wuggy toy's explosive popularity, there is a wealth of evidence to suggest that it has a negative impact on children's psychosocial development. For example, a study by Pelli (2022) on children's fears describes a case of severe fear of the Huggy Wuggy. The child drew a picture of crawling under the bed so that the monster would not see and eat him.

2. Current study

The present study is an experiment based on the ideas of the cultural-historical approach. The aim of this study was to determine the predictors that are related to children's trend dependency in choosing toys. The study covered three research questions: (i) How do children choose toys and how do they explain their choices in relation to the classic and trendy toys? (ii) whether there is any impact of family factors (SES, parents' education and number of children) on children's trend dependency in their choice of toys; (iii) do EF skills predict a children's trend dependency in choosing toys?

The theoretical background for this research is related to key theoretical and methodological ideas of the cultural-historical approach. Based on the work of Vygotsky it follows that a toy should help a child to experience an imaginary situation and to accept a play role and its associated rules (Vygotsky, 2004). Hence, as a result of the experiment it is expected that children will choose preferably those toys which allow to create a rich imaginary situation. This requires children to have an idea of possible play actions and plots which can be implemented in play with a particular toy. In addition, Elkonin showed that the object of children's play is most often the relationship between people (Elkonin, 1980). Thus, as a result of the experiment children are expected to choose toys that represent the meaning and content of people's relationships.

Furthermore, it is expected that children with weak EF skills will show higher trend dependency in choosing toys. The theoretical justification behind this assumption is that EF skills on the one hand provides an opportunity for play (as well as any other complex self-directed activity; Kelly et al., 2011; Veraksa et al., 2019), but also develops through meaningful true play (Veraksa et al., 2020; Vidal Carulla et al., 2021). The choice of a trendy toy will indicate that the child is not looking for the possibility of creating imaginative situations and playful plots in the toy, but is primarily guided by its appearance and popularity.

3. Materials and methods

3.1. Procedure

Data were collected between October and December 2022. During this time in the country of study the virally popular trendy toy was Huggy Wuggy. This toy is described with more detail in the Introduction section. Due to its off-trend popularity among pre-school and school-age children, Huggy Wuggy (hereinafter Trendy Toy) was the one used in this study to assess children's trend dependency in choosing toys.

The research procedure included two stages. In the first stage, an individual assessment of the EF skills was carried out by experienced testers. The tools were administered in a strictly order. Each meeting with a child lasted no more than 15 min.

In the second stage, an individual experimental session within the framework of a forced choice paradigm was conducted to explore children's toy preferences. It consisted of two steps. In the first step, the child was shown a specially selected set of 12 toys. These were the toys that could interest children with different interests and preferences: car, dog, teddy bear, girl doll, male doctor doll, hospital playset, supermarket playset, space robot, fairy dragon, human family, family of tigers, family of cartoon animals. Toys were sampled based on the expression of characteristics according to four criteria: genderness ('girly' toy, 'neutral' toy and 'boy' toy); detailedness (three toys from minimally detailed to maximally detailed); realism (three toys from minimally realistic to maximally realistic); anthropomorphism (three toys from minimally anthropomorphic to maximally anthropomorphic). They were placed on a white cloth in a certain order and at a given distance from each other. Each toy was shown to the child and named. Then a child was asked to choose one of them that he/she would like to play with the most and tell why. Next, the child was shown two toys: the choice toy and the Trendy Toy. The child was again asked to choose one of these two toys, which one he wanted to play with the most. If the child chose the Trendy Toy trendy toy, he/she was asked to tell why he/she chose it.

3.2. Participants

A total of 127 children (51% girls) participated in the study. The children were between 3 and 4 years old at the time of the study ($M = 42.06$, SD = 3.92 months). Their mothers were also involved in the study through the filling in of a short questionnaire. The mothers' level of education in the sample was: college—4.9%; higher professional education (bachelor, master, specialist)—87%; scientific degree—4.8%. 2.4% of respondents refused to provide information on their level of education.

3.3. Measures

3.3.1. Executive functions skills measures

Dimensional Change Card Sort (DCCS; Zelazo, 2006) was performed to evaluate cognitive flexibility. DCCS requires that the child sorts cards; there are three rounds, and rules change for them. First, the classification must be performed based on the color of the picture (al), then the shape (switch trial), and the last round combines contradictory rules: the classification should be based on the color of the shape, depending on the presence of a frame in the picture (post–switch trial). For further analysis, we used the total score (the range consisted of 0–24 points).

Memory for Designs subtest of NEPSY-II (Korkman et al., 2007) was used to evaluate visual–spatial working memory including two parameters: memorization of "images" (the task was to select some pictures following an example from a batch of similar pictures) and memorization of spatial locations of the pictures (children had to remember the exact position of the cards).

Inhibition (Korkman et al., 2007) was used to assesses the ability to inhibit automatic cognitive responses. It includes two series of shapes (circles/squares and arrows). Firstly, the child is asked to name the shape or direction (Naming trial). In the second part of the task, the child is asked to name the shape or direction conversely: to say "circle" when a square is presented and "square" when it is a circle (Inhibition trial). Three scores were taken into analysis: number of corrected errors, number of uncorrected errors, and inhibition processing speed.

3.3.2. Family background

The parent questionnaire was designed with two units. First, it included questions about the socio-demographic characteristics of families (SES and parental education level). Second, it contained questions to obtain data on parents' toy choice practices in the families of the participating children: (i) What do you focus on when choosing toys to buy for your child? (ii) How do you evaluate the appropriateness of the toy for the age of the child? These questions were asked for an exploratory analysis of the potential relationship between children's toy selection and their trends-dependent toys buying practices.

3.4. Data analysis

The analysis was carried out in three stages. The first step was to describe the most and least popular toys in the both experimental trials. It was performed with using the percentage of the number of choices. It was done using the percentage of the number of toys chosen. In order to illustrate the empirical material, this block of analysis presents children's answers to the question of why they chose a particular toy. The second step was to determine the proportion of children who chose a trendy toy over the one they had already chosen in the second experimental trial. The third step included an evaluation of the impact of family factors on children's trend dependency in choosing toys. At the fourth step, a binomial logistic regression was performed to ascertain the effects of age, non-verbal intelligence, and the main EF skills on the likelihood of children having trend dependency in choosing toys.

4. Results

4.1. Children's choice of toys in the experimental trials

In the first experimental trial, out of the 12 toys offered, each toy was chosen at least once. Yet, there were toys which had the highest popularity. The frequencies indicate that children most often chose a hospital playset (34.6%), a supermarket playset (20.5%) and a car (10.2%). A dog figure (2.4%) and family animal (0.8%) were chosen less frequently. After choosing a toy, each child was asked to explain why he or she chose that particular toy. Below are the children's answers to the reasons for the toys that were chosen most often. Children who chose a hospital playset most often explained their decision as follows: "I would play doctor," "I like to play hospital," "I like going to hospitals," "I like being treated," "I would like to treat others," "I want to play ambulance and give injections." Children who chose a supermarket play set were most likely to provide such comments about their decision: "I will sell toys and some fruit," "I will buy sweets and groceries," "I often go to the shop with my mum, want to play in it," "I like to play in the shop." Children who chose a car mentioned the following reasons for that: "I play it with my dad, mum and friends," "I can drive, open doors," "I would play racing with it," "You can play with the car as if you were a doctor," "you can go anywhere." The small group of children who chose a dog said the following about the causes of their choice: "I would play ball with the dog," "you could play with it as if you were walking," "I would play vet, treat a dog and feed it."

In the second experimental trial, children were asked to choose one toy from two: the toy of choice (the first experimental trial) and the Trendy Toy. 43% of the children changed their choice in favor of the trendy toy. Among those children who preferred the viral toy to the toy of choice the most frequent reasons for the choice were: "Because it is scary," "Because it is very cute," "Because it is funny and wants to eat people," "Because I have one at home," "Because my brother already has one," "Because it is evil and you can sleep with it," "Because my mum will not let me buy one," "Because it is from a cartoon," "Because it has sharp teeth and big eyes," "Because its eyes are funny and its mouth is big," "Because it is scary and the bravest."

4.2. Family factors and child trend dependency in choosing toys

An ANOVA was used to test differences in certain family background factors between two groups of children: who showed trend dependency when choosing toys and who maintained their choice even after being presented with a trendy toy. An ANOVA showed no significant differences between these groups of children on any of the parameters, namely SES, level of parental education and number of children in the family ($p > 0.05$).

The buying of new toys in participating families was mostly based on the wish of the child (39.5%), on the feedback and recommendations of other parents (27.6%). Parents were less often dependent on what they themselves would play with (14.8%) and on the search for information on the developmental benefits of a toy (17.1%). A trendy toy was most frequently selected (21.1%) by children whose parents fully rely on the wishes of the child when

buying new toys. However, this relationship was not significant in the correlation analysis ($p > 0.05$).

The assessment of the appropriateness of a toy for a child's age in the participating families is most often based on common sense and personal experience (69.6%), on package labels (11.4%), on independent search for information about psychological and pedagogical expertise of toys (6.3%). In other cases, parents do not pay attention to the age appropriateness of the toy (7.6%) or are guided by whether their peers have similar toys (5.1%). Correlation analysis found no significant relationship between the way toys are age-appropriate and the child's exposure to the trend in toy choice ($p > 0.05$).

4.3. EF skills and trend dependency in choosing toys

A binomial logistic regression was performed to ascertain the effects of age, non-verbal intelligence and the main EF skills on the likelihood of children having trend dependency in choosing toys. This model shows what the probability is that the child will reject the chosen toy in favor of the Trendy Toy. Accordingly, the dichotomous dependent variable was whether or not the trend influenced the child's choice.

The logistic regression model was statistically significant, $\chi^2(8) = 18.3$, $p = 0.019$. The explained variation in the dependent variable based on our model ranges from 23.6 to 31.9%, depending on the Cox and Snell R^2 or Nagelkerke R^2 methods, respectively. Boys were 1.66 times more significantly likely to have trend dependency in choosing toys than girls (see Table 1). Increasing age was not significantly associated with a decreased likelihood that child will reject the chosen toy in favor of the trendy toy. Children with weak inhibitory control were more likely to show trend dependence when choosing toys. Specifically, more uncorrected errors and processing speed in inhibitory control test were significantly associated with an increasing in the likelihood of choosing a Trendy Toy.

5. Discussion

The toy industry has been changing rapidly in the last decade due to connection with digitalization and social networks (Plowman and Luckin, 2004; Marsh, 2017). Animated films, video games and viral videos on social media have a huge impact on children's interests, starting from pre-school age (Adachi and Willoughby, 2017; Edwards et al., 2018). Digital trends quickly become embodied in the physical objects with which children interact in reality. Thus, at certain periods of time, some toys that have gained popularity in media content become "virally" popular among children. The uncontrollability and rapidity of changes in the physical objects with which children play raise a number of concerns. On the one hand, trendy toys may not be age appropriate and relevant to the developmental needs of children. For instance, the Trendy Toy, the subject of this study, provokes fears and psycho-emotional problems in children. This toy has an aggressive appearance and is associated with the horror plots from the video game. On the other hand, trendy toys probably reduce the developmental potential of play because of a decrease in children's initiative, autonomy in creating play stories.

The findings are divided into three groups, in line with the aims of the study. The first objective of the study was to examine in two-part experiment how children choose toys and how they explain their choices. At first each child had to choose 1 toy out of 12 that he or she would like to play with the most. Each toy in this trial was chosen by the children at least once. The toys with the highest popularity refer to children's experiences of visiting public places: hospital and supermarket playset. The way the children explained why they chose them is interesting. Almost all answers contain well-defined ideas of how the child would like to play with the toy (see Subsection 4.1). The children had a good understanding of what kind of play actions and plots they would like to perform with the toy. The stories and ideas told by children can mostly be classified as modelling the reality around them in a playful context. But the choice of Trendy

TABLE 1 Model coefficients from a binomial logistic regression of the effects of age, non-verbal intelligence, and the main EF skills on the likelihood of children having trend dependency in choosing toys.

		95% Confidence interval				
Predictor	Estimate	Lower	Upper	SE	*Z*	*p*
Intercept	6.6559	−4.0571	17.36889	5.46591	1.218	0.223
Gender:						
girls – boys	1.6652	0.4479	2.88244	0.62107	2.681	0.007
Age in months	−0.1275	−0.3277	0.07267	0.10213	−1.248	0.212
Non-verbal intelligence	−0.0617	−0.2690	0.14553	0.10575	−0.584	0.559
Cognitive Flexibility	−0.1750	−0.5196	0.16956	0.17581	−0.995	0.320
Visual working memory	0.0247	−0.0361	0.08538	0.03098	0.796	0.426
Inhibition corrected errors	−0.1022	−0.4351	0.23080	0.16988	−0.601	0.548
Inhibition uncorrected errors	−0.0878	−0.1716	−0.00402	0.04276	−2.054	0.040
Inhibition processing speed	0.0165	3.71e-4	0.03271	0.00825	2.005	0.045

Estimates represent the log odds of "Toy of choice = Classic toy" vs. "Toy of choice = Trendy Toy".

Toy in the second experimental trial was motivated by children in quite a different way. Most children described the appearance of the toy (sharp teeth, big eyes), or expressed a desire to have it (for instance "I want it because my brother already has it"). In other words, children's answers did not contain ideas about what exactly they would like to do with this toy. This pattern of children's answers when choosing Huggy Wagy supports the concern that play with trendy toys is probably does not provide the full developmental potential. The motivation to choose the Trendy Toy is not related to specific ideas or imaginary situations that the child would like to bring into play.

The second aim was to explore the potential impact of certain family factors on children's trend dependency in choosing toys. The study did not provide evidence that trend-dependent children differed significantly in SES, parental education level, and number of children from children who were trend-independent when choosing toys. No significant association was also found between the dependency of a child's trend and the parent's attitude toward choosing the appropriate age and buying new toys for a child.

The third aim was to assess the impact of EF skills on trend dependency in choosing toys. The results showed that with increasing inhibitory control, children became less likely to depend on trends in their choice of toys. Similarly, as the number of uncorrected errors and processing speed increased the inhibitory control test, children were significantly more often choosing the Trendy Toy. It was also found that boys were 1.66 times more likely than girls to choose a trendy toy. The age of the children was not found to be a significant predictor of trend dependence.

The results support the theoretical concerns stated in the Introduction about the reduced benefits of playing with trend toys for children's development (Smirnova, 2015; Ryabkova et al., 2019; Veraksa et al., 2020). The findings, on the one hand, point to "empty" motivation in choosing a trend toy: children do not have an understanding of what they will do with the toy. That is, a trend toy, which is not connected with children's real experience, has no potential to be included in the child's interesting play stories (Veresov, 2006; Fleer et al., 2017). On the other hand, a trend toy in the present study was more often chosen by children who have difficulties in controlling impulsive cognitive reactions (inhibitory control). According to earlier research, a complete play with a rich story could be useful to support inhibitory control (Veraksa et al., 2019, 2020a,b).

6. Limitations and future directions

This study has several limitations. First of all, although trends in toys have become global and are spread throughout the world, attitudes toward them vary depending on the sociocultural values of the region. This study was conducted in Russia, and its results should be interpreted with caution in different sociocultural contexts. Another limitation is the lack of data on how familiar children were with the proposed trendy toy and from which channels information about it came to them. Also, important to note the small amount of information about family factors that could affect the results. Including a detailed survey of parents about their shared values and practices in selecting toys for their child would greatly enhance the results in terms of accuracy and reliability. This study represents the first attempt to examine the problem of children's dependence on trends. These and other limitations of the study will be addressed in the future.

7. Conclusion

The present findings describe the characteristics of children's toy choices in the context of the spread of global trends. The study was conducted between October and December 2022. During this period, the Huggy Wuggy was a very popular toy in many countries. It is a character from a horror video game, which is a blue monster with sharp teeth. Its goal, according to the plot, is to pursue the player and kill him. Unlike previous virally trendy toys (for instance Pop It or Spinner) this toy has caused a public outcry. There are several reports in the media that the toy has a negative impact on the emotional state of children.

The study is the first to examine children's dependence on trends in toy choice. The experimental approach with a combination of individual diagnostics allowed one to determine predictors of child's dependence on trends. Due to the speed and uncontrollability of the spread of new trends in children's subculture, the results of this study may be of practical value for training the resilience of children to trends that might be harmful to children.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of Faculty of Psychology at Lomonosov Moscow State University (the approval no: 2022/21). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

MG, VS, and NV conceived, conceptualized, designed the study, gathered and analyzed the data, and acquired resources. MG drafted the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY
Yulia Solovieva,
Meritorious Autonomous University of Puebla, Mexico

REVIEWED BY
Ana Baltazar,
National Autonomous University of Mexico, Mexico
María Alejandra Morales González,
Instituto de Neuropsicología y Psicopedagogía de Puebla, A.C., Mexico
Daniel Rosas,
National Autonomous University of Mexico, Mexico

*CORRESPONDENCE
Vera Yakupova
✉ vera.a.romanova@gmail.com

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Parental burnout, depression and emotional development of the preschoolers

Vera Yakupova* and Anna Suarez

Faculty of Psychology, Lomonosov Moscow State University, Moscow, Russia

Introduction: Parental burnout is becoming more and more prevalent in the world, mainly incultures with high demands towards parents. Parental burnout is distinctive from depression and might have its unique influence on child development, which isunder current international research. This work contributes to the understanding of parental burnout, maternal depression and child emotional development(specifically emotion comprehension) interrelations. Additionally, we explored whether there are differences in the effects of parental burnout and depressionon boys and girls.

Methods: To analyse the emotional development of the preschoolers, the Russian version of the Test of Emotional Comprehension (TEC) was used. We used the Russian version of the Parental Burnout Inventory (PBI) to analyse the level of PB and the Russian version of Beck depression Inventory (BDI) to assess participants' depression level.

Results: Parental burnout positively correlates with child emotional comprehension skills, specifically understanding of external causes (B=0.20, CI: 0.03; 0.37) and mental causes of emotions (B=0.22, CI: 0.05; 0.40). This effect is gender dependent and is significantlyhigher for girls (B=0.54, CI: 0.09; 0.98). The effect of maternal depression on emotion comprehension skills is also gender dependent: total scores on emotioncomprehension tasks are significantly higher for daughters of mothers with depression (B=0.59, CI: 0.001; 1.18).

Discussion: Maternal depression and parental burnout might provoke development of extra sensitivity and self-regulation strategies in girls.

KEYWORDS

parental burnout, depression, maternal depression, parenthood, emotion comprehension, emotional development

1. Introduction

Parenting can be one of the most challenging jobs, with demands for high emotional involvement, multitasking, and many physical and financial resources. This job does not include sick leave, opportunity to quit, or even weekends. At the same time, societal demands to the standards of parenting have increased significantly in the past decades (Roskam et al., 2021), which may lead to parental burnout (PB). PB is commonly defined as a state of intense emotional exhaustion related to one's parental role, which includes emotional detachment from one's children and doubts in one's capacity to be a good parent (Roskam et al., 2017).

Risk factors for PB include child chronic disease, lack of social and family support, high social demands toward parents, conflicts with the spouse and co-parenting problems, emotional dysregulation of a parent and child-oriented perfectionism (Roskam et al., 2021; Favez et al., 2022; Lin et al., 2022a,b; Wauters et al., 2022). The cross-cultural study across 42 countries showed that the main risk factors for PB were lack of support from extended family and high societal demands

towards parents, namely, the expectation that parents could control physical, emotional, intellectual and social development of the child as well as minimise any risks for it (Roskam et al., 2021).The authors further showed that PB is common in the majority of countries around the world, with particularly high prevalence in the countries with individualistic cultural values and the trend for intensive parenting (Roskam et al., 2021). However, PB is mainly discussed in relation to parents of children with chronic diseases and/or special needs (Lindström et al., 2011; Gerber et al., 2021; Wauters et al., 2022), while cohort and population-based studies on the topic remain scarce.

This may be partially due to the fact that some symptoms of PB overlap with depression, e.g., sleep problems, escape ideation, and emotional exhaustion (Lebert-Charron et al., 2018; Mikolajczak et al., 2019). However, there is convincing evidence that PB is distinctive from depressive symptomatology and it might have unique consequences for the parents and their children (Sánchez-Rodríguez et al., 2019; Mikolajczak et al., 2020). The surge of studies of the association between PB and child mental health during the COVID-19 pandemic, when there was an increased pressure on parents, revealed that PB was positively associated with children's stress behaviours, and negatively associated with children's positive behaviours (Kerr et al., 2021; Koerber et al., 2023).

Nevertheless, to date this topic remains understudied and the existing literature has mainly focused on maternal depression and its consequences for child development. The meta-analysis of 191 studies showed that maternal perinatal depression and anxiety were associated with poorer child's social–emotional, language and cognitive development in infancy, childhood and adolescence (Rogers et al., 2020). In the Norwegian longitudinal study child social–emotional problems at age 2 were strongly associated both with maternal depression during pregnancy and 8 weeks postpartum (Junge et al., 2017). The study of Abdollahi et al. (2017) indicated that developmental disabilities in communication and gross motor skills in 4 years-old children were associated with concurrent and chronic maternal depressive symptoms, rather than with the perinatal maternal depression. The study of 1,992 mother–child dyads also showed the significance of the current maternal depressive symptoms for the child's emotional development and communication skills (Hentges et al., 2020).

Findings on gender differences and maternal depression consequences are contradictory. The US longitudinal study showed that maternal depression was associated with poorer social-emotional child development, particularly among girls (Urizar and Muñoz, 2022). A recent meta-analysis indicates that maternal depression affects cognitive development in boys, but not girls (Ahun et al., 2021). The Norwegian longitudinal study showed that while maternal depression affected both infant boys and girls' cognitive development, girls' scores tended to increase during the time of observation (Azak, 2012). The study conducted on the adolescent sample revealed that the relationship between maternal depression and child internalising symptoms was significantly larger for daughters compared to sons (Livings, 2021). Such data inconsistency on gender differences in child outcomes could be largely explained by cultural differences and measurement diversity (Ahun et al., 2021) and demonstrates a clear knowledge gap in this area.

Cumulatively, the abovementioned findings indicate that the areas of child development most vulnerable for the effects of parental depression are those related to emotional development. While the consequences of PB for the child's emotional development remain unknown, there is data showing that PB is associated with parental neglect and violence more often than depression (Mikolajczak et al., 2020; Griffith, 2022), which, in turn, may be damaging for the child emotional development. Furthermore, there is evidence of association between PB, perceived parental hostility and adolescent later externalising problems (Chen et al., 2022). Although a number of studies have also found the association between PB and adolescent behavioural problems (Yuan et al., 2022), student's problematic behaviour, and academic outcomes (Hong et al., 2022), the direction of these associations remains unclear. To date there is no evidence on gender differences in the PB effects on child emotional development.

Some data suggests that parents of younger age children are at higher risk for PB (Favez et al., 2022). Early childhood is a critical time for social and emotional development: approximately by age 4 children are able to recognize and name emotions and begin to understand how external causes can affect emotions of other people (Pons et al., 2004). High comprehension of emotions performance predicts academic success in preschool children (Da Glória Franco et al., 2017; Garrett-Peters et al., 2017; Józsa and Barrett, 2018; Cavadini et al., 2021). Cultural-historical theory considers understanding of emotions as an important component of any successful child activity (Zaporozhets et al., 1985, p. 26–28). Emotion comprehension plays a significant role in prosocial skills development (Liao et al., 2014; Da Glória Franco et al., 2017). Good understanding of emotions skills are also associated with lower risk of mental health problems (Herba and Phillips, 2004; Martinsen et al., 2019).

Emotional development during the first 3 years of life is strongly associated with social–emotional development at 5 years old (Wang et al., 2022). Maternal depression and anxiety during toddlerhood are also strongly associated with child outcomes at age 5 (Hentges et al., 2020). As there are more tools available to accurately measure emotional development in preschoolers, than in children of 0–3 years old, hence this age group was selected as a cohort for the present study.

Therefore, the aim of this work is to examine the association between PB, depression and child emotional development. We are going to focus on children of preschool age, as it is a sensitive period for emotional development (Pons et al., 2004). Moreover, we are going to compare the effects of maternal concurrent depression and PB on 4 dimensions of the emotion comprehension ability in preschoolers: understanding of emotions caused by external causes, understanding of mental emotions, understanding of the ability to regulate emotions, and the general ability to understand emotions. Finally, we are going to explore whether there are differences in the effects of parental PB and depression on boys and girls.

2. Materials and methods

2.1. Procedure and participants

The study included two stages: (1) a survey for parents that assessed parental depression and PB and (2) observational diagnostics of the preschoolers' emotional development. The data was collected during the period of April–June 2022 on the basis of kindergartens in 4 regions of Russia (Yakutia, Tatarstan, Perm, Moscow). The findings are based on the responses of a sample of 251 dyads: parents ($M = 33.74$, $SD = 5.08$) and children of preschool age ($M = 4.92$, $SD = 0.44$). The participants received an invitation to take part in the study through the kindergarten's administration. Families were included in the study if the participating parent was living together

with the child and was her legal representative, and the parent was able to speak and read in Russian.

2.2. Ethical considerations

Both stages of the study were approved by the Ethical Committee of the Russian Psychological Society, Lomonosov Moscow State University. All participants were asked to sign an informed consent using the online form before starting the completion of the parental survey. The participants signed the agreement for their children to participate in the study. The study was conducted in accordance with the Declaration of Helsinki. All women participated voluntarily in the study. The assessments were carried out with the Testograph online platform.

2.3. Measures

2.3.1. The demographic questionnaire

The survey included questions regarding the participants' age at the time of testing, education (primary/secondary/tertiary) and marital status (married/cohabiting with partner/single). We also collected the data about the child's age, sex and chronic diseases (reported by the parents).

2.3.2. Beck depression inventory

We used the Russian version of the Beck depression inventory (BDI) to assess the levels of parental depression (Yakupova, 2018). BDI is a 21-item, self-report questionnaire measuring symptoms of depression (Beck et al., 1961). Items are scored on a scale from 0 to 3, e.g., 0: "I do not feel guilty," 1: "I often feel guilty" 2: "I feel guilty most of the time," 3: "I feel guilty all the time" The depression score is obtained by summing the 21 item scores. For the Russian version Cronbach's coefficient is $\alpha = 0.866$ (Yakupova, 2018).

2.3.3. Parental burnout

We used the Russian version of the parental burnout inventory (PBI) (Starchenkova, 2019) to analyse the level of PB in mothers. This is a 23-item questionnaire assessing the four core symptoms of parental burnout: emotional exhaustion (9 items; e.g., I feel completely run down by my role as a parent), contrast with previous parental self (6 items; e.g., I tell myself I'm no longer the parent I used to be), loss of pleasure in one's parental role (5 items; e.g., I do not enjoy being with my children), and emotional distancing from one's children (3 items; e.g., I am no longer able to show my children that I love them) (Roskam et al., 2018). The participants were asked to assess each statement using a seven-point frequency scale from 0 to 6 (never, a few times a year, once a month or less, a few times a month, once a week, a few times a week, every day). The parental burnout score is computed by summing the item scores: higher scores reflect higher parental burnout levels. The internal consistency of the Russian version of the scale was Cronbach's alpha $\alpha = 0.97$ (Roskam et al., 2021).

2.3.4. Child emotional development

To analyse the emotional development of the preschoolers, the Russian version of the test of emotional comprehension (TEC) was used (Pons and Harris, 2000; Veraksa et al., 2021). This test is designed to assess the emotion comprehension skills in children of 3–11 years old. The child is presented with 23 simple plot pictures about the emotional experience of children of the same sex with him. Each plot includes four possible emotional responses. The child needs to evaluate what the protagonist of the story felt in the situation presented. For example: "This boy (girl) is getting a birthday present. How is this boy (girl) feeling? Is he (she) happy, sad, alright or scared?" The test captures information about the different components of emotion comprehension: understanding of emotions caused by external causes, understanding of mental emotions, understanding of the ability to regulate emotions, as well as the general ability to understand emotions. Each answer is scored "0," if it is wrong, "1" if it is correct. The internal consistency of the Russian version of the test is $\alpha = 0.97$.

2.3.5. Covariates

Two statistical models were used to test our hypotheses. Model 1 was adjusted for child age at testing and sex. Model 2 was further adjusted for maternal age at testing, level of education, family status, socioeconomic status, and parity as covariates. When testing the hypothesis of differential effects of parental burnout and depression on boys and girls, child sex was removed from the list of covariates, as in this analysis the sample was already stratified by sex.

2.4. Statistical analysis

BDI and PBI scores were log-transformed to attain normality.

Spearman's correlation coefficient was used to estimate the relationship between BDI and PBI scores.

Pearson chi-square test and independent *t*-test were performed to compare the sample characteristics between boys and girls. *t*-tests exploring the differences in emotional development were weighted by age.

Multiple linear regression analysis examined the association between parental depression and PB and child emotional development.

All analyses were performed using SPSS 28 software (IBM).

3. Results

Demographic characteristics for the parents and their children are presented in Table 1. It shows that the majority of the dyads come from middle-income families (69.7%), where mothers were married (81.6%) and had higher education (61.8%). Furthermore, shows that when comparing boys ($n = 106$) and girls ($n = 144$), boys were slightly older, scored statistically significantly higher on TEC External scale and lower on TEC Mental scale. There were no other significant differences between the subsamples divided according to child sex (p-values for all >0.029) (Table 2).

Parental depression and PB scores were moderately correlated (Pearson correlation coefficient = 0.49, $p < 0.001$).

Table 3 shows that, when adjusted for child age and sex, TEC scales of understanding of external causes of emotions and mental emotions scores were significantly associated with PB. Additionally, we discovered an association of general understanding of emotions with PB in Model 2. While the trends were largely the same, there were no statistically significant associations between parental depression and child emotional development.

TABLE 1 Characteristics of the sample.

Characteristics		*N* (total)	Mean/*N*	SD/%	Range
Parental characteristics					
Age (years)		227	33.74	5.08	22–48
Sex	Female	251	251	100%	
Education	General secondary/ vocational education	228	87	38.2%	
	Higher education		141	61.8%	
Family status	Married	228	186	81.6%	
	Have a partner		16	7.0%	
	Single		26	11.4%	
SES	Low	228	42	18.4	
	Middle		159	69.7	
	High		27	11.8	
BDI total score (raw)		251	5.16	7.27	0–54
PBI total score (raw)		228	10.16	18.08	0–120
Child characteristics					
Age at testing (years)		251	4.92	0.44	3–7
Sex	Female	250	144	57.6%	
	Male		106	42.4%	
Parity	1	228	67	29.4%	
	2		79	34.6%	
	3+		82	36.0%	
TEC external scale		240	2.31	0.73	0–3
TEC mental scale		241	0.84	0.76	0–3
TEC reflective scale		241	1.03	0.80	0–3
TEC total score		241	4.18	1.52	0–8

SES, socioeconomic status; BDI, Beck depression inventory; PBI, parental burnout inventory; TEC, test of emotional comprehension.

Table 4 further shows that when we performed the multiple regression analyses separately for boys and girls, the associations remained significant only for fully adjusted models for total and mental scales and only in girls. Furthermore, we discovered a borderline significant association between parental depression and total emotional development in girls, when controlling for child sex, maternal age, education, family status, socio-economic status (SES), and parity (Table 4).

However, the interaction analyses revealed that the differences between the subsamples divided by sex were not statistically significant due to low statistical power (p-value for all >0.31; observed power <0.17 for all).

4. Discussion

The aim of our research was to examine the association between PB, depression and preschoolers' emotional development.

The obtained data indicate significant correlation between PB and child emotional development. In the present study the association with PB was stronger, than with maternal depression. To date there is a lack of evidence of the PB effects on child emotional development, and our results contribute to this topic. Higher PB scores are associated with higher child outcomes on understanding of the following components of emotion comprehension: external and mental. It is easier for the child to recognize emotions based on facial expressions, to understand external causes of emotions and how memories, desires and beliefs influence emotions. These results contradict our hypothesis of direct adverse effects of PB on child emotional development. PB is associated with parental neglect and violence more often than depression (Mikolajczak et al., 2020; Griffith, 2022). Neglect presumes emotional deprivation, which may be damaging for the child's emotional development and contribute to internalising problems (Christ et al., 2017; Hunt et al., 2017).

Mothers who are suffering from emotional exhaustion (the dominant PB symptom) report having difficulties in providing clear and consistent emotional responses and have depleted facial expressions of emotions (Roskam et al., 2017). The child has to make an effort to interpret the parent's state as her safety depends on it and, thus, might develop extra sensitivity. PB is associated with lower parent emotional intelligence and regulation skills (Lin et al., 2022a,b), therefore, the child might develop its own regulation skills to compensate for a parent's lack of self-regulation. There is data showing that negative effects of PB on child's mental health can be minimised when parent's emotional regulation skills are improved (Yang et al., 2021; Lin et al., 2022a,b). In the present study we did not assess

TABLE 2 Characteristics of the sample according to child's sex.

Characteristics		Boys (n =106)			Girls (n =144)			p
		Mean/N	SD/%	Range	Mean/N	SD/%	Range	
Parental characteristics								
Age (years)		33.29	4.96	22–48	34.02	5.15	22–46	0.29
Sex		106	100%		144	100%		
Education	General secondary/ vocational education	38	39.6%		48	36.6%		0.68
	Higher education	58	60.4%		83	63.4%		
Family status	Married	80	83.3%		105	80.2%		0.83
	Have a Partner	6	6.3%		10	7.6%		
	Single	10	10.4%		16	12.2%		
SES	Low	16	16.7%		26	19.8%		0.71
	Middle	67	69.8%		91	69.5%		
	High	13	13.5%		14	10.7%		
BDI total score (raw)		5.08	7.20	0–54	5.26	7.36		0.85
PBI total score (raw)		8.79	15.92	0–120	11.24	19.55		0.31
Child characteristics								
Age at testing (years)		4.99	0.40	4–6	4.86	0.45	3–7	0.020
Parity	1	31	32.3%		36	27.5%		0.73
	2	32	33.3%		47	35.9%		
	3+	33	34.4%		48	36.6%		
TEC external scale		2.37	0.66	1–3	2.27	0.77	0–3	0.021
TEC mental scale		0.76	0.67	0–2	0.88	0.79	0–3	0.007
TEC reflective scale		1.03	0.86	0–3	1.00	0.75	0–3	0.45
TEC total score		4.16	1.56	1–8	4.15	1.46	0–8	0.86

SES, socioeconomic status; BDI, Beck depression inventory; PBI, parental burnout inventory; TEC, test of emotional comprehension; p, p-value from chi-square and t-tests examining the differences between the subsamples of boys and girls.

TABLE 3 Association of parental depression and burnout with child emotional development.

Predictor	Parental depression						Parental burnout					
	Model 1			Model 2			Model 1			Model 2		
Outcome	B	SE	95% CI	B	SE	95% CI	B	SE	95% CI	B	SE	95% CI
TEC external scale	0.11	0.10	−0 0.088; 0.31	0.16	0.11	−0.066; 0.38	**0.17***	**0.085**	**0.005; 0.34**	**0.20***	**0.09**	**0.03; 0.37**
TEC mental scale	0.19	0.10	−0.014; 0.39	0.20	0.11	−0.024; 0.42	**0.21***	**0.09**	**0.043; 0.38**	**0.22***	**0.09**	**0.05; 0.40**
TEC reflective scale	−0.05	0.11	−0.26; 0.17	0.008	0.07	−0.23; 0.24	−0.046	0.09	−0.22; 0.13	−0.022	0.09	−0.21; 0.16
TEC total score	0.25	0.21	−0.16;0.66	0.36	0.23	−0.090;0.82	0.34	0.17	−0.005; 0.68	**0.40***	**0.18**	**0.046; 0.75**

B refers to unstandardized regression coefficient from multiple regression model; SE refers to standard error; 95% CI refers to 95% confidence interval. Parental depression and burnout score were log-transformed to attain normality for the regression analyses. Model 1 is adjusted for child age at testing and sex. Model 2 is further adjusted for parity, maternal age, level of education, family status, and SES. *$p < 0.05$. Statistically significant values are highlighted in bold ($p < 0.05$).

parent's emotional regulation skills, which could play a mediating role and decrease adverse PB effects on children.

According to the cultural-historical framework, parenting is a social construct and parenting behaviour depends on the demands and norms of the society during the historical period (Zakharova, 2012). The social image of the parenting role serves as an orientation system for the style of everyday childcare and parent self-efficiency assessment (Zakharova, 2012; Burmenskaya, 2022). The results obtained in the study may be attributed to the intensive parenting trend and high social demands towards parents and their positive

TABLE 4 Gender dependent association of parental depression and burnout with child emotional development.

Predictor	Boys								Girls							
	Parental depression				Parental burnout				Parental depression				Parental burnout			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
Outcome	*B*	95% CI	*B*	95% CI	*B*	95% CI	*B*	95% CI	*B*	95% CI	*B*	95% CI	*B*	95% CI	*B*	95% CI
TEC external scale	0.10	−0.18; 0.38	0.17	−0.16; 0.47	0.18	−0.06; 0.43	0.17	−0.08; 0.42	0.12	−0.16; 0.40	0.15	−0.18; 0.47	0.17	−0.06; 0.40	0.20	−0.05; 0.44
TEC mental scale	0.20	−0.08; 0.49	0.20	−0.13; 0.52	0.21	−0.05; 0.47	0.24	−0.02; 0.49	0.18	−0.10; 0.46	0.24	−0.07; 0.55	0.21	−0.001; 0.44	**0.24***	**0.003; 0.47**
TEC reflective scale	−0.26	−0.62; 0.10	−0.16	−0.56; 0.23	−0.15	−0.46; 0.16	−0.16	−0.48; 0.16	0.12	−0.14; 0.38	0.20	−0.09; 0.50	0.02	−0.19; 0.24	0.10	−0.12; 0.33
TEC total score	0.05	−0.63;0.72	0.19	−0.58; 0.96	0.24	−0.35; 0.84	0.25	−0.37; 0.87	0.41	−0.10; 0.93	**0.59***	**0.001; 1.18**	0.41	−0.01; 0.83	**0.54***	**0.09; 0.98**

B refers to unstandardized regression coefficient from multiple regression model; 95% CI refers to 95% confidence interval. Parental depression and burnout score were log-transformed to attain normality for the regression analyses. Model 1 is adjusted for child age at testing. Model 2 is further adjusted for parity, maternal age, level of education, family status, and SES. *$p < 0.05$. Statistically significant values are highlighted in bold ($p < 0.05$).

association with PB risks (Roskam et al., 2021). Parents with PB might have invested much effort in the child's development, which could have led to their exhaustion. Their children, in turn, might have higher TEC scores because of the parent's past investments. There is also evidence on the role of attachment style in the emotion comprehension development (Cooke et al., 2016; Psychogiou et al., 2018). The parent with PB could manage to develop the secure attachment style, which is associated with better emotion comprehension skills. Moreover, there is data on the significant role of father-child attachment style in the emotion comprehension development (Psychogiou et al., 2018). In our study only mothers participated, and data on fathers' PB and mental health could enrich the results.

The insignificant association between depression and emotional development contradicts the research accumulated to date (Hentges et al., 2020). This finding might be explained by the characteristics of the sample—there is low awareness of depressive symptoms in Russian society and depression is stigmatised (Dubitskaya, 2009; Beshanova and Kashirskikh, 2020). The study was conducted in the kindergartens, and it might be important for the participants to show the researchers and kindergarten administration that they are competent parents, despite the assurance in the confidentiality of their responses. Therefore, the data may be limited by the social desirability bias. PB is far less stigmatised, so the questionnaire might not elicit socially desirable answers. However, it is important to note that in the present study PB and depression moderately correlate.

One more possible explanation is based on the findings of Nonnenmacher et al. (2021), which indicated no significant associations between theory of mind development and mother's depression in preschoolers. The authors discovered a mediating role of self-comforting behaviour developed by children, which was a protective factor against an insensitive parenting environment. Children of depressed mothers can develop their own emotion regulation strategies that can decrease the adverse effects of maternal depression.

Our results show moderate gender differences in emotional development: in our study boys scored statistically significantly higher on TEC External scale and lower on TEC Mental scale. Data on gender differences in emotion comprehension is contradictory. There is evidence on girls' better performance (Bosacki and Moore, 2004; Garner and Waajid, 2008), some studies reveal boys' better performance in emotion comprehension tasks (Laible and Thompson, 2000), while others indicate no gender differences in emotion understanding (Pons et al., 2004; Denham et al., 2012). Although Aznar and Tenenbaum (2013) found no gender differences in overall TEC scores, boys scored higher than girls in understanding the situational causes of emotion, whereas girls scored higher on understanding reflective emotions. Fidalgo et al. (2018) revealed no gender differences in 8 of 9 TEC components, with the exception of the False belief task, where girls performed better. Thus, our findings support the hypothesis that there are gender disparities in different types of emotion comprehension, but no such trend in total emotional development.

Finally, our study indicated the gender difference in PB and depression effects on emotional development as well: they positively correlate with girls' emotional development, specifically total TEC scores. PB is also positively related with understanding of mental causes of emotions in girls. The possible explanation of this finding could be related to the characteristics of women's gender socialisation, as girls are expected to be more sensitive, show empathy and high self-regulation skills (Chaplin and Aldao, 2013). Thereby girls might be more likely to develop understanding of a parent's emotions as a strategy, compensating for parent's dysregulation. The 13 years longitudinal study by Murray et al. (2006) also showed that daughters of depressed mothers tend to develop higher sensitivity. Similarly, they demonstrated elevated social maturity. Extra sensitivity was associated with adolescent depression, therefore, the influence of maternal depression can be considered as adverse.

5. Conclusion

Our findings support the evidence that PB is distinctive from depression and can have its unique consequences for child emotional development. PB positively correlates with child emotional comprehension skills, specifically understanding of external causes and mental causes of emotions. This effect is gender dependent and is significantly higher for girls. Maternal depression and parental

burnout might provoke development of extra sensitivity and self-regulation strategies in girls.

6. Limitations

The data obtained in the study might be contaminated by a social desirability bias, because it was collected *via* kindergartens. Despite the confidentiality guarantees, parents could be anxious about revealing their depressive symptoms, as they are socially stigmatised.

Data on PB in fathers could enrich the results and, therefore, further studies that include paternal mental health measures are warranted.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Russian Psychological Society. The patients/participants provided their written informed consent to participate in this study.

Author contributions

AS and VY contributed to conception and design of the study. VY organized the database and wrote sections of the manuscript. AS performed the statistical analysis and edited the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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EDITED BY
Ann Dowker,
University of Oxford, United Kingdom

REVIEWED BY
Gustavo Cunha de Araujo,
Federal University of North Tocantins, Brazil
Juan Pablo,
Universidad Autónoma del Carmen, Mexico

*CORRESPONDENCE
Yulia Solovieva
✉ aveivolosailuy@gmail.com

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The program for introduction of basic mathematical knowledge: the effects in six years old Mexican children

Yulia Solovieva[1,2]*, José Rodríguez Zavaleta[2], Andrea Celeste Rosete Carrillo[2], Luis Quintanar[3] and Valeriya Plotnikova[1]

[1]Department of Educational Psychology and Pedagogy, Lomonosov Moscow State University, Moscow, Russia, [2]Department of Psychology, Autonomous University of Puebla, Puebla, Mexico, [3]Department of Psychology, Autonomous University of Tlaxcala, Tlaxcala, Mexico

Introduction: The process of teaching and learning mathematics in primary school represents an obstacle for both teachers and pupils. According to the historical-cultural conception of development and education, the way how intellectual concepts are initially introduced may radically affect a student's success in learning. The historical-cultural conception of development, together with activity theory, may serve as the basis for creating a novel methodology for pedagogical work on mathematical concepts with pre-school and school children.

Methods: The goal of the present study was to show the effects of work with an original program for the initial introduction of mathematical concepts to young school children. The program included reflexive symbolic and logical actions on the materialized and perceptual level, which were introduced and performed collectively by six-year-old children under the guidance and assistance of a teacher. The pupils were tested before and after their work with the program.

Results: The results showed important qualitative and quantitative progress by the children in solving the tasks of the assessment, together with an increment of reflection on their intellectual actions.

Discussion: The study points to the necessity for more intensive and extensive research, involving specialists in psychology and pedagogy trained in cultural-historical methodology.

KEYWORDS

mathematical concepts, historical-cultural theory, basic mathematical knowledge, preparedness for school learning, activity theory

1. Introduction

According to Sánchez Luján (2017), the teaching and learning of mathematics constitute a fundamental element in the field of educational sciences. Probably there is no modern society which does not consider it necessary to teach mathematics in primary school and to have an elaborated plan for study in this area (Mora Castor, 2003). At the same time, difficulties in mastering mathematics are very common and are reflected in many assessments of children's abilities by official institutions in many countries (OCDE, 2002; OECD, 2006). The difficulties which the pupils suffer in the classroom are multiple, and cannot be explained only by developmental diseases, organic damage, or brain immaturity. The problem of the necessity of

analysis of the methods of teaching, especially of initial introduction of mathematical knowledge, is a great challenge of educational and developmental psychology and pedagogy.

The difficulties of the pupils are related, among other factors, to the passive attitude of the educational authorities, as well as administrative obstacles for implementation of original methodological proposals. Some novel proposals have led to experimental studies based on the historical-cultural approach with limited groups of children and had the enthusiastic support of researchers and directors of educational programs (Zárraga et al., 2012).

Benítez and García (2011) have mentioned that mathematical competences refer to a person's capacity to identify and understand the role of this science in the world, to make fundamental judgments, and to use this knowledge in his or her life as a thoughtful, constructive citizen. Gómez Moreno (2019) points out that the development of mathematical competences is extremely important, because it allows students to solve problems, adapt to new situations, establish relationships among diverse kinds of knowledge, and learn new concepts.

The present study was based on cultural historical conception of psychological development (Vigotsky, 1994, 1995). According to this approach, mathematical knowledge is a part of general cultural experience, acquired by the child during shared activity introduced by the adults (Talizina, 2019), which includes gradual acquisition of intellectual actions by child (Solovieva, 2022). Acquisition of intellectual actions is not a spontaneous and free process. The gradual formation of intellectual actions implies identification of the central action as an ability, which needs to be introduced and trained with the children (Galperin, 2016). The process of introduction should be planned and fulfilled by the teacher, who should organize joint solutions of intellectual problems. Such intellectual problems require of the use of numeric, logical, and symbolic means.

In this approach, the work of the teacher is organized according to the concept of the zone of proximate development, when the teacher helps the children by establishing of the questions for better orientation, demonstrating the procedures, showing examples, modeling decisions, and providing the logic of the process of each intellectual action (Vigotsky, 1995; Rosas, 2019; Solovieva, 2022; Ushakova, 2023). One of the central concepts of this psychological and pedagogical approach is the concept of orientation, which allows to design and organize the process of creation of experimental programs with their posterior approbation in groups of children.

The goal of the present study was to show the effects of an original experimental program for the initial introduction of intellectual actions with mathematical content on a group of six-year-old Mexican children, who were regular pupils of the first grade of primary school. The actions of measurement of the magnitudes of longitude, area and volume of the liquids were selected as central intellectual actions. The logical actions were related to the reflexive selection of the means for measurement and the comparison of the results. The program was designed according to the principles of cultural historical approach and psychological activity theory, which considers the psychological age of the children, the content of their intellectual actions, and the organization of constant collective interaction under the guidance of an adult. The program was based on the content of a fairy tale, so that all intellectual actions were presented as symbolic actions of the characters of the tale. The children were tested before and after their work with the program. The process of assessment was individual and included originally organized tasks (Veraksa et al., 2022).

2. Materials and methods

2.1. Participants

The participants of the study were 10 Mexican children (6 boys and 4 girls), pupils in the first grade of a private primary school in the city of Puebla. The age of the pupils was between 6, 5 and 8, 4 years old, and the average age of the children were 6, 8. The age was not essential criterion for the inclusion in the study, as it was important to include the children as regular pupils of the first grade of primary school with no previous experience of detailed work with the actions of measurement and the means of measurement. The oldest boy was included into the study because he was not able to assist the first grade of primary school due to difficult family conditions during international pandemic, so that he entered primary school 1 year later. All children were Spanish speaking pupils. The school was situated in an urban zone of medium economic level, according to the location and average economic income of the families. All the children were regular pupils who were finishing their first year of formal school education. The administration of the school agreed to take part in the study, as the school uses cultural historical methodology, based on Vigotsky's approach. This approach considers the necessity of adult's active orientation in the tasks of assessment, according to the conception of the zone of proximate development (Vigotsky, 1995). The study took place during the months of May and July, which represent the end of school year according to the Mexican Secretary of Education. It is important to stress that during these months the children were included into mathematic lessons, designed only according to experimental program. The children were tested before and after the work with experimental program.

The selection of the participants was based on the following criteria: (1) to be between six and 7 years old; (2) to be a regular pupil according to the norms of the educational institution; (3) to belong to the middle class of the city of Puebla; and (4) to attend most of the sessions of the experimental program as well as the sessions of initial and final assessment. The criteria of exclusion were as follows: (1) to have a history of neurological or psychiatric disturbances; and (2) to be absent during the work with the program and/or during initial or final assessment. The children's participation in the study was voluntary and was arranged by previous agreement with the parents and the school administration.

The work with the experimental program was carried out by a teacher previously trained for work with the program content who was familiar to the children. The procedure of initial and final assessment was accomplished by two students from the Faculty of Psychology of the Autonomous University of Puebla, who were participants in the research project. The program work was done as a group, while the process of assessment was individual for each pupil before and after his work with the program. All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethical Committee of the Department of Psychology, Lomonosov Moscow State University.

2.2. Design of the study

The design of the research was quasi-experimental, with the same group of participants tested before and after implementation of the experimental program. The children's success in the solution of the problems was related to selection of appropriate external mean for the action of measure was tested before and after the work with experimental program. All tasks of the assessment and of experimental program were new for the children.

2.3. Instruments

Initial and final assessment were accomplished using two psychological protocols created on the basis of cultural-historical psychology, which takes into account the appropriate content for children of preschool age and the aspects of preparedness for school learning. Each participant was tested individually on selected tasks according to the protocol for the assessment of the level of preparedness for school (Quintanar and Solovieva, 2019) and on tasks from the experimental protocol for evaluation of basic mathematical knowledge (Veraksa et al., 2022).

The tasks selected from the protocol for assessment of the level of preparedness for school belonged to three spheres: (a) mediatized recollection of an object; (b) voluntary actions on verbal and graphic levels; and (c) previous mathematical abilities, such as mastery of one-to-one correspondence, seriation, and equation of conjunctions. Table 1 shows the content of the tasks selected from the protocol (Quintanar and Solovieva, 2019). It shows the sphere of the protocol and the content of each task along with the instructions and materials required for its fulfilment. The protocol was created on the basis of Vigotsky's conception of dynamic psychological assessment, which calls for mutual collaboration between the child and an adult, and the possibility of using external help in cases of difficulties (Vigotsky, 1984; Akhutina and Pilayeva, 2008; Solovieva et al., 2021).

The protocol for evaluation of basic mathematical knowledge, translated from Russian into Spanish for the purposes of this study, included 17 tasks for the measurement of longitude, area, and volume (Veraksa et al., 2022). Each measurement was achieved through choosing the practical means (tools) for measuring the magnitudes. The actions of measuring included the choice of the same measure, and the understanding of the dependence of the number on the chosen measuring tool. The tasks left open the possibility of being fulfilled with the help of an adult, which shows the zone of proximate development for the practical and conceptual use of the measures as a mathematical tool.

Table 2 shows the content of the experimental protocol for evaluating the children's basic mathematical knowledge. The table shows the sphere of the protocol and the content of each task with the instructions and materials.

2.4. Procedure

The methodology of the experimental program was also based on cultural-historical psychology and activity theory applied to the process of teaching and learning. Such methodology considers psychological age of the children with the necessities of realization of interactive collective activities, which allow to guarantee the pupil's motivation for learning of mathematics. The study was organized by academic assessors of the college who are representatives and followers of this approach in Mexico.[1]

The tasks of both protocols were presented to all participants at the beginning of the last bimester of the school year before the work with the program. The assessment was individual to each child; it took place on school premises, according to prior agreement with the director and the parents. In case of difficulties, the children received help and orientation from the adult, which did not involve completely solving the tasks. The analysis of the results considered the nature of external help used by the researcher during his work with each child. Different types of external help during the fulfilment of the protocol were also used during initial assessment.

The work with the protocol took between 45 min and 2 h. The sessions were videotaped for further analysis, according to the ethical norms and agreements with the director and the parents. The identity of the participants was never revealed.

Once the initial assessment was finalized, the experimental formative program (in writing) was presented to the participants.

The program aimed at the introduction, use, and reflection on the means of measuring longitude, area, and volumes. The tasks for the measurements were provided in different situations, which were attractive and interesting for the pupils. This was achieved by the presentation of the actions of measuring as the necessities of the characters of a fairy tale. The characters of the fairy tale found themselves in situations where the measurements necessary for achieving a goal or saving somebody were represented as a magical action. The work with the program was interactive, involving the participation of all pupils in the classroom at school and guided by the teacher. The work was programmed for planned lessons dedicated to mathematical abilities and was aimed at helping the children understand the interdependence between the means used and the magnitude in the action of measurement. The work with the program was carried out by previously trained schoolteacher known to the children. The teacher used the materials of the program prepared and explained by the researchers. The teacher did not take part in the initial and final assessment, which was fulfilled by the researchers.

The basic content of the program was related to the introduction of the actions for the measurement of longitude, area, and volume of the liquids. Different symbolic means were presented to the children to achieve the action of the measurement. All tasks were collective and interactive; so that all children took part in each task of the measurement altogether. The actions of the children were oriented and supervised by the teacher on all occasions, in line with the concept of the zone of the proximate development (Vigotsky, 1993). The basic program materials were the content of the fairy tale, the visual images of the characters, and the images of the content of the tasks needed to be fulfilled during the work with the story. Various means for measuring the magnitudes of longitude, area, and volume were used. The tools for measuring the longitudes were strips of paper of different sizes; the tools for measuring the area were paper shapes of squares and rectangles of different sizes; and the tools for measuring the volumes were glasses and other receptacles of different sizes.

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TABLE 1 Tasks from the protocol for assessment of the level of preparedness for school.

Sphere of development	Task	Instruction	Materials
Mediatized recall	First part of the task, at the beginning of the work with the protocol	"I shall give you this button, you must keep it for me and return it at the end of our work. When you give it to me, I shall tell you something interesting."	The button
	Final part of the task, at the end the, the child must remember and return the button	"We have finished our work."	The button
Voluntary sphere	Oral voluntary language	"Please, count from 10 to 1"	Oral task
	Voluntary actions in the graphic plan. *Subtask 1*	Put the pencil on the first point on the paper, draw a small straight line as I tell you, you must notice the direction of each line. All lines should be longitude, like squares in your notebook. Try not to separate the pencil from the paper and draw all the lines carefully Draw one line straight to the bottom, one line to the right, one line down, one line to the right, one line down, one line to the right. Now, continue the same sequence. What does the figure look like? What can you call this figure?	The pencil. A paper with four start points marked by an adult
	Subtask 2	Put the pencil on the second point. Draw a line down, one line to the right, one line up, one line to the right, one line down, one line right. Now, continue the same sequence. What does the figure look like? What can you call this figure?	The pencil. A paper with four start points marked by an adult
	Subtask 3	Put the pencil on the third point. Draw one line up, one line to the right, one line up, one line to the right, one line down, one line to the right, one line down, one line to the right; and now continue this sequence. What is the figure looks like? How can you call this figure?	The pencil. A paper with four start points marked by an adult
	Subtask 4	Put the pencil on the last point. Now, draw three lines to the right, one line up, one line to the left, one line up, three lines to the right, one line down, one line to the left, one line down, three lines to the right. What does the figure look like? What can you call this figure?	The pencil A paper with four start points marked by an adult
Previous mathematical logical abilities	Correspondence	The adult shows the child two groups of little sticks with two different colors. The quantity of sticks in two groups is almost the same and it is difficult to determine the difference visually (the difference is only one stick). The child must answer the questions as follows. Which group has more little sticks and which has less? How can we find out? If the child starts to count the sticks, the adult asks him not to do it but think about another way of discovering of the quantity of the sticks in each group. How else can we get the answer without counting? If the child does not know, the adult starts to show the action of one-by-one correspondence between the sticks of one group with the sticks of the other one. The adult asks the child to continue the action of correspondence. In cases where the child does not understand the idea, the adult completes the whole procedure	Two groups of little sticks of two different colors
	Matching of sets of sticks	After the work with the action of correspondence, the adult asks the child whether the quantity of the sticks is different in both groups. The child must show how to make the quantity equal: adding one or removing one stick to make the groups correspond (both arithmetical actions are possible)	Two groups of little sticks of two different colors
	Seriation	Copy this sequence on the paper and continue it for one line	The model of the sequence drawn on the paper (one square and two circles)

Table 3 presents some examples of the tasks used during the program work.

A total of 16 sessions were held devoted to the work of the program. The sessions were held three times a week for 1 h. Two pupils were unable to continue the program for health reasons, so that only eight pupils finished the project.

After finishing the program, the children were assessed by the same protocols individually by the researchers. Different types of external help during the fulfilment of the protocol were also used during the final assessment.

The work with the program and final assessment were finalized in the month of July, which is the end of school year according to the

TABLE 2 Tasks of the protocol for assessment of previous mathematical knowledge.

Magnitude for measure	Task	Instruction	Materials
Longitude	Task with the pencils and pens	Find the example, in which the tool was used correctly for the measurement	The model for measure
	Task with the line	Find the proper tool for measurement of the line and use it correctly	The model of the line for measurement, the pencil, the strips of paper of different sizes
	The task with horizontal strips of paper	Cut the tool correctly and choose the lines of the same size as the example	The model, the pencil, the stamen, the cutters
	The task with vertical strips of paper	Cut the tool correctly and choose lines of the same size as the example	The model, the pencil, the stamen, the cutters
	The task with the dependence between the mean and the number	Identify the number of times each tool was used to measure the same magnitude	The model, the pencil
Area	The task with carpets	Identify the examples which used the same tool correctly	The model, the pencil
	The task with the tools for measure	Identify the number of times each tool was used to measure the magnitude correctly	The model, the pencil, an example of bigger size
	The task for the measurement of an area	Choose the figures with the same tool for measurement	The model, the pencil
	Task Tangram	Choose the figures which have the same tool but a different distribution	The model, the pencil
	Task for the dependence between the number and the measure	Identify the number of times each tool was used to measure the same magnitude	The model, the pencil
The tasks for the zone of proximate development (together with an adult)	Task with the bicicle	Identify the number of the elements in each group	The model, the pencil
	Task with the flowers	Identify the number of the elements which correspond to each other in the different groups	The model, the pencil
Volume	Task with the pool	Choose the figure with the biggest volume	The model, the pencil
	Who measured correctly (1)?	Identify an example where the tool was used correctly during the measurement	The model, the pencil
	Who measured correctly (2)?	Identify the examples, where the tool was used correctly during the measurement	The model, the pencil
	Tasks by Piaget (modified)	Identify the conservation of the volume in different receptacles. Which receptacle contains more water?	The model, the pencil
	The dependence between the number and the mean chosen for measurement	Identify the number of times that each tool can be used for measuring the same magnitude	The model, the pencil

TABLE 3 Examples of the tasks used during the work with the experimental formative program for introduction of the concept of tool and measurement.

Measurement	Examples of the task
Longitude	Find and use the tools on the basis of an example; identify a figure of the same longitude
	Choose the same tools to measure different paths; determine which path is the longest and which the shortest
Area	Choose concrete tools between different choices and measure the image of the square
	Measure the area of the picture by putting different tools for measurement of the square
Volume	Serve the water in different glasses and correct the quantity of the liquid according to the standard tool
	Identify which receptacles of different sizes hold the same volume of water

official calendar of the Mexican Secretory of Public Education (SEP). Additionally, after their summer vacations, in the month of September, the children were tested in an interview conducted by the researcher. All children, who take part in the program, were included in this interview. The goal of the interview was to find out whether the children had enjoyed their work with the program, and whether they remembered its content. The session for this interview took place at the school during one session of 30 min in the presence of a new teacher assigned by the school for the second grade of primary school. The teacher who initially worked with the program did not take part in the interview, in order to exclude any influence on the children's answers and opinions.

TABLE 4 Quantification of the tasks of the protocol.

Type of response	Punctuation
Correct and quick response	2
Correct and quick response after an adult's help on the content of the task	1
Wrong response even after an adult's help on the content of the task	0

TABLE 5 Types of external help provided by an adult during the work with the protocol for assessment of the level of preparedness for school [9].

Task	Repeat the instruction	Show the way to find the solution (without giving the whole solution)	Detailed question or presentation of the model for the answer (without giving the whole solution)
Proposal for mediatized retention (button)	Repetition of the instruction	An example of hiding the button	Show the way to hide the button by repetition of the instruction
Recall of mediatized retention	What did I tell you when you came?	What did I give you at the beginning and what was it for?	I gave you the button and I told you to give it to me, so I would tell you something. Where is the button?
Voluntary speech	Repetition of the instruction	If we start with 10 and go backwards, which number is next?	You can see; I can count backwards as follows: 10, 9, 8. Can you continue?
Voluntary actions on graphic level 1	Repetition of the instruction	Orientation for the direction of the line on the paper	Orientation for each fragment of the line and the changes of the direction
Voluntary actions on graphic level 2	Repetition of the instruction	Orientation for the direction of the line on the paper	Orientation for each fragment of the line and changes of direction
Voluntary actions on graphic level 3	Repetition of the instruction	Orientation for the direction of the line on the paper	Orientation for each fragment of the line and changes of direction
Voluntary actions on graphic level 4	Repetition of the instruction	Orientation for the direction of the line on the paper	Orientation for each fragment of the line and changes of direction
Correspondence	Repetition of the question	Orientation by putting two pairs of sticks in two series	Orientation by showing the process of one-by-one correspondence in two series
Equalizing the groups	Repetition of the question	Orientation by showing one stick and asking: what can we do with this one?	Orientation by showing one stick and asking: we can add the stick to this group. What else can we do? (We can take one stick from another group)
Seriation	Repetition of the question	Orientation by showing the series: "look at the order of the figures, can you finish the series?"	Use of external figures (shapes) and asking the child to follow the series of external figures

Taken from Quintanar and Solovieva (2019, p. 17–41).

TABLE 6 Descriptive statistics of global results obtained in the protocol for assessment of the level of preparedness for school.

Descriptive Statistics	Pretest	Posttest
Value	8	8
Absent	0	0
Mean	11.250	16.125
Typical error for Mean	0.750	1.109
Typical deviation	2.121	3.137

2.5. Punctuation

The children's responses for each task of the protocols were classified and quantified by 0, 1, and 2, as shown in Table 4.

During the fulfilment of the protocol, the children who had difficulties received help from an adult. Different types of external help were used, according to the specific content of the tasks. Table 5 shows the types of the external help provided to the children by the adult.

3. Results

The analysis of the data is presented below for the two protocols used for the initial and final assessments: (1) the tasks selected from the protocol for assessment of level of preparedness for school learning, and (2) those selected from the protocol for assessment of previous mathematical knowledge.

The general results obtained during the comparison of the fulfilment of the tasks selected from the protocol for assessment of level of preparedness for school learning (Quintanar and Solovieva, 2019) showed the presence of differences between the average of initial (11.250) and final (16.125) assessment (Table 6). The results were favorable for the final assessment, which pointed out that the children were able to fulfil the tasks correctly and they needed less external help from the adult.

The student *t*-test was used for the comparison of the results of fulfilment of the tasks during initial and final assessment. This test revealed significant differences favorable to the final assessment, with a significance value of 0.001, which is significantly higher than 0.05 ($t = -8.397$, $p < 0.001$, gl = 7).

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TABLE 7 Descriptive statistics of global results obtained for each task of the protocol for assessment of the level of preparedness for school.

	Value	Absent	Mean	Typical error for Mean	Standard deviation
1A	8	0	1.375	0.263	0.744
1B	8	0	2.000	0.000	0.000
2A	8	0	0.750	0.164	0.463
2B	8	0	1.625	0.183	0.518
3A	8	0	1.375	0.183	0.518
3B	8	0	1.625	0.183	0.518
4A	8	0	1.625	0.183	0.518
4B	8	0	1.875	0.125	0.354
5A	8	0	1.375	0.324	0.916
5B	8	0	1.750	0.250	0.707
6A	8	0	1.000	0.327	0.926
6B	8	0	1.125	0.350	0.991
7A	8	0	0.500	0.267	0.756
7B	8	0	1.250	0.313	0.886
8A	8	0	0.875	0.125	0.354
8B	8	0	1.500	0.189	0.535
9A	8	0	1.625	0.263	0.744
9B	8	0	1.875	0.125	0.354
10A	8	0	0.625	0.324	0.916
10B	8	0	1.500	0.327	0.926

A corresponds to the initial assessment.
B corresponds to the final assessment.

TABLE 8 Contrast *T* for paired samples of global results obtained for each task of the protocol for assessment of the level of preparedness for school.

Measure 1	Measure 2	*t*	gl	*p*
1A	-1B	NaN		
2A	-2B	−3.862	7	0.006
3A	-3B	−1.528	7	0.170
4A	-4B	−1.528	7	0.170
5A	-5B	−1.426	7	0.197
6A	-6B	−0.314	7	0.763
7A	-7B	−2.393	7	0.048
8A	-8B	−2.376	7	0.049
9A	-9B	−1.528	7	0.170
10A	-10B	−2.497	7	0.041

Contrast of student *t*-tests.
A corresponds to initial assessment.
B corresponds to final assessment.
[a]The variance of 1B is equal to 0.

Statistical analyses of the individual results for each task showed that not all the tasks of the protocol had shown statistical differences (Table 7), but all the tasks showed better results in execution during the final assessment, compared with the initial assessment.

The tasks of correspondence and equation of groups and seriation showed significant differences (Table 8).

The results of fulfilling the protocol for assessment of previous mathematical knowledge were compared before and after the work with experimental program. These results were analysed with the statistical program JASP, version 0.16.3.0, which evaluated two student t-tests for two conditions of the protocol: one for the global results and the other for each task carried out before and after implementation of the program with significant value of $p < 0.05$.

The comparison of the global results for the fulfilment of all the tasks of the protocol for assessment of basic mathematical abilities (in writing), found significant differences between the initial and final

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assessments. The median of the correct answers in the initial assessment was 14.313; and in the final assessment it was 20.875 (Table 9).

TABLE 9 Descriptive statistics of global results in initial and final assessment during fulfilment of the tasks of the protocol for assessment of previous mathematical knowledge.

Descriptive Statistics	Pretest	Posttest
Value	8	8
Absent	0	0
Median	14.313	20.875
Typical error for Median	1.785	1.302
Typical deviation	5.049	3.682

The student t-test results had a significance value of p 0.007 ($t = -3.792$, gl = 7), which was significantly lower than 0.05. This data allows to conclude that the differences between the results of initial and final assessment were statistically significant. The children's total results were much higher in the final assessment.

The results were also analysed for each concrete task of the protocol, to establish which tasks showed differences between the initial and final assessments. Table 10 shows the data obtained by the student *t*-tests for each task.

Table 11 indicates the presence of significant differences in performance between tasks 2, 8, 14, and 17. All these tasks are related to the measurement of magnitudes and showed significantly better results in the final assessment. In the rest of the tasks differences also existed, but the degree of difference was less. Tasks 11 and 16 did not show any statistical difference between the initial and final assessments.

TABLE 10 Statistical Description of the results in tasks of the protocol of evaluation of previous basic mathematical knowledge.

	Value	Absent	Medin	Typical error for Median	Standard deviation
1A	8	0	1.875	0.125	0.354
1B	8	0	1.500	0.327	0.926
2A	8	0	0.875	0.295	0.835
2B	8	0	1.500	0.189	0.535
3A	8	0	0.875	0.227	0.641
3B	8	0	1.250	0.164	0.463
4A	8	0	0.625	0.263	0.744
4B	8	0	1.000	0.189	0.535
5A	8	0	1.000	0.327	0.926
5B	8	0	1.625	0.183	0.518
6A	8	0	1.375	0.183	0.518
6B	8	0	1.375	0.183	0.518
7A	8	0	1.313	0.340	0.961
7B	8	0	1.625	0.263	0.744
8A	8	0	0.250	0.164	0.463
8B	8	0	0.750	0.164	0.463
9A	8	0	0.625	0.183	0.518
9B	8	0	0.875	0.125	0.354
10A	8	0	1.500	0.327	0.926
10B	8	0	1.875	0.125	0.354
11A	8	0	0.875	0.125	0.354
11B	8	0	1.000	0.000	0.000
12A	8	0	0.750	0.164	0.463
12B	8	0	0.875	0.125	0.354
13A	8	0	0.875	0.125	0.354
13B	8	0	0.875	0.125	0.354
14A	8	0	0.375	0.183	0.518
14B	8	0	0.875	0.125	0.354
15A	8	0	0.125	0.125	0.354
15B	8	0	0.500	0.189	0.535
16A	8	0	0.500	0.327	0.926
16B	8	0	2.000	0.000	0.000
17A	8	0	0.625	0.263	0.744
17B	8	0	1.375	0.263	0.744

A corresponds to initial assessment.
B corresponds to final assessment.

TABLE 11 Contrast *T* for paired samples in the results in the tasks of the protocol for evaluation of previous basic mathematical knowledge.

Measure 1	Measure 2	*t*	gl	*p*
1A	-1B	NaN		
2A	-2B	−3.862	7	0.006
3A	-3B	−1.528	7	0.170
4A	-4B	−1.528	7	0.170
5A	-5B	−1.426	7	0.197
6A	-6B	−0.314	7	0.763
7A	-7B	−2.393	7	0.048
8A	-8B	−2.376	7	0.049
9A	-9B	−1.528	7	0.170
10A	-10B	−2.497	7	0.041
11A	-11A	NaN[a]		
12A	-12B	−0.552	7	0.598
13A	-13B	0.000	7	1.000
14A	-14B	−2.646	7	0.033
15A	-15B	−2.049	7	0.80
16A	-16B	NaN[b]		
17A	-17B	−2.393	7	0.048

Contrast of student *t*-tests.
A corresponds to initial assessment.
B corresponds to final assessment.
[a]The variance of 11B is equal to 0.
[b]The variance for 16B is equal to 0.

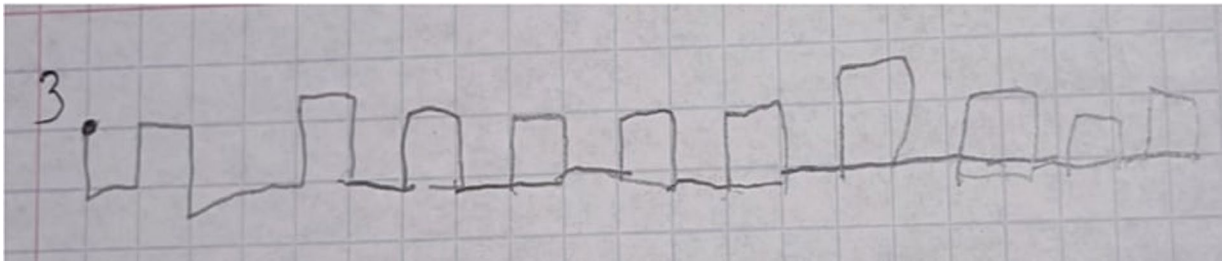

FIGURE 1
The task of graphic dictation during the initial assessment.

The Figures 1, 2 show fulfilment of the task of graphic dictation from the Protocol for assessment of preparedness for school learning. In this task, the child has to follow oral instructions of an adult and draw graphic sequences on the paper.

Figure 1 shows the execution of the task of graphic dictation for the protocol of assessment of preparedness for school during the initial assessment. In this example it is possible to notice the difficulties of the child, who is not able to follow oral instructions of the adult for drawing the sequence of graphic lines.

Figure 2 shows the execution of the same task during the final assessment, in which there is no mistakes.

The Figures 3, 4 show the examples of execution of the task from the protocol of assessment of previous mathematical knowledge. In these tasks the child has to establish the proper way for measuring the volume of the liquid.

Figure 3 shows the execution of the task of identification of correct use of the method for measuring liquid, in which the child commits a mistake by choosing wrong way for measuring. On the contrary, Figure 4 shows the correct execution of the same task during the final assessment.

3.1. The interview of the participants

During the interview, applied to all children after participation in experimental program, the pupils were asked questions by an adult about the content of the fairy tale and their work with the program. Below we present the collective answers of the children, who took part in the program.

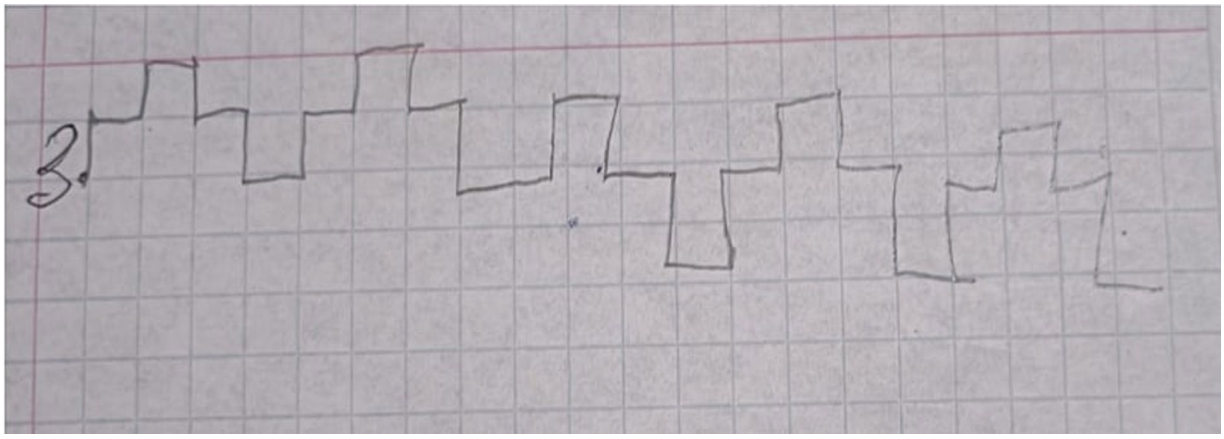

FIGURE 2
The task of graphic dictation during the final assessment.

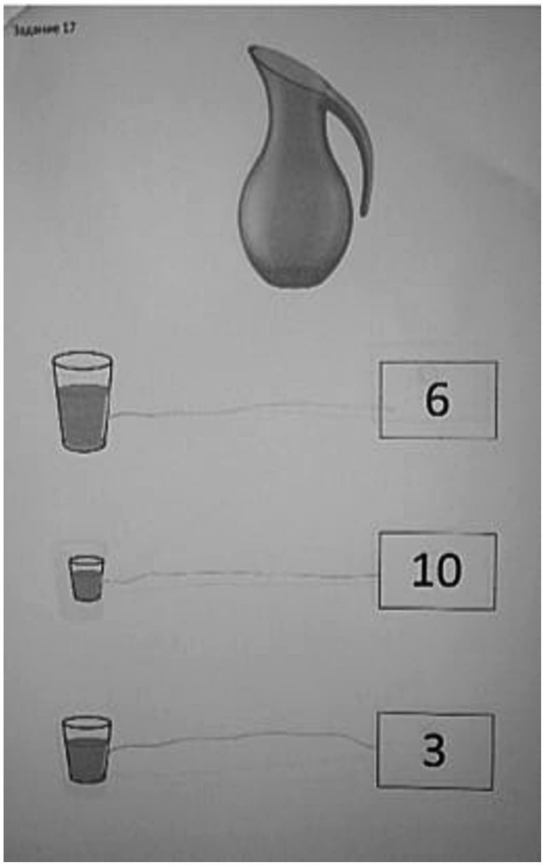

FIGURE 3
The task of identifying the correct use of the method for measuring liquid during the initial assessment.

Researcher: Do you remember the fairy tale, with which you worked before your summer vacations?

Participants: Yes!

Researcher: Well, we shall ask you some questions about this tale. Do you remember what it was about?

Participants: Yes, it was about how to measure.

Researcher: Yes, it was about measurement. Do you remember the main protagonist of the tale?

Participants: Yes, the prince.

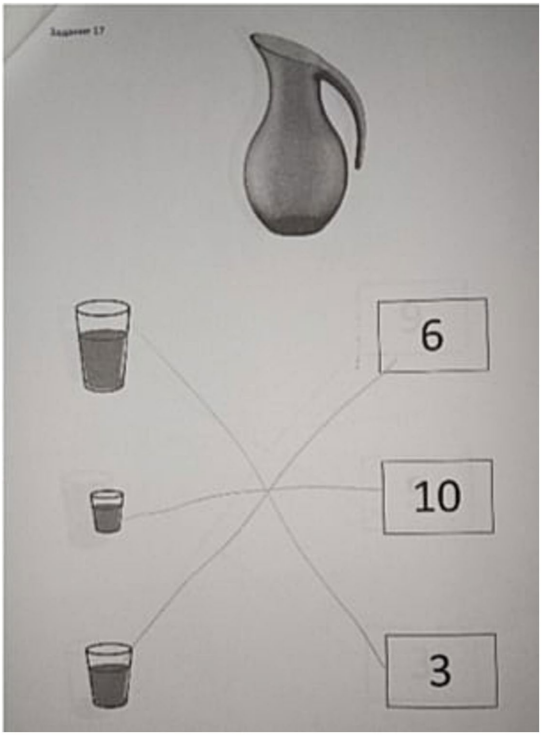

FIGURE 4
The task of identifying the correct use of the tool and method for measuring liquid during the final assessment.

Researcher: That's true, it was the prince. Do you remember what he did?

Participants: He was helping others.

Researcher: He was traveling everywhere and helping the people. Do you remember the tasks which he had to solve?

Participants: He had to measure.

Researcher: What was the easiest measurement task?

Participants: To measure the water.

Researcher: Which tasks did you like most?

Participants: We liked the task with the cave, with the water, and with the magic sticks.

Researcher: Which were the tasks you did not like, or that you liked less?

Participants: The task with the shields.

Researcher: Why?

Participants: Because the shields were moving all the time and the wind took them away.

Researcher: Do you remember any other task which you did not like?

Participants: No, that was the only one.

Researcher: Did you like to study mathematics with the tale, or is it better without the tale?

Participants: It was better with the tale because it was fun.

Researcher: Did you like this tale?

Participants: Yes, because the tasks were very funny.

Researcher: Very well. Do you remember some tasks which we had to solve using sticks, nets, threads, and rectangles, while we were measuring different figures?

Participants: Yes.

Researcher: Was it easy or difficult when we did it for the first time?

Participants: It was easy.

Researcher: And what about the second occasion; was it easier or was more complicated?

Participants: Easier.

> Researcher: Do you believe that the fairy tale helped you to answer?
>
> Participants: Yes.
>
> Researcher: Do you remember what was to be measured in these tasks?
>
> Participants: Some sticks.
>
> Researcher: Were these tasks easy?
>
> Participants: Yes, easy.
>
> Researcher: Well, thank you very much.

4. Discussion

The analysis of the results of the study shows that the children performed better during the final assessment, after their participation in the experimental program. Some results of the execution of the tasks were significantly different, and favorable during the final assessment. For example, in the protocol of assessment of the level of preparedness for school, the tasks of correspondence and equation of groups, and seriation showed significant differences, as the children were able to fulfil these tasks correctly without any help from the adults.

The examples of the executions of the tasks during the initial and final assessments showed important improvement. The final assessment showed correct fulfilment of the proposed tasks and no mistakes. Most of the children were able to fulfil the tasks correctly during the final assessment, while it was not possible during initial assessment.

It is necessary to stress that the tasks on the assessment were not included in the content of the program, which was directed to providing tasks of reflective and conscious actions of measurement of different magnitudes in the context of the fairy tale. The results of the research point out that the program helped the children improve their ability to solve logical tasks which are essential for the initial introduction of mathematical concepts. The children's participation in the final interactive interview showed that they remembered the content of the program, and the actions and means (tools) used for measurement, and that they enjoyed working with most of the proposed tasks. They were also able to detect the most difficult and confusing tasks of the program. This data shows positive effects of collective organization of children's work with the use of mathematical intellectual actions. Such work guarantied positive emotions and attitude toward mathematical knowledge in children. This data supports the idea of the previous publication about positive effects of the work of young scholar in teams (Glozman and Plotnikova, 2021; Sidneva et al., 2022). The study allows to think that introduction of mathematical knowledge might be presented as attractive and pleasant collective activity.

Piaget (Piaget, 1954), in his studies, discovered the importance of elementary logical actions for further acquisition of mathematical abilities in school. At the same time, the followers of Piaget, who represent the constructivist approach to teaching mathematics, did not propose any kind of training to develop logical actions. Rather, the constructivist approach claims that logical thinking is predetermined to appear by the age of 12, so that school learning can be a "free" and "spontaneous" process. Proponents of constructivism are directed to stimulate individual solutions for tasks proposed by the teacher (SEP, 2017) or provide guidance by physical sensory models of groupings and unions (Montessori, 2004; Navarro and Larrea, 2018).

On the contrary, representatives of the cultural-historical approach and activity theory in psychology claim that logical actions do not appear spontaneously but require specially organized work with the children at school (Talizina, 2018, 2019). In this sense, it's possible to affirm that mathematical knowledge is not spontaneous, is not constructed individually by each child and do not appear just as the consequence of brain maturation. Mathematical knowledge is an example of cultural historical cultural experience with its specific symbolic language (Antonsen, 2021), which the child may or may not acquire during his or her life (Bell, 2021). This positive and successful acquisition depends on the methodology of teaching and guidance provided by the teacher (Rosas and Solovieva, 2019). This kind of effort to provide innovative experimental programs requires more research and creativity (Van Oers and Pompert, 2021). It is especially important in the region of Latin America, where successful learning of mathematics is rare (Sánchez and Escotto, 2013).

Unfortunately, official programs for teaching mathematics are mostly based on the constructivist way of thinking, which understands the acquisition of logical and mathematical abilities to evolve spontaneous spontaneously (Piaget, 1972). The central topic of constructivism is how to stimulate development; such a proposition does not involve tackling the problem of finding new methods of teaching (Inhelder and Cellérier, 1996). But the cultural-historical approach and activity theory applied to teaching and learning processes works on how to guarantee the positive development of logical action in most school children (Talizina, 2019).

Probably, now when international pandemic and impossibility of children having face-to-face studies have ended, it is a good time to start thinking about coherent changes in teaching and learning methodology. Such changes should aim to establish emotional and positive communication between the pupils and the teacher during classes, not expect pupils to "construct" logical knowledge independently, as constructivism claims (Díaz and Hernández, 2002). The teachers must organize the lessons and present mathematical data in attractive and understandable manner, so that the children might be involved in this sphere of knowledge emotionally and intellectually. The big challenge of the system of education is that the latest programs for teaching mathematics according to competences and active constructivism have not achieved any kind of methodologically clear solution. Particularly in Mexico, there is no clear systematic elaboration of proposals for work at the pre-school and school level for the initial introduction of mathematical concepts. International organizations have recommended reconsidering how to develop mathematical knowledge, and strengthen its functional aspect and reflexive, variable, and flexible use in multiple situations (OECD, 2006). While little things have been done in this direction, stagnation has dominated the basic methodology of teaching mathematics.

According to Carrillo et al. (2012), mathematical competence represents the capacity for using mathematics for judgment in a variety of situations; this applies even in extra-mathematical contexts, due to the broadness of possible application of mathematical actions. In our opinion, this view is completely accurate for the general aspects of mathematical concepts. At the same time, it is false, because it tends to lose sight of the specific character of mathematical knowledge in comparison with general intellectual knowledge. Specifically, such a broad interpretation of

mathematical knowledge might be very useful at advanced levels of study, but not at the time of its introduction in primary school, because it does not offer any specific method for introducing mathematical concepts, which are represented by specific actions and specific concepts.

Radical changes in the method of teaching mathematics should be related to the content of methodological work in the classroom. The data of the research allows to stress that such changes are possible, based on psychological activity theory.

Psychological activity theory, developed by Leontiev (2009), offers a dynamic and dialectical vision of the process of teaching and learning. This process should be understood as complex cultural activity, which has its own goals, structure, content, and participants (Solovieva, 2019). The role of the teacher is fundamental during the teaching, especially at the initial stage of introduction of the concepts. At the same time, the teacher must be specifically prepared and able to systematize and organize the knowledge to guarantee its positive acquisition by the pupils.

According to Vigotsky (1993), such teaching leads to the psychological development of the child or, expressing the same idea in other words, "there is no good learning without previously organized good teaching." This means that the teacher must possess a specific methodology to be used in the classroom. Frequently, the specific methodology must be created and applied in experimental groups, before being understood and used as a practical instrument in the classroom. Such is the case in the initial introduction of mathematical knowledge, which is expressed in the reflective fulfilment of symbolic and logical actions by children, which are normally poorly formed at pre-school age (Nisskaya, 2018; Talizina, 2018; González, 2021; Veraksa et al., 2022). The sequence and the content of these actions should be articulated with the help of concrete methods or programs and applied in groups of children who are starting to learn mathematics formally. In this research, specific mathematical abilities were introduced and formed in children, such as the measuring of different magnitudes. After the work with experimental program, the children were able to follow oral instructions of the adult for realization of graphic tasks, to understand the content of action of measuring of longitude, area, and volume of liquids and to choose proper means for measurement. The children were able to identify the actions of measurement fulfilled with and without mistakes and to correct these mistakes. Such clear understanding did not exist before participation in the experimental program, even though the children studied in the school which uses cultural historical methodological approach. Experimental program helped the pupils to identify properly the means for the measurement of the length, area, and volume and to understand the logical process of each measurement, which was not possible before the work with the program, according to initial and final testing.

The results of our study allow to offer a new original way for introducing innovative programs for interaction with the children in the classroom together with the teacher, which helps them achieve better results in understanding logical actions and the mutual dependence of the processes of measuring, the magnitude to be measured, and the tools which should be selected for these actions. All children, who took part in the program, were able to understand logical actions and enjoy the process of learning mathematical concepts in primary school. The results of the study might be used for improvement of the process of initial introduction of mathematical abilities. The study opens an opportunity for creative implementation of the concepts of zone of proximate development and orientation as main concepts of cultural historical approach.

One of limitations of this study was the small sample of the children who took part in the experimental program, because the private school chosen for the study works with small groups of children. Another limitation was the absence of the control group, as it was impossible to get permissions for assessment of children from other private primary school with similar characteristics. An essential advantage of the study consists in the effort of creation and implementation of new original program for introduction of initial mathematical knowledge by working with measurement as joint intellectual actions guided by the teacher, according to the conception of the zone of proximate development. The program should be taken into account as new contribution for initial introduction of mathematical actions within cultural historical approach. Our future efforts will include preparation for publication of the whole content of the experimental program in Spanish for its generalized use by teachers in primary schools and for correction of difficulties in the process of acquisition of mathematical knowledge.

5. Conclusion

The results of the study show significant differences between the initial and final assessment of the ability of children in the first grade of primary school to use the proper tools for the action of measurement. Such findings allow to confirm that the program used for our work on the intellectual actions of measurement in the context of a fairy tale was useful for the children's understanding of the dependence of determining a magnitude on the tools and methods chosen for the measuring it. The pupils, who took part in the program showed interest and pleasure during the work with experimental program. Such data is relevant for design and approbation of original programs for introduction of basic mathematical knowledge. The children of form the first grade of primary school worked eagerly with the content of intellectual actions, guided by the teacher. The content of a fairy tale might be used as a pedagogical strategy, while the actual actions of measurement should be included and carried out by the children according to the content of the tale. The teaching of initial mathematical concepts should include the use of different and flexible symbolic means as tools of the children's for introducing reflection during solution of logical problems. The experience of the work with the content of fairy tale allows to confirm that symbolic means and logic actions must not be only presented or explained but fulfilled by the children in the classroom under the guidance of the teacher. The program, used in the study, might be reproduced in different educational institutions and social contexts, where the work on introduction of initial mathematical knowledge is needed.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethical Committee of the Department of Psychology, Lomonosov Moscow State University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

YS: conceptualization and supervision. YS and LQ: methodology, investigation, writing – review, and editing. JZ: software and visualization. JZ and AC: formal analysis. YS, JZ, AC, LQ, and VP: writing – original draft preparation. LQ: project administration. YS and VP: funding acquisition. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY
Aleksander Veraksa,
Lomonosov Moscow State University, Russia

REVIEWED BY
Vera Yakupova,
Lomonosov Moscow State University, Russia
Alessio Porreca,
University of Padua, Italy

*CORRESPONDENCE
Ana Moreno-Núñez
✉ ana.moreno@uam.es

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Early triadic interactions in the first year of life: a systematic review on object-mediated shared encounters

Ana Mendoza-García and Ana Moreno-Núñez*

Departamento de Psicología Evolutiva y de la Educación, Universidad Autónoma de Madrid, Madrid, Spain

Infants' early interactions with adults and everyday objects are key to socio-communicative development, but their emergence and development are still under debate. Aiming at describing the diversity of theoretical and methodological approaches on triadicity during the first year of life, we conducted a systematic and qualitative review of recent literature. Following PRISMA 2020 guidelines, we explored the scientific production of recent decades on triadic interactions up to 12 months of age. We initially screened 1943 items from which we obtained a final sample of 51 publications. Studies are usually conducted in laboratory settings, while ecological research is becoming increasingly common, especially in home settings. According to a thematic analysis of the data, we discussed the different perspectives on the origin and conceptualization of triadic interactions, and how they contribute to structuring and facilitating other developmental phenomena, such as the children's communicative gestures and uses of objects. Prior to the origin of intentional communication, adults facilitate early forms of triadicity based on fostering opportunities for infants' communication and engagement with both adults and materiality. However, there is a need for further research that explore the potential of early triadic interactions for parenting and early childhood education practises.

KEYWORDS

triadic interactions, referential communication, joint action, materiality, early development

1. Introduction

The first social experiences of infants take place, from the first months of life, through interactions with their caregivers and with everyday objects (Moreno-Núñez et al., 2021a). This is consistent with the cultural-historical approach and, more specifically, with the postulates of activity theory developed from Vygotskian proposals. From this perspective, individuals act collectively based on shared activities and communicative exchanges that allow us to appropriate cultural tools (Vygotsky, 1978; Foot, 2014). According to this, social interactions, especially with adults, are essential during early childhood as they favour an inter-communicative space of mediation and collaboration that facilitates the child's learning and development (Vygotsky, 1984; Veraksa and Veraksa, 2018).

Adult mediation refers to the guided process of equipping children, through shared activities, with the psychological tools necessary to operate in a specific sociocultural context. It enables children to progressively internalise their learning and, consequently, to develop in the

world in an increasingly autonomous way (Vygotsky, 1934/1986). Throughout the first year, infants' relationship with their environment is modified by the intervention of the adult (Vygotsky, 1932/1996; McCune and Zlatev, 2015), who responds to their first signals and attempts to communicate while sharing bouts of attention and action on specific objects or events (Bakeman and Adamson, 1984; Solovieva and Quintanar, 2021). This process does not, therefore, occur in a vacuum, but within the framework of early interactions that take place in a given socio-material context. In these interactions, objects are incorporated not as mere material realities, but as communicative vehicles that encourage joint action based on their social and cultural properties (Rodríguez, 2012; Burner and Svendsen, 2020). Thus, it is in these interactions where the conventional meanings and uses of objects are transmitted (Rodríguez, 2006; Solovieva et al., 2020). This enables progressive sophistication in infants' actions, by turning these into social acts directed to, and coordinated with, the other person (Carpendale et al., 2021).

The role of these triadic encounters (adult-infant-object) in socio-communicative development has been the focus of much debate, especially over their origin. Traditionally, it has been considered that babies relate first to adults, during the first months of life, and somewhat later, also to objects. This has given rise to the differentiation between primary intersubjectivity, referring to early dyadic exchanges between adults and infants, and secondary intersubjectivity, in which interactions incorporate external referents, acquiring a triadic character (Trevarthen and Hubley, 1978; Carpenter et al., 1998; Tomasello et al., 2005; Striano and Reid, 2006). The transition from one stage to the other is usually considered to take place at around nine months of age, when the infants' first intentional communicative acts towards the adult emerge in what Tomasello (2013) called the "nine-month revolution." From then on, the complexity of the infants' socio-communicative behaviours increases, as they can share experiences with others through, for example, the use of gestures and the diversification of communicative functions (Bates et al., 1975).

However, more recent work questions whether the emergence of infants' first triadic experiences is limited to the end of the first year (Rodríguez, 2006). Some authors have characterised this process as a continuous and gradual development, mediated by the adult from birth (Reddy, 2010). In this sense, early communication would develop from the beginning of life according to interactional dynamic processes (Fogel and Thelen, 1987; Fogel, 1993; Thelen and Smith, 1994) in which what is shared is not transmitted unidirectionally, from one mind to another, but is jointly created between adult and child (Fogel, 1993; Trevarthen and Reddy, 2017) or within the family dynamics with more than one primary caregiver (Fivaz-Depeursinge and Corboz-Warnery, 1999; León and Olhaberry, 2020). Communicative intentionality, therefore, is gradually co-constructed and integrated as part of the infant's repertoire of skills, thanks to the adult-mediated encounters that take place over time (Rączaszek-Leonardi et al., 2019) and in which they often incorporate objects to communicate about—and through—the material world (Rodríguez, 2012).

Precisely, the lack of consideration given to objects in early interactions is another of the problems underlying their conceptualisation. From classical positions, triadic interactions with objects are based on episodes of joint attention, which can be understood from different perspectives (Gabouer and Bortfeld, 2021). On the one hand, from an associative perspective they would depend on the infant's visual orientation system and its ability to follow the gaze of the other (Butterworth, 1991), which is considered to occur in the absence of interactive processes from six to 18 months of age (Butterworth and Jarrett, 1991; Corkum and Moore, 1998). On the other hand, from a social perspective, this highlights the coincidence of gazes between adults and infants on a referent (e.g., objects) in the framework of a dynamic interaction process that begins early in the first year of life (Striano and Stahl, 2005) but continues to develop throughout the second year (Tomasello and Farrar, 1986). Indeed, some studies emphasise the attentional, communicative, and co-regulatory processes between adults and infants in relation to an object of mutual interest, that unfold between 6 months and 1.5 years old. In this way, they distinguish between "coordinated joint engagement," which refers to the multimodal components that occur in intersubjective episodes (e.g., smiles or gestures), and "passive joint engagement," which would be limited to the coincidence of attentional focus on the same object (Bakeman and Adamson, 1984).

While the joint attention paradigm has occupied a central role in research over the last few decades, recent studies invite us to modify the analytical prism based on the growing interest in the multimodal components that underpin these adult-infant encounters (Yu and Smith, 2016, 2017). For example, adults tend to accompany episodes of joint attention by combining verbal input and tactile stimulation towards the infant (Suárez-Rivera et al., 2019). This could be associated with a longer duration of the infant's gaze towards the object, compared to non-multimodal episodes. This evidence has called into question the study of joint attention as an isolated process, as it could be part of a conglomerate of cognitive, social, and communicative phenomena (Siposova and Carpenter, 2019; Jacobson and Degotardi, 2022) that take place in joint action dynamics between the infant and others (Reddy, 2005). In this sense, adopting an interactive and multimodal perspective would make it possible to emphasise not only attentional aspects but also other elements of the interaction such as emotion, touch, or use of objects (De Barbaro et al., 2013; Rossmanith et al., 2014; Moreno-Núñez et al., 2017).

The lack of an established consensus around triadic interactions, such as how and when they emerge, or the particular characteristics that arise from their conceptualisation has left an open theoretical and methodological debate. As such, there may be reason to identify those inconclusive areas and to explore the different perspectives on their origin, development, and nature of triadic interactions. To this end, we conducted a systematic and qualitative review that explored the scientific production of the last decades and its main findings, discussing their potential implications for the study of early development and early childhood education and care. In doing so, we can inform further empirical exploration of this phenomena.

2. Methods

Following the recommendations of the PRISMA 2020 statement (Page et al., 2021), an updated version of PRISMA 2009 (Moher et al., 2009), we conducted a comprehensive literature search in eight databases: Web of Science, Scopus, ProQuest, PubMed, ScienceDirect, PsycINFO, Dialnet, and Dimensions. To do so, we started with four keywords, in English and Spanish, which were combined with Boolean operators according to the following search equation: ("triadic

interactions" OR "joint engagement") AND object* AND child*. In addition to the articles recovered from the databases, other relevant studies, retrieved from the references cited in other research, were also included.

The PRISMA flow chart (Figure 1) illustrates the study selection process performed for this systematic review. The total number of results obtained in the initial search was 1,943 articles, of which 297 duplicates were eliminated. We then collected general information on each study (author, year of publication, title, source database and abstract) and reviewed their appropriateness to the study topic, based on the title and abstract. This resulted in the exclusion of 1,356 articles that were not related to our objectives, as they focussed, for example, on parental mental health, family interventions or research with non-human primates. From the resulting database ($n = 290$), full texts were analysed and screened according to the following eligibility criteria:

- *Publication type*: empirical articles published in peer-reviewed scientific journals were selected. Doctoral theses, book chapters, monographs, theoretical articles, and reviews were excluded.
- *Publication area*: we included studies that provided results in psychological terms (human development or behaviour).
- *Aim of study*: publications selected were those that explored triadic interactions between adults, objects, and infants during the first months of life. Articles on related topics (joint attention) were included if they referred to the 'triadicity' of the interactions.
- *Age of participants*: given our interest in early interactions, we have prioritised the inclusion of studies focussing on the first year of life. Nevertheless, longitudinal studies where data collection was extended up to 18 months of age of the participants were also considered.
- *Language*: only articles published in English or Spanish were included.
- *Date of publication*: to provide an updated analysis, only studies published between 2000 and 2022 were considered.
- *Access to full text*: articles for which it has not been possible to access the full text for review were also excluded.

During the decision-making process, discrepancies regarding the inclusion of certain articles were resolved by consensus among the investigators. The screening process resulted in a final sample of 51 publications, which were subjected to a methodological quality analysis using QualSyst (Kmet et al., 2004). This tool provides checklists adapted to a wide range of methodologies and topics that

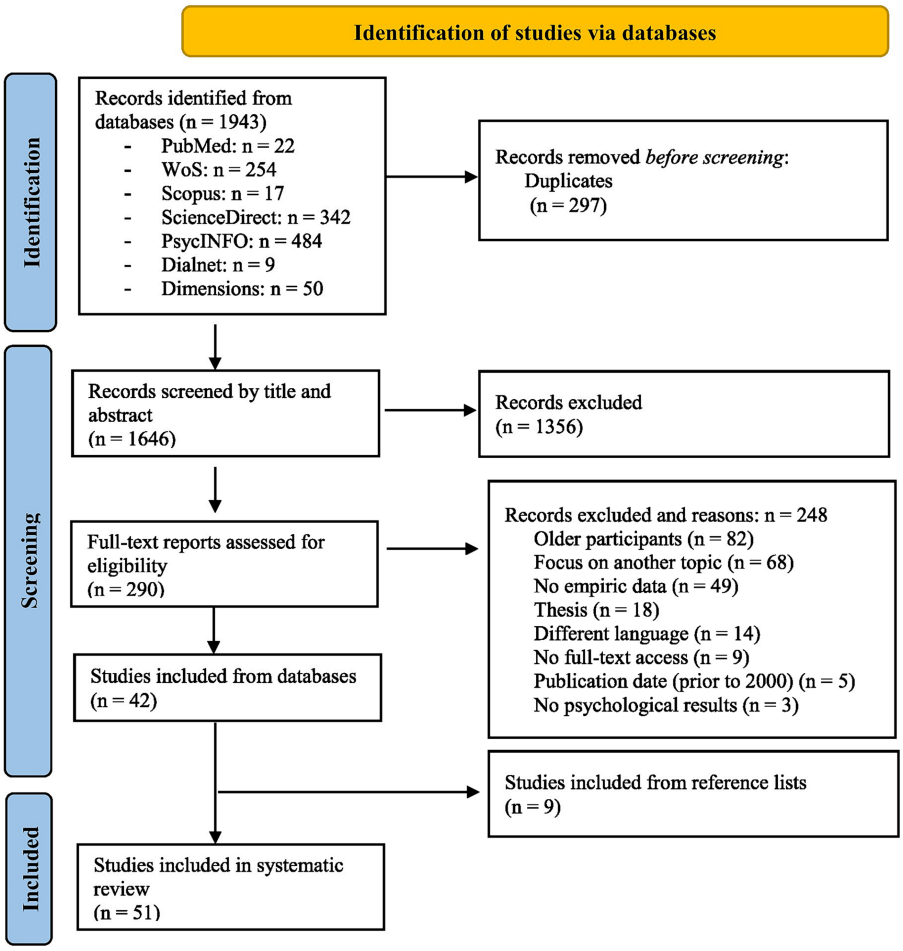

FIGURE 1
PRISMA Flow chart.

allow the critical evaluation of qualitative and quantitative scientific papers. On this basis, it provides an estimate of the methodological quality of studies as a result of a score between 0 and 1, with 1 being the highest possible quality score. It also proposes different cut-off points for deciding on the exclusion of studies, ranging from 0.55 to 0.75. All the studies included in the final sample exceed the highest cut-off point of 0.75 (M = 0.925; SD = 0.06).

3. Results

For the analysis, we first explored the distribution of the scientific production included in the sample in terms of its population characteristics (where the studies were carried out and the context in which the data were collected) and methodological characteristics (type of study, type of design, type of interaction task, and data analysis strategy). Secondly, we carried out a thematic analysis of the results, based on the discussion of findings related to the origin, development, and educational implications of triadic interactions.

3.1. Description of recent scientific production

When analysing the data on the location where the studies were conducted (Figure 2), we observed that studies run in European countries (59%) and North America (25%) predominated. Nonetheless, probably since our review also included texts in Spanish, the sample includes a considerable percentage of studies run in Latin American countries (12%). The limited share of research run in Asian contexts was striking (4%), with only two studies run in Japan and India, respectively. We did not find any work on this subject based on data collected in Australia or New Zealand.

We also looked at recent trends in the study of triadic interactions in different contexts (Figure 3), as these could lead to different ways of interacting with the environment. To this end, we defined four categories that classify the interactions according to the degree of control of variables: laboratory, home, nursery school and mixed categories (i.e., studies that combined two or more of the above). The laboratory was and is the predominant setting for data collection in most of the research analysed (53%). However, there has been a recent increase in the number of studies using data collected in naturalistic settings, especially the home (41%). This includes studies in which the interactions take place between the child and their mother/father in a familiar environment (e.g., their own home or school). Nonetheless, other everyday interactions in the infants' life, such as those with educators and peers at nursery school, are still underrepresented in the scientific literature (4%). Finally, although we found only one such study (2% of the sample), it is important to note that we were able to find mixed studies that combined data from more than one of these contexts, for example, the home and the laboratory (Danis et al., 2000). However, this is not an alternative that has been maintained over time, favouring studies focussing on one or the other context.

Finally, Table 1 shows the distribution of the sample in terms of three elements: first, the type of study; second, the type of empirical design; and third, the data analysis strategy (Montero and León, 2002). For comprehensiveness purposes, we also included the type of interaction task used in the studies in our sample. Regarding the type of study, the sample comprises mainly descriptive (71%) and experimental (29%) research. In relation to the type of empirical design, we observed a more homogeneous distribution between longitudinal (55%) and cross-sectional designs (43%), while pre-post test designs in this area are scarce (2%). Studies were most frequently based on free-play interactions between adults (both researchers and parents) and babies (74.5%), followed by experimental interactions (17.5%) aimed at eliciting certain behaviours in infants. We found very few studies based on everyday routines at home such us feeding activities (4%) or teacher-led interactions in nursery schools (4%). Although not all studies provided data on the type of objects utilised, the vast majority of studies in our sample used toys (including musical toys and books) and artifacts (e.g., a spoon) to promote interaction. Finally, according to the data analysis strategy, there is a significant predominance of quantitative studies (78%), compared to qualitative (10%) or mixed methods (12%).

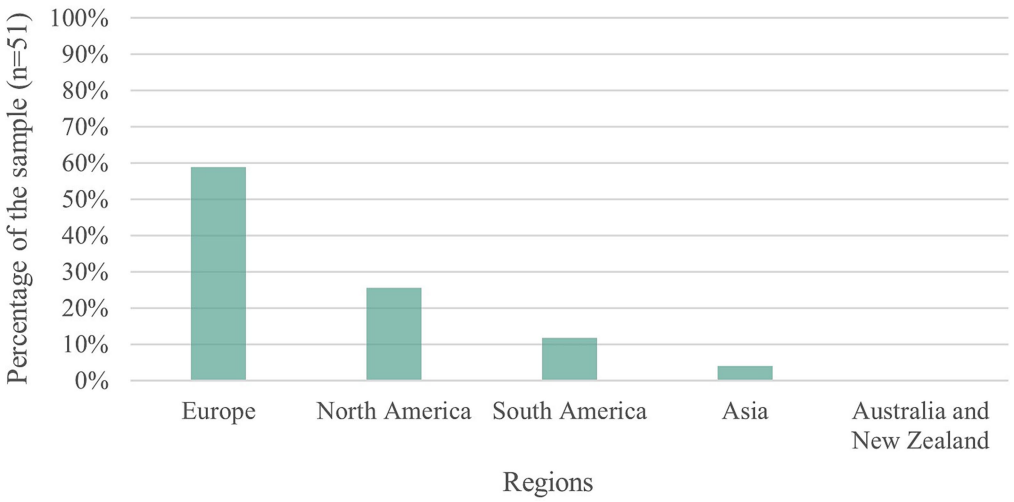

FIGURE 2
Sample distribution according to the regions where the studies were conducted.

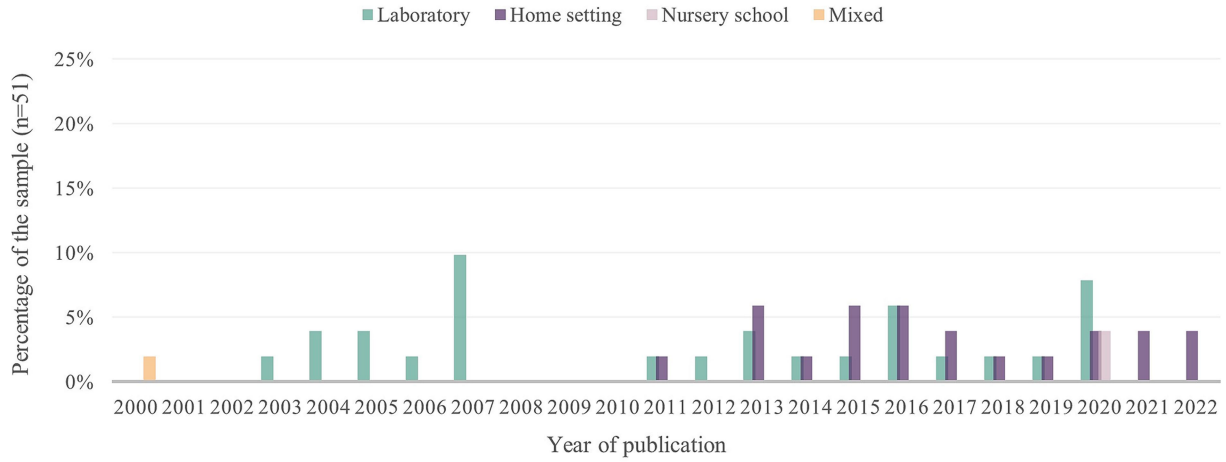

FIGURE 3
Sample distribution by year of publication according to the settings in which the interactions were observed.

TABLE 1 Frequency and percentage of studies in the sample ($n = 51$) by type of study, type of design, type of interaction task, and data analysis strategy.

		No. of studies	% of sample
Study type	Descriptive	36	71%
	Experimental	15	29%
Design type	Longitudinal	28	55%
	Cross-sectional	22	43%
	Pre-post test	1	2%
Interaction task type	Free play	38	74.5%
	Experimental	9	17.5%
	Teacher-led	2	4%
	Everyday routine	2	4%
Data analysis strategy	Quantitative	40	78%
	Qualitative	5	10%
	Mixed-methods	6	12%

3.2. Thematic analysis of the data

The second part of this study consisted of a thematic analysis of the data (Braun and Clarke, 2006), for which we organised the results along four lines of discussion: (1) the phenomena associated with the beginnings of triadicity, (2) the origin of early triadic behaviours, (3) the process of co-construction of adult-infant interaction, and (4) the function of triadic interactions as a shared learning framework.

3.2.1. The first triadic encounters: from joint attention to joint action

One of the most studied phenomena on the origin of triadicity in early infancy is joint attention, which is an inherently socio-communicative process based on social cognition and communicative intentionality. While much research has confined its empirical study to aspects related to the infant's visual orientation system, for example, through measures such as gaze fixation and/or visual trajectory tracking between three and 12 months of age (Cleveland and Striano, 2007; Parise et al., 2007; Tremblay and Rovira, 2007; Gattis et al., 2020), other work proposes that joint attention should be described on the basis of infant and adult socio-communicative skills that mediate interactions with objects throughout the entire first year of life (Striano and Bertin, 2005; Striano and Stahl, 2005; Striano et al., 2007; Osório et al., 2011). Among these, gaze following seems to emerge as an essential component from the first months after birth (Perra and Gattis, 2012), although it is not the only one.

There are more behaviours that make it possible to sustain and participate in the interaction, for example, the visual following of adults' pointing gestures that arise around three to 4 months of age, and object manipulations in the last third of the first year (Amano et al., 2004; Flom et al., 2004). Although these studies have made important contributions to the study of early perceptual-attentional development, their point of view is limited in that they do not incorporate other variables of the psychological relationships between adults, objects, and infants, such as their multimodal characteristics or the construction of shared meanings in the interaction.

This problem, in part, derives from the lack of attention from this approach to the role played by referents in triadic interactions. Objects and their cultural norms of use favour and catalyse interactions by constituting a shared referent and are, therefore, essential when analysing triadic exchanges, especially at a very early age (Dimitrova and Moro, 2013; Palacios and Rodríguez, 2015; Dupertuis and Moro, 2016; Moreno-Núñez et al., 2017; Alessandroni et al., 2020; Vietri et al., 2021). In a study based on shared reading situations, Rossmanith et al. (2014) described how adults, from the age of 3 months of the baby, turn the object into an element both to be attended to (for example, by showing the book and using sounds, vocalisations, and verbalisations) and acted upon together (turning pages, opening fold-out flaps, touching different textures, or pointing to pictures). From this point of view, attention and joint action are two inseparable parts of complex, multimodal, socio-communicative exchanges, in which objects act as communicative vehicles between adults and babies (Moreno-Núñez et al., 2021b). At the beginning, it is the adult who endows these encounters with a triadic character, by progressively facilitating the infants' learning about how to relate to and operate in the world.

3.2.2. The origins of the development of triadicity

Given the different perspectives on when the first triadic interactions emerge, we considered that this could be reflected in the designs represented in the sample. For example, considering that the interaction is only triadic from the age of 9 months onwards, this might have an impact on the age selection of participants, resulting in a lower volume of evidence in earlier months. To this end, we explored the distribution of studies according to the ages analysed (in months). Since some studies addressed a particular age range, each age was considered as a non-mutually exclusive category. Thus, Table 2 shows that there is a higher proportion of studies in the sample as the infants' age increases, especially during the last third of the first year of life, where 53% of the total observations were concentrated (Flom et al., 2004; Abels and Hutman, 2015; Abels, 2020). These studies provide relevant information from the time when infants already possess some skill in triadic communication (Parise et al., 2007; Osório et al., 2011; Mendive et al., 2013). Nevertheless, by focussing only on when infants acquire this achievement, they leave unresolved how these skills are developed at earlier stages.

Despite the above, in recent decades there has been an increase in studies that specifically focus on early social-communicative skills (Amano et al., 2004; Striano and Bertin, 2005; Striano et al., 2007; Tremblay and Rovira, 2007). For example, Striano and Stahl (2005) already suggested that triadic skills develop progressively over the first months of life, based on a comparative study on the duration of infants' gaze. Two experimental conditions were designed to run this: in the first, the adult presented an object to the infant accompanied by affectionate comments, while coordinating visual attention between the object and the infant; in the second, the adult presented the object in the same way, but this time only directing the gaze towards the object. They found that, already at 3 months, infants' gaze duration was longer in the first experimental condition, which may indicate some early sensitivity to relevant communicative cues, such as eye contact with the adult in relation to the object.

This highlights the role played by the adult in the infant's daily exchanges and routines in the environment and, specifically, in relation to the material world. Recently, other studies suggested that the adult actively involves the infant and the object in the same communicative act from the first months of life (De Barbaro et al., 2013, 2016; Rossmanith et al., 2014; Moreno-Núñez et al., 2017), producing early triadic interactions even when infants are not yet able to initiate them on their own (Moreno-Núñez et al., 2017). From birth, adults and infants habitually engage in interactions based on iterative actions with objects, which provide a defined and facilitating structure (Moreno-Núñez et al., 2015; Alessandroni et al., 2020). The reiterative and organised environment in which the first triadic interactions take place also favours attunement and understanding actions between infants and adults (Dimitrova et al., 2015). Redundancies created, for example, through stimulation by touch, may occur in response to situations where the affective mediation of the adult becomes more necessary. This may occur, either because of the very young age of infants (Alessandroni et al., 2020), or the difficulty of the task, where adults accompany infants in their attempts (Serra et al., 2020).

3.2.3. Co-constructing the interaction: the role of the adult in the infant's developing agency

In line with this idea of early triadic interactions, i.e., before the age of 9 months, more research seeks to describe the role of the adult in establishing the first shared references jointly with the child (Danis et al., 2000; Hobson et al., 2004; Moreno-Núñez et al., 2017). This has enabled us to identify some interactive strategies that the adult uses during triadic exchanges (Dimitrova and Moro, 2013; Dimitrova et al., 2015) as shown in Table 3. In the light of results, some strategies might be more effective in engaging infants in shared activities with objects (Trautman and Rollins, 2006; Serra et al., 2020). For example, Mendive et al. (2013) found that following and reinforcing an infant's interest with an object (which they call *action maintenance*) favours the occurrence of coordinated episodes of triadic interaction. However, other strategies, such as proposing a new activity to the infant (*introduction*) or one different from the ongoing action (*redirection*), often result in passive observation or individual exploration of the object by the infant. This suggests that adult mediation should be adjusted to the infant's developmental progress (De Schuymer et al., 2011; Zuccarini et al., 2018; Gattis et al., 2020), this also being key to observing the course of the action to provide responses that are consistent with the child's actions and expressions of interest.

These adjustments also appear to follow a dynamic development over time, which is reflected in different interaction behaviours. For example, Danis et al. (2000) observed variations in the content of maternal speech to the infant as a function of the infant's progressively more sophisticated motor skills between the second and fourth month of life. While messages related to the physical properties of the object tended to decrease, in contrast, verbalisations referring to the infant's hands, manipulative actions, and invitations to grasp the object increased. This is consistent with the findings of Dimitrova and Moro (2013), who observed how adults adapt their communicative action to the degree of knowledge they perceive in infants in relation to the use of the object: the more knowledge they attributed to the infant, the less gestural support they gave, and the less repetitive and exaggerated production of movements they made. In this way, the co-construction of communicative dynamics with these babies favoured development towards new learning.

While adult mediation is key to creating spaces for early interaction, the infants' progressively more active participation favours the dynamic interactive patterns that both co-construct (Rollins and Greenwald, 2013; Schneider et al., 2022). Some studies suggest that, in situations of triadic interaction with objects, a symmetrical co-regulation prevails between both participants (Aureli et al., 2017). This is not observed in conditions of dyadic interaction (i.e., without objects), in which it is the adult who tends to attract, maintain, and

TABLE 2 Frequency and percentage of studies in the sample ($n = 51$) according to participants' age in months.

	Months of age												
	1	2	3	4	5	6	7	8	9	10	11	12	> 12
No. studies	1	6	12	17	15	18	16	19	29	25	24	29	15
% sample	2%	12%	24%	33%	29%	35%	31%	37%	57%	49%	47%	57%	29%

TABLE 3 Studies that reported adults' verbal and/or behavioural strategies during triadic interactions ($n = 13$).

Reference	Topic	Infants' age (in months)	Adults' verbal strategies	Adults' behavioural strategies
Danis et al. (2000)	Description of adults' mediation in the emergence of prehension in infants.	2–4	Comments	Gestures
Moreno-Núñez et al. (2017)	Characterisation of adults' communicative actions in home interactions.	2–4	Comments	Gestures and use of objects
Guevara et al. (2020)	Depiction of adults and infants use of gestures in nursery schools.	4–11	Verbal utterances (not specified)	Gestures and use of objects
Gattis et al. (2020)	Exploration of the emergence of attention sharing in infants.	5	Comments and directive speech	Gestures, use of objects and responsive actions
Legerstee et al. (2007)	Examination of affective attunement between adults and infants.	5–10	Comments, questions and responses to infants' actions	Affective behaviour
Dimitrova and Moro (2013)	Illustration of how adults adjust to infants to construct shared knowledge.	8–16	N/A	Gestures
Dimitrova et al. (2015)	Characterisation of adults' responses to infants' gestures.	8–16	Questions and responses to infants' actions	N/A
Dupertuis and Moro (2016)	Description of adults' mediation in infants' gesture development.	8–16	Comments	Use of objects
Mendive et al. (2013)	Identification of adults' strategies to promote joint engagement with infants.	9	N/A	Responsive actions
Palacios et al. (2018)	Depiction of symbolic use of objects in infants.	9–15	N/A	Gestures and use of objects
Serra et al. (2020)	Identification of adults' haptic patterns during play.	12	N/A	Affective behaviour
Trautman and Rollins (2006)	Exploration of the relationship between adults' verbal utterances and infants' communicative development.	12	Comments	N/A
Hobson et al. (2004)	Examination of adults' sensitivity to infant's engagement cues.	12–14	N/A	Responsive actions

redirect the infant's attention. Likewise, certain routines such as shared reading activities appear to favour the active and dynamic involvement of both participants (Rossmanith et al., 2014).

Although it is true that both start from different levels of attention and coordination, the fluency and sophistication of their exchanges increases progressively over time. In this process, the episodes of individual exploration and social initiatives related to the first conventional uses of the object also tend to increase. This is further influenced by factors such as affective attunement (Legerstee et al., 2007; Rollins and Greenwald, 2013). This, combined with the fact that the infant is increasingly effective in combining a variety of communicative resources, seems to increase the likelihood of the adult's response, who may more easily identify the child's actions as "something to react to" (Moreno-Núñez et al., 2021b). Moreover, in recent years, several studies have been interested in how family socioeconomic status could be related to different conceptions and socialisation goals, which could influence the degree of initiative and interactional agency of infants (Abels and Hutman, 2015; Abels, 2020) and the development of triadic coordination skills (Gago-Galvagno and Elgier, 2020; Simaes et al., 2022).

3.2.4. Triadic interactions as a shared learning framework

In addition to the analysis of how and when children's first intentional behaviours emerge, the study of triadic interactions may help to understand other important developmental milestones and their social nature. For example, from the age of 6 months, the number of episodes of triadic interaction in which children engage is positively related to their anticipatory response to adult action (Brandone et al., 2019). This may be evidence of a progressive identification of others as intentional agents. In addition, recent research also proposes to approach the development of intentional understanding from enactive

and embodied perspectives, which differ from the classical cognitivist paradigm: "It seeks to attend to the practical aspect of social cognition, that is, what subjects do when they intentionally understand others" (Vietri et al., 2021, p. 4).

According to these positions, infants' own bodily activity and its congruence with adult action would constitute a basic form of intentional understanding. Infants' anticipatory bodily adjustments during every-day routines, for example, when at mealtimes they lean forward and open their mouths to facilitate adults' deliberate action with the spoon, appear to point to an early "understanding" of certain intentions. This lays the foundation for the origin of communicative intentionality in the child, from the first references shared with others. In this process, triadic interactions constitute a fundamental setting for the origin and development of various communicative mediators, such as gestures. In this sense, the pointing gesture has traditionally been considered one of the first communicative milestones. It allows Infants, towards the end of the first year, to interact with others and to communicate intentions, feelings, and requests about present but distant referents.

Notwithstanding, some studies included in this review question whether the establishment of shared reference is associated only with the pointing gesture, suggesting that ostensive gestures (e.g., giving and showing) also permit sharing interest in an object with the other, and could therefore contribute to the child's understanding of the referent (Boundy et al., 2016; Guevara et al., 2020; Moreno-Núñez et al., 2020). In ostensive gestures, the referent occupies the hand itself and, therefore, these present less semiotic complexity than distal gestures. Children often address these gestures to themselves (Dupertuis and Moro, 2016), in a self-presentation of the object with exploratory and gradually reflexive functions. The transition between individual exploration of the object and the emergence of communicative behaviours directed to others would take place within the framework of triadic interactions. This enables the semiotic complexity of the interaction to be increased from the gradual distancing of the referent and the construction of socio-cultural meanings around the uses of objects (Moreno-Núñez et al., 2020).

Precisely, in the interaction with infants, adults rely on diverse repertoires of actions that include how they act with objects (Bialek et al., 2014). Thus, children receive a great deal of information about their environment, for example, mediated by the incorporation of musical elements and dynamics that organise the interaction and contribute to attracting the child's attention and interest (Moreno-Núñez et al., 2015). This promotes the establishment of shared activity niches and favours affective and communicative harmony with the adult. These proposals have given rise to new methodological designs, which include the combination of software and analysis procedures that make it possible to detect patterns and variations in the musical resources present in the interactions (Alessandroni et al., 2020). Although adults readjust their mediation as the child gains in agency, they continue to support the acquisition of later skills such as evoking events or objects that are not present (Palacios and Rodríguez, 2015; Palacios et al., 2016, 2018) or language (West and Iverson, 2017). In relation to the latter, some studies have observed that adults' verbal utterances during the child's manipulative periods contain a higher proportion of labels, which facilitate object-word association and encourage interaction based on specific proposals for action (e.g., while playing with a phone and commenting: "Are you talking to Daddy? Say hello to Daddy") (West and Iverson, 2017, p. 198).

4. Discussion and conclusions

The scientific literature on early social-communicative development has dealt extensively with the study of infants' first triadic interactions with adults and objects, giving rise to different theoretical and methodological perspectives for their empirical study. The aim of this paper was to analyse some relevant issues on which there is still no consensus. To this end, recent scientific projects were explored, describing their methodological characteristics and discussing their results based on a thematic analysis. With respect to the distribution of the studies, we have been able to verify that most of the studies have been carried out in Western regions, mainly Europe and North America, thus reproducing a common bias in psychological research based on the study of WEIRD (Western, Educated, Industrialised, Rich, and Democratic) population samples. From a gender perspective, while this is not a study focused on gender disparities, it is striking that in most of the studies in our sample (except for those in which no details on gender were provided), adult data came from female participants, including mothers, educators, and researchers. Thus, to obtain a true picture of early socio-communicative development in everyday routines, it would be interesting for future research to explore the reasons behind this imbalance, as well as to promoting the participation of male adults in interaction studies with young children.

Moreover, the laboratory has been the predominant context for data collection, although there is a growing trend towards research in naturalistic contexts, such as the home. In this regard, technological advances in recent decades have led to the use of activity recording instruments that impact on the degree of ecological validity of the data. For example, some studies use head-mounted camera and eye-tracker systems to record infants' field of vision and their visual trajectory during certain activities (Yu and Smith, 2013, 2016). However, we have not found studies that analyse triadic interactions by using *wearable* sensors, which could add accurate and relevant information about infants' autonomy and/or motor activity when interacting in their environment (De Barbaro, 2019).

In relation to the methodological characteristics of the studies in our sample, there is a greater representation of descriptive studies as opposed to experimental designs, which are mainly longitudinal and cross-sectional. We consider this to be an important factor, especially at an early age, as longitudinal research allows for a better definition over time of the dynamic and changing processes related to the phenomena studied (Grimm et al., 2017). Finally, we have been able to observe how, in this sample, the use of quantitative strategies for data analysis prevails over qualitative or mixed methods approaches. Nonetheless, in qualitative studies, it should be noted that some of the techniques used could be particularly useful in the study of adult-infant interactions. For example, microgenetic procedures allow for in-depth and systematic analyses of the subtle changes that occur on a small scale in early development (Alessandroni et al., 2020; Lourenço et al., 2021). Furthermore, ethnographic studies such as that of Abels (2020), enrich observational data through researchers' manual annotations during the continuous accompaniment of participants in their daily activities.

Subsequently, thematic analysis of the results has allowed us to identify different dilemmas about the nature of infants' early experiences with adults and objects. First, research on joint attention and, specifically, on visual trajectories, has enabled us to approach the

origins of adult-infant referential communication (Parise et al., 2007; Tremblay and Rovira, 2007; Perra and Gattis, 2012; Yu and Smith, 2013, 2016, 2017). Even when infants are limited by biological constrictions that prevent them from sustaining prolonged gaze, following the other's gaze enables them to share references about the world (Flom et al., 2004; Cleveland and Striano, 2007; Osório et al., 2011).

Nonetheless, more recent work considers that joint attention goes beyond a simple coincidence of the gaze of two participants on the same object: during the interaction, they must also be attentive to the interlocutor's behaviours and accommodate them, which implies understanding themselves and the other as intentional agents (Tomasello, 1995). For example, the adult takes advantage of the child's bouts of attention to prolong exchanges by using various mediators, such as facial expression or language. This has led to an increasingly important role being given to exploration and communicative interaction, rethinking the study of phenomena associated with the beginnings of triadicity, based on the possibilities offered by materiality (Gibson, 1979). Accordingly, perception (attention) and action are part of the same process of active knowledge construction (Reddy, 2005; Heras Escribano, 2012). In this, attentional encounters would constitute the basis on which to establish instances of communication and joint action with others. These usually take place through objects and their cultural meanings (Moreno-Núñez et al., 2021b; Alessandroni, 2023), promoting learning that will gradually enable the child to operate coherently with the socio-material environment that surrounds them (Bruner, 1983; Rogoff, 1990; Carpenter et al., 1998).

This has led us to analyse other dilemmas surrounding the origin of the first triadic behaviours, such as when they emerge in the child's development. In this regard, numerous studies agree that infants' social-communicative skills become more sophisticated from the age of 9 months to a year (Trevarthen and Hubley, 1978; Tomasello et al., 2005), so a greater proportion of studies focussed on this period was expected (Flom et al., 2004; Parise et al., 2007; Osório et al., 2011; Mendive et al., 2013; Abels and Hutman, 2015; Abels, 2020). Despite this, it seems unlikely that infants' communicative intentionality would suddenly emerge; on the contrary, it may emerge from early triadic encounters that adults organise around the object well before the age of 9 months (Striano and Bertin, 2005; Tremblay and Rovira, 2007).

Accordingly, the coordination of the processes necessary for triadic interaction would take place on the basis of the adult action (Amano et al., 2004; Cleveland and Striano, 2007) and infants' early sensitivity to communicative cues, such as the exchange of glances at others and the object (Striano and Stahl, 2005). Consequently, before the infant can actively participate in triadic exchanges, the adult promotes their participation in a continuous process (Rodríguez and Moro, 1999) involving various semiotic mediators. On the one hand, they often resort to reiterative actions that favour the predictability of exchanges, making it easier for adults and infants to mutually "read" each other's intentions over time (Alessandroni et al., 2020). On the other hand, adult mediation frequently relies on the use of objects and gives rise, as the infant acquires greater communicative tools, to actions which respond to the other's behaviours and the cultural functionality of objects (Rossmanith et al., 2014; Moreno-Núñez et al., 2015, 2017; Cárdenas et al., 2020; Guevara et al., 2020).

Thus, aligned with a socio-constructivist and externalist approach to development, children build a shared "fund of knowledge," which facilitates the learning of numerous skills (e.g., intentional understanding) and enables them to behave in a culturally situated manner (Barresi and Moore, 1996; Rochat, 2007; Brandone et al., 2019, 2020). Notwithstanding, these results must be considered in the light of some limitations. On the one hand, the underrepresentation of studies run in certain environments familiar to the child (e.g., nursery schools) and populations beyond the Western context, implies a bias that prevents extrapolation of some of the results. Future research aimed at a global understanding of early communicative processes (Amir and McAuliffe, 2020) should adopt an ecological perspective that responds to the everyday social, material, and cultural circumstances in which triadic interactions take place (Keller et al., 2009; Rowe and Goldin-Meadow, 2009; Abels, 2020).

Furthermore, the diversity of theoretical and conceptual interpretations of the origin and development of triadic interactions has made it necessary to adopt a qualitative approach in this review, aimed at describing and discussing the different positions. In contrast, a quantitative review (meta-analysis) would enable further exploration of some of the specific questions that arise from this study, such as the extent to which triadic interactions benefit early communicative development, or the relationship between different factors and children's experiences of triadic interaction. For example, family socioeconomic status may be linked to different degrees of exposure to triadic interaction (Gago-Galvagno and Elgier, 2020), while atypical developmental trajectories (such as prematurity at birth, Down syndrome or high-risk for ASD) may result in difficulties over social participation (Chiang et al., 2008; Adamson et al., 2009; Benassi et al., 2016; Vilaseca et al., 2022) which can be improved through early intervention (Olafsen et al., 2006; Bejarano-Martín et al., 2022; Mattie and Fanta, 2023).

Further study of the development of early triadic interactions (i.e., from birth) could also provide possible improvements in early childhood education and care practises. For example, in the family context, some studies suggest that infants' early communicative behaviours are not always effective in eliciting adult responses (Dimitrova et al., 2015; Boundy et al., 2016). Therefore, further exploration of infants' cues in the context of early interactions around materiality could lead to the promotion of low-cost daily stimulation activities, such as shared reading practises (Black et al., 2017). This could also be relevant for exploring the impact of parental mental health in the development of early triadic interactions (e.g., in cases of postpartum depression or parental stress), as parental emotional regulation may affect their interactive and communicative styles (Apter and Devouche, 2019). In this sense, interventions aimed at accompanying parents by enhancing their interactive skills through video-feedback have been shown to boost caregivers' self-perceived efficacy (Fisher et al., 2016) and contribute to improving parental mental health (Izett et al., 2021). In addition, they have also been shown to benefit infants' development, for example, by fostering expressive and receptive communication skills (Imhof et al., 2023) or reducing behavioural problems (Liu et al., 2021).

Additionally, given the importance of the early years in psychological development and the importance of school as a socialising context, the findings synthesised in this review could be relevant for educators, as they could permeate educational processes to promote infants' engagement with others and their environment. This requires further transferences between research and school, based on processes of joint reflection between professionals on their own educational practise. As is observed with parents at home, educators frequently mediate children's participation in shared activities loaded with socio-cultural meanings and tools (Brossard, 2001; Rodríguez and De los Reyes, 2021). This takes place, again, through a multimodal

prism in which objects, materials, language, gestures, and emotional expressions are usually involved (Estrada, 2021). Although these types of interactions are part of children's everyday lives, it is surprising how little scientific literature to date has explored the educational practises at these early stages (0–3 years), particularly the role that material culture plays in shaping early development in various contexts.

The results of this review suggest that early triadic interactions: (1) are characterised as multimodal communicative exchanges that are structured in sequences of joint attention and action through materiality, (2) are built from the first months of life and develop thanks to adult mediation, and (3) constitute a privileged context for the construction of sociocultural meanings, which are fundamental for infants' engagement with others and their environment.

Author's note

A Spanish-language version of this article can be found online in the Supplementary material.

Data availability statement

Publicly available datasets were analysed in this study. This data can be found here: https://doi.org/10.5281/zenodo.8134795.

Author contributions

AM-G: conceptualization, methodology, data curation, analysis, investigation, and writing – original draft. AM-N: conceptualization, writing – original draft, writing – review & editing, and supervision. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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EDITED BY
Yulia Solovieva,
Meritorious Autonomous University of Puebla, Mexico

REVIEWED BY
Ana Baltazar,
National Autonomous University of Mexico, Mexico
Gustavo Cunha de Araujo,
Federal University of North Tocantins (UFNT), Brazil

*CORRESPONDENCE
Daria Bukhalenkova
✉ d.bukhalenkova@inbox.ru

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Similarities and differences between CLASS and ECERS-R estimates of educational environment quality

Daria Bukhalenkova[1]*, Olga Almazova[2] and Margarita Aslanova[1]

[1]Department of Educational Psychology and Pedagogy, Faculty of Psychology, Lomonosov Moscow State University, Moscow, Russia, [2]Department of Developmental Psychology, Faculty of Psychology, Lomonosov Moscow State University, Moscow, Russia

The conducted research was devoted to comparison of kindergartens' educational environment quality evaluation via ECERS-R and CLASS methods. Both methods were applied in the same kindergarten groups. Therefore, in this study we attempted to find out if the educational environment quality assessments acquired via the two methods mentioned above would coincide. We analyzed the results from the cultural-historical psychology perspective. The educational environment quality assessment has been conducted in 83 Moscow kindergarten groups where study 5 to7 years old preschoolers. The correlation analysis results show that the ECERS-R method subscales are not related to the "Emotional support" CLASS domain, however, a significant correlation with the total ECERS-R score has been revealed. The "Classroom Organization" CLASS domain has the highest number of correlations to the ECERS-R subscales (4) as well as to the total ECERS-R score. The "Instructional Support" domain is connected only to the Parents and Staff subscale within the ECERS-R method. As a result of comparing groups with relatively low and high quality of the educational environment, that were identified based on the evaluation via the ECERS-R and CLASS methods, a good agreement between the results has been revealed. However, a fairly large number of groups with high CLASS scores have made it to the pool of average-low ECERS-R scores, which demonstrates a non-linear connection between the educational environment quality evaluations according to these two methods. Research allows to conclude that the ECERS-R and CLASS approaches complement each other well.

KEYWORDS

preschool age, early care and education quality, learning environment, kindergarten quality, CLASS, ECERS-R

1. Introduction

As shown by numerous longitudinal studies the preschool education quality plays the key role in preschoolers' cognitive and social development (Mashburn et al., 2008; Hamre et al., 2014; Hemdan and Marzouk, 2015) as well as their further academic success (Hamre and Pianta, 2003; Vandell et al., 2010; Welsh et al., 2010; Hall et al., 2013; Weiland and Yoshikawa, 2013; Sylva et al., 2014). In this regard, the assessment of preschool care and education quality is crucial (Schad and Arnold, 2019; Krivtsova, 2022). Over the past few decades, various instruments for measuring the educational environment quality in kindergarten groups have

been developed around the world (ECERS, CLASS, STR, etc.). For countries that do not have their own instruments for educational environment quality evaluation it is important to identify the most useful and effective tools.

In this article, we will focus on two methods used widely all over the world, for the educational environment quality evaluation in preschool institutions – Early Childhood Environment Rating Scale – Revised (ECERS-R) (Harms et al., 2005) and Classroom Assessment Scoring System (CLASS) (Pre-K level) method (Pianta et al., 2008). The research goal was to compare the assessments of preschool education acquired using methods mentioned above. This aim becomes especially relevant as more and more researchers highlight the absence of the connection between the educational environment quality assessments and the results of the cognitive and social abilities development in preschoolers (Brunsek et al., 2017; Burchinal, 2017; McDoniel et al., 2022). This evokes a need to understand the educational environment evaluation methods in greater detail. It is also crucial not to make generalized conclusions about the efficacy of all methods used.

Kindergartens' educational environment quality has been conceptualized in terms of structural and process quality (Vandell and Wolfe, 2000; Brunsek et al., 2017). Structural quality assessment focuses on aspects of the physical kindergarten environment, daily schedule and staff-child ratios. Process quality assessment focuses on interactions that occur within the kindergarten environment.

The ECERS-R method allows to assess the overall educational environment quality (both structural and process aspects), which includes information on object-material arrangement of kindergarten space, daily routine, and the nature of child's interaction with the environment as well as social surroundings. The ECERS-R (Harms et al., 2016) consists of the following 7 subscales: (1) Space and Furnishing, (2) Personal Care Routines, (3) Language – Reasoning, (4) Activities, (5) Interaction, (6) Program Structure, (7) Parents and Staff. Each scale includes several (from 4 to 10) indicators. Therefore the ECERS indicators cover the whole spectrum of conditions, in which children find themselves in kindergarten (Shiyan and Vorobieva, 2015).

As opposed to the ECERS-R method, the CLASS approach does not assess the availability of various materials, physical environment or security. It focuses on student-teacher interactions, as well as on what the teacher does with the materials at their disposal, how effectively teacher uses them. Regardless of the age group under consideration, the CLASS highlights 3 main domains: (1) Emotional support, (2) Classroom organization, (3) Instructional support. Each domain includes several (from 3 to 4) dimensions, in its turn each dimension is evaluated on a 7-point scale (there are 10 dimensions in total) (Pianta et al., 2008).

The criteria given within the CLASS method are based on research that shows that the student-teacher interactions are the main mechanism of children's development and education (Pianta et al., 2002; Mashburn and Pianta, 2006; Hamre and Pianta, 2007). This fits well with the ideas of Vygotsky (1984) on the leading role of an adult in children's mental development. According to Vygotsky (1984), learning leads to development. In fact, learning is a specifically organized communication between a child and an adult. The teacher is a carrier of cultural norms and values, the teacher is an example that children seek to imitate. As Vygotsky wrote, "Human behavior is a product of development … of a social connections and relationships system, collective forms of behavior, and social cooperation" (Vygotsky, 2005, p. 865). Therefore, as part of the educational environment quality evaluation, the most significant is the study of the social situation of development from the standpoint of cultural-historical psychology. The social situation forming in kindergarten groups is what the CLASS method is mostly focused on.

Because the ECERS-R and CLASS methods evaluate different aspects of educational environment quality in kindergartens, the comparison of estimates obtained using these techniques in the same kindergarten groups is of interest in this study. We consider these methods since they are the most recognized by the world community as well as the most commonly used in the research worldwide (Perlman et al., 2016; Brunsek et al., 2017; McDoniel et al., 2022). In this study, we have taken an attempt to find out if the assessments of the quality of the educational environment acquired via these two methods would coincide. So, despite the differences in targeted parameters, the two methods could demonstrate identical assessments of the overall level of the educational environment. Alternatively, the scores for the two methods could be different, which would show that they measure different aspects of the educational environment quality. There is also a third option (the most probable one) – if the assessments would partially intersect (correlate) and partially differ, which would allow us to conclude that the two methods complement each other. This kind of research task rarely becomes the focus of scientists' attention (Mashburn et al., 2008; McDoniel et al., 2022), as most researchers study just one of the methods mentioned above (Setodji et al., 2018), while comparing the tools for assessing the quality of the educational environment can help to understand how these methods work, how interchangeable they are, and which one of them will be more effective for the educational environment quality evaluation.

2. Materials and methods

2.1. Sample

The educational environment quality assessment has been conducted in 83 senior and preparatory Moscow kindergarten groups where study 5 to 7 years old preschoolers Senior (5–6 years old) and preparatory (6–7 years old) kindergarten groups are the last two stages of preschool education in Russia.

The study included municipal kindergartens in districts characterized by similar levels of infrastructure and designed to accommodate families with primarily medium income. All kindergartens used the same educational program called "From birth to school" (Veraksa et al., 2019).

In all kindergarten groups there were approximately the same number of children (about 30) and 1 or 2 preschool teachers (most often 2, but they work in shift). The number of teachers per group has varied from 1 to 3 people. The teachers' average age was around 42 years old (M = 41.9; SD = 10.3 y.o.), and their experience of working as a teacher in preschool institutions was 13 years on average (M = 12.9; SD = 9.7). 72.1% of teachers have higher pedagogical education, 16.3% of teachers have graduated from pedagogical

colleges, and 5.7% have higher education not related to pedagogy (engineering, law, economics).

In this study, CLASS and ECERS-R methods were used to assess the educational environment quality.

The CLASS method (Pre-K level) (Pianta et al., 2008) implies at least four 30 min group observation cycles (120 min. Per group in total) done by a trained expert. After each observation the expert sets scores on a 7-point Likert scale for each of the 10 method dimensions. At the same time, scores 1 and 2 conditionally refer to the low level, scores 3–5 characterize an average level, and 6–7 scores refer to a high level of interaction quality. As a result, the arithmetical mean of scores obtained from all observations in one group is acquired on each dimension, and based on the values obtained, scores are calculated according to a specific formula for the three main domains of the methodology (such as Emotional support, Classroom organization, Instructional support). The CLASS method (Hamre et al., 2014; Murray and Pianta, 2015) has been tested in about 50 senior and preparatory kindergarten groups in Russia (Bukhalenkova and Almazova, 2022) and has revealed a connection with executive functions development in preschoolers (Veraksa et al., 2020; Bukhalenkova et al., 2022a, 2022b).

The ECERS-R method (Harms et al., 2005) is a techynique for expert assessment done according to a specially designed evaluation sheet. Using this sheet, the expert evaluates 43 indicators of the kindergarten educational environment, organized in 7 subscales: "Space and furnishing," "Personal care routines," "Language – reasoning," "Activities," "Interaction," "Program structure," "Parents and staff" each of which is evaluated on a 7-point scale, with 1–2 point representing inadequate quality, 3–4 points – satisfactory, 5–6 points – good and 7 points representing excellent quality (Harms et al., 2016). According to the method, the total score is calculated as an arithmetic mean for all sub-scales. The research community has made great efforts to localize and adapt ECERS-R for Russia (Shiyan et al., 2016). The methodology was tested on a sample of 1,357 kindergarten groups in 76 subjects of the Russian Federation (Shiyan et al., 2016, 2021).

2.2. Procedure

Independent, specially trained and certified experts were assessing the quality of the educational environment according to CLASS and ECERS-R methods during one academic year.

The research was approved by the Ethics Committee of the Faculty of Psychology at Lomonosov Moscow State University (the approval No: 2023/18).

2.3. Data analysis

The following statistical methods and procedures were used in this research: descriptive statistics for general data analysis as well as correlation analysis (Spearman's correlation coefficient) to identify relationships between estimates by CLASS and ECERS; cluster analysis (K-means method) and Kruskal–Wallis and Mann–Whitney test to identify groups with different levels of educational environment quality; cross tabulation and chi-square to identify relationships of educational environment levels according to the CLASS and ECERS methods.

3. Results

3.1. The results of educational environment quality assessment using CLASS and ECERS-R methods

Based on the educational environment quality evaluation obtained via the CLASS methodology (Table 1), we can conclude that the lowest scores in teachers' interaction with children in Russian kindergartens are observed within the Instructional support domain. As low and average scores on all three dimensions included in this domain were obtained. For the other two domains (Emotional support and Classroom organization), medium or high scores were obtained.

The results of the educational environment quality evaluation obtained via the ECERS-R methodology (Table 2), show that on all scales Russian kindergartens are at the low or average level. According to the ECERS-R method, among the groups observed, there is none that would have had good or excellent educational environment quality (5–7 points).

With the help of Kolmogorov–Smirnov criterion, verification of the normality of the distribution of scores according to scales and parameters of both methods was performed. Not all scales' data is distributed normally, which points at the need to use nonparametric criteria in the statistical analysis of the results.

3.2. Comparison of results by CLASS and ECERS-R methods

To compare the results of the educational environment quality evaluation using CLASS and ECERS-R methods, Spearman

TABLE 1 Descriptive statistics for the CLASS domains and dimensions.

	M	SD	Min	Max
Positive climate	5.1	1.08	2.3	7.0
Negative climate	1.6	0.79	1.0	5.5
Teacher sensitivity	5.0	1.32	2.3	7.0
Regards for students' perspectives	4.6	1.14	2.3	7.0
Emotional support	5.3	0.83	2.8	6.9
Behavioral management	5.0	1.29	1.8	7.0
Productivity	5.0	1.06	2.3	7.0
Instructional learning formats	4.6	1.09	2.0	7.0
Classroom organization	4.9	0.99	2.5	7.0
Concept development	2.5	1.11	1.0	5.7
Quality of feedback	2.8	1.09	1.0	5.3
Language modeling	2.9	1.11	1.0	5.7
Instructional support	2.7	1.03	1.0	5.4

TABLE 2 Descriptive statistics for the ECERS-R subscales.

	M	SD	Min	Max
Space and furnishing	3.2	0.56	2.0	4.5
Personal care routines	3.4	0.85	1.8	5.2
Language – reasoning	3.1	0.63	1.3	4.3
Activities	2.7	0.52	1.8	3.9
Interaction	3.5	0.82	1.6	5.2
Program structure	3.3	0.74	2.0	5.7
Parents and staff	3.1	0.71	1.8	5.2
Total score	3.1	0.47	2.1	4.1

correlation coefficient was used. Based on the correlation analysis results (see Table 3), the "Classroom organization" domain has the highest number of correlations to the ECERS-R methodology scales (4 scales out of 7 and total score). The "Instructional Support" domain is connected to one scale only – Parents and Staff – of the ECERS-R method. None of the ECERS-R scales scores (except the total score), were significantly connected to the scores on "Emotional Support" domain of the CLASS method.

As the next step, we compared the groups with different levels of educational environment quality according to CLASS and ECERS-R methods. Cluster analysis was used to identify groups with significantly different levels of environmental quality since we divided the groups based not only on the total score, but also on the main parameters of each of the methods (domains and subscales).

Using cluster analysis (K-means method), kindergarten groups were divided into 2 clusters according to the estimates based on the three domains of the CLASS method (Emotional Support, Classroom Organization, Instructional Support). 47 kindergarten groups (average scores) have made it to the first cluster, and 36 (high scores) have made it to the second. Using the Mann–Whitney criterion, it was found that there are significant differences in the scores for all three domains from different clusters ($p < 0.001$), which allows us to talk about the resulting clusters as different levels.

Using cluster analysis (K-means method), kindergarten groups were divided into 3 clusters based on ECERS-R subscales scores. 30 groups made it to the first cluster (low scores), 33 groups formed the second (low-average scores) cluster, and 20 kindergarten groups made up the third (average scores) cluster. With the help of Kraskel–Wallis criterion, it was demonstrated that there are significant differences in the scores for all seven subscales (Space and Furnishing, Personal Care Routines, Language – Reasoning, Activities, Interaction, Program Structure and Parents and Staff) in all clusters ($p < 0.001$), which allows us to view the resulting clusters as different levels.

Using the χ^2 criterion, we have found out that the educational environment quality levels by CLASS and ECERS-R are connected ($\chi^2 = 7.276$, $p = 0.026$, Cramer's $V = 0.296$) (Table 4). According to the data obtained, the majority of the groups with low ECERS-R scores have also received average (the lowest) scores by CLASS (73.3%). At the same time, the majority of the groups that received the highest ECERS-R scores (corresponding to the average level), the also got high CLASS scores. However, a fairly large number of groups with high CLASS scores have made it to the pool of average-low ECERS-R scores, which demonstrates a non-linear connection between the assessments of educational environment quality according to these methods.

TABLE 3 The correlations between ECERS-R and CLASS estimates.

ECERS-R subscale/ CLASS domain	Emotional support	Classroom organization	Instructional support
Space and furnishing	0.10	0.18	0.19
Personal care routines	0.18	0.27*	0.17
Language – reasoning	0.16	0.10	0.18
Activities	0.17	0.26*	0.16
Interaction	0.17	0.19	0.11
Program structure	0.12	0.22*	0.10
Parents and staff	0.14	0.27*	0.30**
Total score	0.32*	0.34*	0.15

TABLE 4 Comparison of education environment quality levels according to the ECERS-R and CLASS methods.

		Quality of the educational environment by CLASS	
		Average	High
Quality of the educational environment by ECERS-R	Low	22 (73.3%)	8 (26.7%)
	Low-average	18 (54.5%)	15 (45.5%)
	Average	7 (35.0%)	13 (65.0%)

4. Discussion

The goal of this research was to compare the results of the educational environment quality evaluation in kindergarten groups measured using ECERS-R and CLASS methods.

It is important to note that as the result of ECERS-R assessment, none of the kindergarten groups have received a high total score (most scores were low or average), while the same groups have received average or high scores based on CLASS method. The data obtained by both methods within this study are consistent with the Mashburn's and colleagues results on a sample of 671 kindergarten groups from 11 USA states (Mashburn et al., 2008). Rather low ECERS-R total scores were also obtained in many countries (for example, in Netherlands (De Kruif et al., 2009), Bahrein (Hadeed, 2013), Brazil (Mariano et al., 2018), Columbia (Betancur et al., 2021) etc.), that lead researchers to propose changes in the stop-coding system of ECERS-R indicators assessment that we support (Fujimoto et al., 2018).

From our point of view, the reason behind low quality of the educational environment of Russian kindergarten groups according to ECERS-R is primarily due to the discrepancy between the structural environment parameters, and not due to the interaction within the

group itself: the lack of rest, relaxation and emotional comfort spaces; insufficient number and variety of toy blocks, books and materials for creativity and play (Remorenko et al., 2017). For the better understanding of obtained data it is important to view the arrangement of ECERS-R method's scales and indicators in detail. In this method, separate indicators cannot be attributed to physical environment or interactions only: the scores within each indicator point to the quantity of conditions, as well as their quality. For example, if the object-material conditions (e.g., toy blocks, books, places for privacy, etc.) are available, the group may already count on getting 3 score points, however receiving higher scores (5–7 points) is only possible if the environment reaches a new level: not only the objects are present, but they are also available to children, and there are conditions provided for children's independent and creative use of these objects (Shiyan and Vorobieva, 2015). Such arrangement of scales may be considered a distinctive feature of this method, but we also see a certain restriction to it: if there is a lack of some objects/conditions in the group, then the quality of interaction is not assessed whatsoever [a low score for the parameter is given straightaway, and the parameters related to high scores (often related to the quality of interaction) are not analyzed].

Whereas the CLASS methodology does not assess the diversity of the material-object environment, but only how the teacher uses the available materials to interact with children. In this regard, the rather high CLASS scores in the Emotional support and Classroom organization domains are due to the fact that teachers in Moscow kindergartens are well able to organize the effective routine and create a positive emotional climate in kindergarten groups using the means available (through verbal and non-verbal communication with children, attention to their opinions and assistance in solving emerging difficulties). One of the reasons for such results may be the education received by Russian teachers, based on the cultural-historical psychology, which focuses on the importance of the "child-social adult" interactions for children development. The adult poses as a bearer of an ideal form (signs) which child masters, improving their primary form in the process of interaction, mimicking the adult. Children learn cultural signs in the process of communication and begin to use them to control their inner mental processes – Vygotsky (1934) called this mechanism of assimilation of signs – internalization. Signs are not invented by children, but are acquired by them in communication with adults. Thus, the sign first appears on the outer plane, on the plane of communication, and then passes into the inner plane, the plane of consciousness (Vygotsky, 2005). Vygotsky was the first to deduce a specific mechanism of environmental influence, which actually changes the child's psyche, leading to the emergence of higher mental functions (Lektorsky, 2023). Thus, it is through the communication of an adult and a child that the development of the latter occurs, which is reflected in the CLASS methodology. And the fact that the indicators for CLASS are generally higher than for ECERS just shows the foundation of the Russian educational system.

In the "From birth to school" educational program, which is widely used in Moscow kindergartens, authors emphasized that the physical environment itself does not guarantee the presence of a child's initiative and its realization; it is rather guaranteed by an adult (Veraksa et al., 2019). The "From birth to school" program emphasizes the role of how exactly the teacher offers the child new knowledge: what type of orientation he/she uses to master children mental actions (Burmenskaya, 2022), what teaching resources for forming concepts he/she uses (Veraksa et al., 2022), how he/she supports independence and initiative in typical activities of a preschool child (e.g., playing, cognitive activities, etc.) (Karabanova, 2022; Veraksa, 2022) which is also evaluated in the Instructional Support domain of the CLASS, method. This similarity is natural, since the authors of both CLASS method as well as of the "From birth to school" program used the ideas of Vygotsky (1934). In addition, the main reason for parents' dissatisfaction with kindergartens in Moscow was not the lack of material support, but the quality of interaction between a parent and a teacher, between the teacher and a child as well as between children (Podyanova and Polivanova, 2022). Thus, the CLASS method logic better complements the cultural-historical psychology ideas and the principles of preschool educational system in Russia.

The correlation analysis results show that the scales of the ECERS-R method are not related to the "Emotional support" domain of the CLASS method, however, a significant correlation with the total score by ECERS-R has been revealed. With this, the presence of emotional support is a pervasive parameter in ECERS scales, so it is impossible to give a high score by a number of criteria if there is no evidence of an emotionally warm treatment of the child (Shiyan and Vorobieva, 2015). Indeed, we have not received high scores based on the ECERS-R method, which may be the reason for the lack of the correlation with this domain. At the same time, such pervasive parameter may have shown itself in the presence of a significant correlation between the "Emotional support" CLASS domain and the ECERS-R total score. This result is also consistent with those obtained by Mashburn et al. (2008).

It is with the CLASS method's "Classroom organization" domain with which the largest number of correlations of the ECERS-R method scales has been revealed. It demonstrates that both methods assess educational environment qualities that are connected to all processes in the group (learning, free play, eating, etc.) more or less in the same way.

Interestingly it was shown that, the "Instructional support" domain of the CLASS method is connected with the "Parents and Staff" ECERS-R scale only, while we would rather assume its link to "Language - Reasoning" and "Activities" scales, which, probably, may be explained by the peculiarities of scoring according to the ECERS-R method. The "Parents and Staff" scale results are not seen as completely reliable, since an expert makes his/her evaluations based on teacher's answers alone, not on his/her own observations, which reduces the objectivity of the data obtained. Therefore, it was decided to exclude this parameter from the latest versions of the ECERS method (ECERS-3) (Harms et al., 2015) and we will study the revealed connection.

The obtained data on the ratio of different levels of environment according to ECERS-R and CLASS indicate a nonlinear relationship of scores of the two methods, which, as the analysis carried out previously (Bukhalenkova and Almazova, 2022), repeatedly confirms the significance of using both methods for the educational environment quality evaluation. With this in mind, we assume that this nonlinear correlation could be explained by the differences in which parameters of the educational environment are assessed by these methods. We suppose that the richness of the kindergartens' physical environment may not be directly related to the quality of interactions between the teacher and children in the kindergarten group.

The limitations of the study include a small number of observed groups, which did not allow us to conduct several types of analysis.

The research did not consider the important characteristics of teachers, such as their work experience, level of education, beliefs about children's development (Hamre et al., 2012), and personality traits (Mazilov and Kostrigin, 2022; Nikitin and Lavrenyuk, 2022). Moreover, an analysis of the relationships between CLASS and ECERS-R scores with the results of children's cognitive and emotional development considering their mono- or bilingual status will be crucial (Tvardovskaya et al., 2022), we plan to focus our attention on this in the future. Also we are going to compare the assessments of the quality of kindergartens' educational environment with data regarding teachers (their work experience, level of education, and beliefs about child development).

5. Conclusion

The results of the study showed that the educational environment quality assessments acquired via the CLASS and ECERS-R methods partially intersect (correlate) and partially differ, which allowed us to conclude that the two methods complement each other. Also the conducted comparison of the educational environment quality evaluation obtained via the CLASS and ECERS-R methods showed that the ECERS-R method does not fully reflect the procedural quality of the environment, however from the cultural-historical psychology perspective, procedural quality is more important for children's development than the structural quality. The CLASS methodology, which is aimed at assessing the procedural quality only, better agrees with the ideas of Vygotsky and complements the ECERS-R method well.

The usage of both methods in practical work with preschool educational institutions, as well as in scientific research, will allow us to take the largest number of educational environment characteristics that are significant for the preschoolers' development into account, and get more objective data on the educational environment quality in kindergarten groups, due to the fact that these two methods focus on different aspects of the educational environment.

Analysis of the study results shows that these two methods do not replace each other. We hope that the study will help researchers who are thinking about choosing a method for the educational environment quality evaluation to make this choice taking into account the analysis of both methods from the standpoint of cultural-historical psychology.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Ethics Committee of the Faculty of Psychology at Lomonosov Moscow State University (the approval No: 2023/18). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

DB and OA contributed to the presented idea (i.e., research questions) and the theoretical framework. MA and DB was involved in data collection. MA have prepared the data for the analysis. OA verified the analytical methods and conducted the analyses. DB wrote the manuscript considering critical feedback and input from OA. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY
Aleksander Veraksa,
Lomonosov Moscow State University, Russia

REVIEWED BY
Himmbler Olivares,
Universidad de Concepción, Chile
Mojgan Rashtchi,
Islamic Azad University North Tehran Branch, Iran

*CORRESPONDENCE
Evgeniya O. Shishova
✉ Evgeniya.Shishova@kpfu.ru

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Cultural and educational environment in the development of younger schoolchildren's creative potential

Vera Yu. Khotinets[1] and Evgeniya O. Shishova[2]*

[1]Department of General Psychology, Institute of Pedagogy, Psychology and Social Technologies, Udmurt State University, Izhevsk, Russia, [2]Department of Educational Psychology, Institute of Psychology and Education, Kazan (Volga Region) Federal University, Kazan, Russia

The purpose of our research is to study the creative potential as psychological capacities for younger schoolchildren's creative self-realization and self-development in various conditions of the educational environment. The methodological basis of this work is Vygotsky's conceptual provisions according to which the human psyche is culturally determined, and a sociocultural environment is considered to be the main source and condition for the child's mental development. The study involved younger schoolchildren (a total of 160 children from the 4th grade aged 9–10 years, $n = 160$, $M = 9.5$ years, SD = 2.6; 49% boys) from schools in Kazan (Russian Federation). We used a test of verbal creativity when studying the creative potential of younger schoolchildren, the proposed method is a Russian-language adapted version of the RAT test (remote association test) by Mednik. The Johnson Creativity Inventory was used as adapted by Tunick. To study the level of communicative control, the test "Diagnostics of communicative control" by Schneider was used. To assess the personal qualities of younger students, we used a modified version of the children's personality questionnaire intended for 8–12 year-old children and developed by Cattell and Koan. As a result of a comprehensive expert assessment, we identified four types of schools with different severity degrees of essential characteristics of educational environments: serene, dogmatic, career and creative. According to the analysis of variance (one-dimensional one-factor ANOVA), the younger schoolchildren's creative potential was revealed in the context of the educational environment variability and the contingency of the educational environment parameters with the personal characteristics of the children. We have empirically confirmed that in a *creative* educational environment with cultural content based on ethno-cultural values, patterns and norms, the development of the child is actively supported largely, with the disclosure of his creative potential. Younger schoolchildren are characterized by greater subjective agency and the capability to gain unique achievements in educational and cognitive activity.

KEYWORDS

cultural-historical psychology, cultural-educational environment, educational environment design, creative potential, communicative creativity, primary school ages

1. Introduction

Research problem. One of the focuses in current research is the problem of creating a system of conditions for the personality formation. This system provides positive opportunities and various options for choosing the optimal trajectory of the personality development, which places the concept of "cultural and educational environment" among the basic ones in a modern developmental education. **An educational environment** is studied as a component of the social situation of the child mental development and as a condition for its personal development (Leontyev, 1975; Vygotsky, 1999, 2005; Yasvin, 2010; Veraksa, 2018; Veraksa et al., 2019; Rubtsov and Ulanovskaya, 2022 and others). However, the research into the influence that educational systems exert on the child's intellectual, emotional and personal development primarily focuses on the consideration of theoretical aspects, there are very few empirical studies of the educational environment developing potential, which is specific to each educational institution. Existing studies, devoted to this problem, are very contradictory, they do not take into account the current reforms in the field of education (Rubtsov and Ulanovskaya, 2022). In this regard, of primary importance for educational psychology is the problem of assessing the quality of education in educational institutions that provide specific conditions and development opportunities for the subjects of education. This accounts for **the significance** of the research into the creative potential of a growing person, the need to further explore the social situation of development and the conditions for the ontogenesis of creativity, potentially contributing to its formation. By **a cultural and educational environment** we mean a system of conditions and opportunities for the development of subjects of education with cultural content (Khotinets and Medvedeva, 2021). **Creative potential at primary school age** is understood as an integrative quality, reflecting the measure of the younger schoolchild's creative self-realization and self-development ability (Veraksa, 1990). Primary school age is the period most open to various changes. A change in the leading activity promotes "the erasure" of past experiences, laying a new foundation for the child's personality. During this period, the younger schoolchild is most sensitive to the formation of a cognitive attitude to the world, the manifestation of free personal expression, the development of creative abilities, and communicative creativity, which ensures the creative nature of communication and communicative activity of the child (Runco and Acar, 2012; Runco et al., 2020; Khotinets et al., 2022; Shishova and Akhatova, 2022 etc.). According to Vygotsky's theoretical provisions concerning the systemic nature of the higher mental functions' development, at the early school age, thinking becomes a "system-forming" function moving from the visual-figurative to its verbal-logical type, which undoubtedly affects other mental functions seeking to occupy the center of consciousness. The change in the system of internal relationships allows the central function to become more differentiated and developed. At this time, other mental processes function as processes serving the formation of the central function. Thus, the complexity of interfunctional relationships and the differentiation of mental functions gradually increase. To acquire higher mental functions, it is necessary to transfer and assimilate knowledge about their structures in an organized educational environment through specially organized training (Vygotsky, 1999).

In the context of studying a growing person's creative potential, the problems identified by Vygotsky remain relevant today: "the relationship between learning and development at school age," "the social situation of development," "mechanisms for the practical mastery of reality." According to Vygotsky, it is "learning that creates the zone of proximal development, that is, it brings up the child's interest in life, awakens and sets in motion a whole series of internal development processes that are so far possible for the child only in the sphere of its relationships with others and through its cooperation with peers, but which, performing the internal course of development, later become the child's own internal property" (Vygotsky, 1935, p. 16). The "social situation of development" is understood as "a completely peculiar, specific for a given age, exclusive, unique and inimitable relationship between the child and the reality surrounding it, primarily the social one" (Vygotsky, 1984, p. 258). This social reality is "the main source of development" when the social becomes the individual.

1.1. Literature review

According to Vygotsky, "in the child's development, the outcomes that we are to achieve at the end of the development, as a result of this development, are already given in the environment from the very beginning" (Vygotsky, 2001, p. 83). "The greatest feature of the child's development is that this development takes place in such conditions of interaction with the environment, when the ideal form, the final (cultural) form that should appear at the end of development, not only exists in the environment and comes into contact with the child from the very beginning, but also actually interacts with it, influencing the primary (natural) form, the first steps of the child's development, i.e., something that should take shape at the very end of the development somehow influences the very first stages of this development" (Vygotsky, 2001, pp. 83–84).

Answering to the question about the role of the educational environment in the mental and personal development of the child, Vygotsky said that "in relation to the development of higher human-specific properties and forms of activity, the environment acts as a source of this development, i.e., it is the interaction with the environment that is the source generating these properties in the child" (Vygotsky, 2001, p. 88).

According to Vygotsky, "the best stimulus for children's creativity is the organization of their life and environment in such a way that it creates the needs and opportunities for children's creativity" (Vygotsky, 2004, pp. 57–58). The meaning and significance of children's creativity lies in the fact that it allows the child to overcome that tough challenge in the development of creative imagination, which gives a new and lifelong direction to his fantasy. The meaning of children's creativity is its effect of deepening, expanding and cleansing of the child's emotional life. The significance of children's creativity is its ability to allow the child, by exercising its creative aspirations and skills, to master human speech - the most subtle and complex instrument for the formation and transmission of human thoughts, human feelings, human inner world (Vygotsky, 2004, pp. 60–61).

Vygotsky highlights the importance of cultivating creativity at school age. A person can comprehend his whole future with the help of creative imagination. His orientation in the future, his behavior, based on the future and proceeding from this future, is the main

function of the imagination. And since pedagogical work is mainly oriented toward preparing the students' behavior for the future, the development and exercise of their imagination are the main driving forces in realizing this goal. The shaping of a creative personality, aspiring to the future, is prepared by creative imagination embodied in the present (Vygotsky, 2004, p. 78).

This report argues that a national strategy for creative and cultural education is essential to that process. We put the case for developing creative and cultural education; we consider what is involved; we look at current provision and assess the opportunities and obstacles; and we set out a national strategy. By creative education we mean forms of education that develop young people's capacities for original ideas and action: by cultural education we mean forms of education that enable them to engage positively with the growing complexity and diversity of social values and ways of life. We argue that there are important relationships between creative and cultural education, and significant implications for methods of teaching and assessment, the balance of the school curriculum and for partnerships between schools and the wider world (The National Advisory Committee on Creative and Cultural Education (NACCCE), 1999).

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In modern educational theory, creativity, as the ability to build a unique product, create new, unique solutions to complex problems and approaches to challenging tasks, is a students' priority competence (Rotherham and Willingham, 2010; Donovan et al., 2014). Based on the results of a review of modern publications on creativity in education, we identify a number of research areas, which include the study of trends in the development of creative potential, creative abilities and cognitive styles; environmental conditions that promote or hinder creativity; links between creativity and learning models; development of techniques teaching creativity (creative learning', teaching for creativity) and technologies aiming to increase creativity and unlock creative potential (Runco, 2007; Newton and Beverton, 2012; Newton and Newton, 2014; Gruszka and Tang, 2017; Runco et al., 2020). The most important factors that determine the child's creativity (Lebuda et al., 2021) are creative potential and creative abilities (Kim, 2005), general cognitive abilities (Zabelina and Ganis, 2018; Gerwig et al., 2021), specific skills in a particular subject area (Simonton, 2009; Szen-Ziemiańska et al., 2017; Ahmed and Feist, 2021); learning (Kaufman and Kaufman, 2007; Agoguéa et al., 2014) in an enriched cultural and educational environment (Vygotsky, 2001).

At the same time, experts in the field of modern education and educational policy are faced with a certain kind of contradiction. On the one hand, the research highlights the important role of education in encouraging and developing children's creativity (Thurlings et al., 2015). On the other hand, due to diversification (variability of educational services and educational curricula, types and kinds of educational institutions, teaching methods and techniques) and standardized testing of basic skills, children's creativity actually decreases as they move along their educational trajectory (Robinson, 2011; Kupers et al., 2019).

We believe that by finding answers to our research questions we will be able to resolve the identified contradictions.

In our research, Vygotsky's theory is implemented by means of fundamentally important theoretical provisions:

1. A creative cultural and educational environment, as an accumulator of psychological tools, is the source of the child's mental and personal development.
2. Higher mental functions, as a result of the internalization of psychological tools, are formed in learning by assimilating historically developed methods and forms of activity, both as a way of the student's interaction with the educational environment, and as a form of the student's cooperation with others.
3. In order to create a zone of proximal development and to give rise to a number of internal development processes, we need a properly constructed school education and a properly organized educational environment.

1.2. Aims and objectives of the research

The purpose of our research is to study the creative potential as psychological capacities for younger schoolchildren's creative self-realization and self-development in various conditions of the educational environment.

1.3. Research objectives

1. Conduct a comprehensive expert assessment of the educational environment qualitative parameters, identifying four types of schools with different severity of characteristics: serene, dogmatic, career and creative.
2. Identify indicators of younger schoolchildren's creative potential and personal qualities in accordance with the variable parameters of the educational environment.

2. Materials and methods

The methodological basis of this work is the conceptual provisions of Vygotsky's cultural-historical psychology. We distinguish both external determinants (a specially organized educational environment) and internal factors, whose actions explain such phenomena as the zones of actual, proximal and further development.

2.1. Schools and participants

Our study of junior schoolchildren's creative potential was conducted on the basis of Kazan state schools corresponding to various pedagogical models of organizing education (a gymnasium

with in-depth study of individual subjects - English, biology, mathematics and physics; "Specialized Olympiad and Scientific Center 'Sun,'" a general education boarding school; two schools with a general education curricula).

Nine experts assessed the school educational environment using Yasvin's method of vector modeling: psychologists and teachers of educational institutions, university professors and master students of Kazan. All diagnostic procedures were carried out in full accordance with the diagnostic standard: using uniform forms, instructions and stimulus materials. The reliability of the study results was ensured by the preliminary training of experts in a series of workshops that were devoted to the development of a consensus assessment. We revealed a high degree of consistency in observations found in the experts' assessments.

Our empirical study included 160 4th grade students without developmental delays or disabilities, aged 9–10 years ($n = 160$, $M = 9.5$ years, SD = 2.6; 49% boys), with written parental consent; among them 40 children were from the gymnasium with in-depth study of individual subjects - English, biology, mathematics and physics (17 boys, 23 girls), their parents' education: 78% - higher, 22% - secondary vocational, the family social status: 45% - workers, 15% - engineers, employees, 40% - entrepreneurs, businessmen; 40 children were from the general education boarding school "Specialized Olympiad-Scientific Center 'Sun'" (21 boys, 19 girls), their parents' education: 83% - higher, 17% - specialized secondary; the family social status: 70% - workers, 13% - engineers, employees, 17% - entrepreneurs, businessmen; 80 children studied according to the general education curriculum (40 boys, 40 girls), their parents' education: 58% - higher, 42% - specialized secondary; the family social status: 87% - workers, 3% - engineers, employees, 10% - entrepreneurs, businessmen.

2.2. Measures

2.2.1. Assessment of the schools' educational environment

To study the features of the educational environment, Yasvin identifies 11 parameters (five 'main' characteristics: breadth, intensity, modality, degree of awareness and stability, and six 'secondary' characteristics: emotionality, generality, dominance, coherence, mobility and agency). This method is characterized by the construction of a vector that corresponds to a certain type of educational environment. This operation is carried out after counting up the answers to diagnostic questions: three of them aim to determine the opportunities for the student's free development in the educational environment, and three more show the availability of opportunities for the development of the child's agency. Further, in the coordinate system (agency-inaction, freedom-dependence), a vector is built showing the type of environment, which constitutes modality as a feature of the educational environment.

Diagnostic questions and interpretation of the answers.

For the "freedom-dependency" axis:

1. Whose interests and values come first in this educational environment?

(a) personality; (b) society (group).

The priority of personal interests and values over the interests and values of society is interpreted as an opportunity for free development, and a score is accordingly marked on the "freedom" scale; in case of the priority of public interests, a score is marked on the scale "dependence."

2. Who usually adjusts to whom in the process of interaction?

(a) the teacher to the students; (b) the students to the teacher.

If it is noted that in the given educational environment, the situation when the teacher adjusts to the students (or at least the teacher strives for this situation) dominates, this is interpreted as an opportunity for the students' free development, respectively, a score is marked on the "freedom" scale; if it is stated that students are constantly forced to obey their teachers, a score is marked on the "dependence" scale.

3. What form of education is predominantly carried out in this educational environment?

(a) individual; (b) collective (team).

The educational environment with individual-oriented forms of learning is interpreted as the environment possessing additional opportunities for the free development of a self-directed student, and a score is given on the "freedom" scale; in the case when teamwork has priority in the educational environment, a score is marked on the "dependency" scale.

For the "Agency –Inaction" axis:

4. Is punishment of the child practiced in this educational environment?

(a) yes; (b) no.

The absence of punishment is considered as a condition conducive to the development of agency; thus, a score is given on the "agency" scale; in the case when punishments are practiced (both directly and indirectly) in this learning environment, a score is given on the "inaction" scale.

5. Does the given educational environment stimulate the manifestation of any children's initiative?

(a) more often yes; (b) usually not.

If in this learning environment, positive reinforcement of student initiatives is observed, then this is interpreted as an additional opportunity for the development of students' agency and a score is given on the "agency" scale; if the initiative demonstrated by the child is usually ignored or can lead to all sorts of troubles, then a score is marked on the "inaction" scale.

6. Do certain children's creative manifestations find any positive response in this educational environment?

(a) more often yes; (b) usually not.

In the case when the learning environment encourages or appreciates creativity, such an environment is considered as conducive to the development of agency, a score is marked on the "agency" scale; if the children's creative self-expression is ignored and goes unnoticed and underestimated, a score is marked on the "inaction" scale.

The author proposes four basic types of educational environment: "dogmatic" (contributes to the development of passive behavior and dependence of the child); "career" (contributes to the development of agency and the dependence of the child at the same time); "serene" (promotes the free development, but causes the formation of the child's passive behavior); "creative" (contributes to the free development of an active child). Based on the answers to the diagnostic questions, corresponding vector, which allows one to assess the learning environment, is constructed in the coordinate system (Figure 1); an example of the possible construction options of a vector model of the environment based on the answer to diagnostic questions). The studies of Yasvin

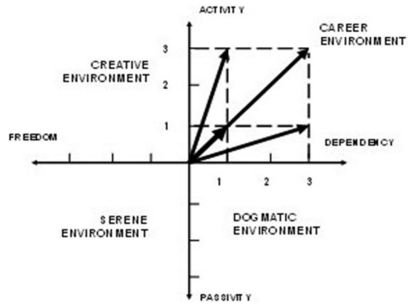

FIGURE 1
An example of the possible construction options of a vector model of the environment based on the answers to diagnostic questions. Reproduced from Yasvin et al. (2015), licenced under CC BY 4.0.

provide a detailed description of the methodology for examining a school educational environment and the typology of educational environments at schools (Yasvin et al., 2015; Yasvin, 2020).

2.2.2. Creative potential

We used a test of verbal creativity when studying the creative potential of younger schoolchildren. It includes two qualitative characteristics: "originality index" and "uniqueness index." The technique aims to identify and assess the teste's often hidden, blocked creative potential. The proposed method is a Russian-language adapted version of the RAT test (remote association test) by Mednik (2006). The Remote Associates Test (RAT) is a creativity test used to determine a human's creative potential. The test typically lasts 40 min and consists of thirty to forty questions each of which consists of three common stimulus words that appear to be unrelated. The subject must think of a fourth word that is somehow related to each of the first three words. Scores are calculated based on the number of correct questions.[1] The technique was adapted by Alekseeva and Galkina in the Druzhinin's Laboratory of the Abilities Psychology at the Institute of Psychology, the Russian Academy of Sciences, based on a sample of schoolchildren; Voronin based his study on a sample of managers aged 23 to 35 years. For the Russian version Cronbach's coefficient is $\alpha = 0.87$ (Ushakov, 2011; Druzhinin, 2019).

The Johnson Creativity Inventory was used as adapted by Tunik (1997a, 1998), based on two approaches:

- according to Torrens, creativity manifests itself with a lack of knowledge; in the process of incorporating information into new structures and relationships; in the process of identifying missing information; in the process of finding new solutions and testing them; in the process of reporting results;
- according to Johnson (1979), creativity manifests itself as an unexpected productive act performed spontaneously by the performer in a certain environment of social interaction. In this case, the performer relies on his/her own knowledge and capabilities.

1 RAT https://en.wikipedia.org/wiki/Remote_Associates_Test.

TABLE 1 Levels of Creativity adapted from Tunik (1997b).

Creativity level	Sum of points
Very high	40–34
High	33–27
Medium	26–20
Low	19–15
Very low	14–8

This creativity questionnaire focuses on the elements that are associated with creative self-expression. The Creativity Inventory is an objective, eight-item checklist of creative thinking and behavior characteristics, designed specifically to identify externally observable manifestations of creativity.

Each statement of the questionnaire is evaluated on a scale containing five gradations (possible rating points: 1 - never, 2 - rarely, 3 - sometimes, 4 - often, 5 - always). The overall creativity score is the sum of scores for eight items (the minimum score - 8, the maximum score - 40 points). The Table 1 shows the correspondence of the sum of points to the levels of creativity. The internal consistency of the Russian version of the scale was Cronbach's alpha $\alpha = 0.79$. To assess the retest reliability, the correlation coefficient of Spearman ranks was calculated (interval - three months), which turned out to be 0.78 (sample size - 80 children). To compare the data of various experts (the experts were three teachers teaching different subjects), Spearman's correlation coefficients were found. For a sample of 8-year-old children, the value of the correlation coefficient ranged from 0.51 to 0.71, for a sample of 10-year-old children - from 0.49 to 0.78, for a sample of 14-year-old children - from 0.58 to 0.79. It should also be noted that with the increase in the age of children, the consistency of the data of various experts among themselves increases (Tunik, 1997b, 1998, 2000).

To study the level of communicative control, the test "Diagnostics of communicative control" by Schneider was used (Schneider, 2002). The test consists of 10 statements reflecting reactions to some communication situations. The internal consistency of the Russian version of the test is $\alpha = 0.85$.

To assess the personal qualities of younger students, we used a modified version of the children's personality questionnaire intended for 8-12 year-old children and developed by Cattell and Koan (Children Personality Questionnaire – CPQ). The internal consistency of the Russian version of the test is $\alpha = 0.88$ (Alexandrovskaya and Gilyashev, 1978, 1995).

2.3. Research results

In the course of solving the first task, we performed a comprehensive expert assessment of the qualitative parameters of the educational environment based on the parameters formulated by Yasvin (2020). As a result, we identified four types of schools with different severity degrees of the essential characteristics of educational environments: serene, dogmatic, career and creative (see Figure 2). In the course of the study, we found that the general education spaces of Kazan schools are more consistent with the dogmatic and serene environment, a career type of modality characterizes one of the gymnasiums, and the "Specialized Olympiad and Scientific Center 'Sun' has a creative development environment. The histogram shows

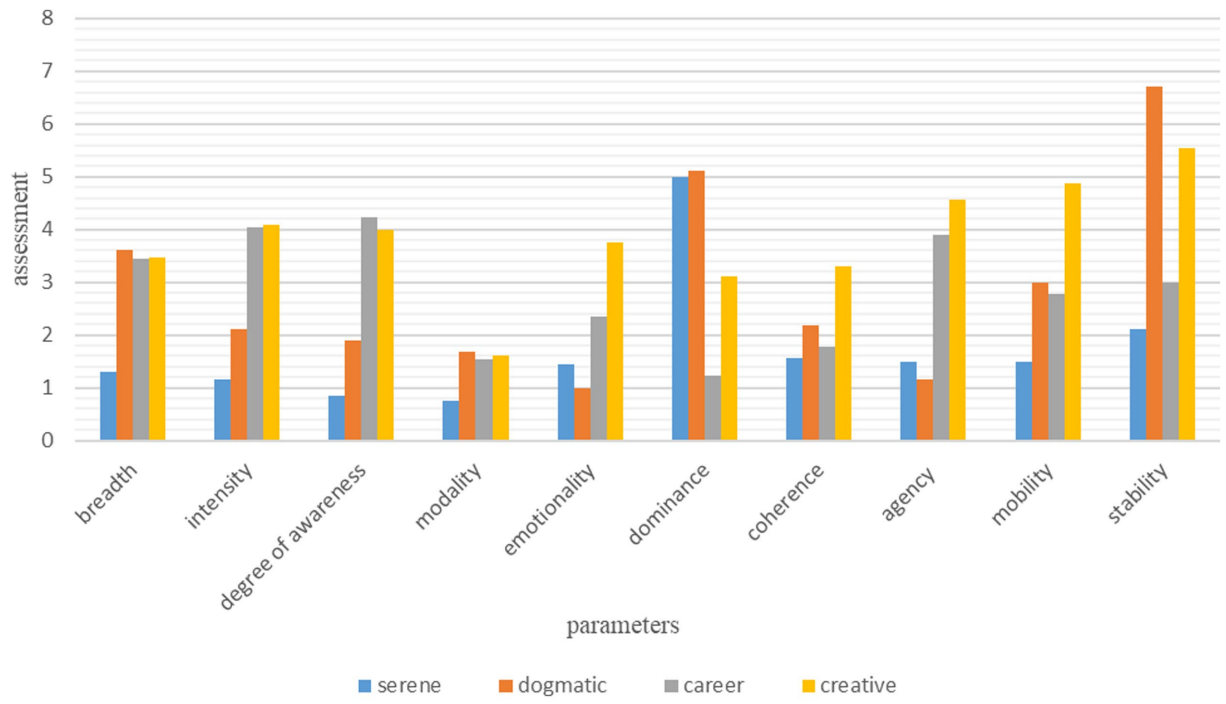

FIGURE 2
Severity of the essential characteristics of educational environments based on vector modeling (V. Yasvin).

that dogmatic schools are characterized by high stability and the ability to quickly adapt to external pressure, by a clear internal organization of the system, respect for traditions and order. However, it should be noted that this educational environment shows low agency and emotionality, demonstrated by the subjects of educational relations.

As can be seen from the histogram, a serene-type general education school is characterized by high dominance, the significance of this local environment in the system of values of the subjects of the educational process. A distinctive feature of a serene environment is relatively low stability, manifested in the precariousness of its system, low rates of awareness, intensity, generalization and mobility of the educational process. "There is no perseverance either in the desire to preserve, hold out, or in the desire to achieve, find. The child lives in an atmosphere of internal well-being and lazy, conservative habits, condescension to modern trends, among attractive simplicity" (Korchak, 1980).

According to the data obtained on a multidisciplinary career-type gymnasium, we have found that the features of this environment are characterized by a high level of intensity and awareness due to a deeper study of individual subjects and the focus of all activities on achieving the set goals. This environment shows high agency, which indicates the ability to produce socially significant results with a beneficial impact on society.

Specialized Olympiad and Scientific Center 'Sun' is distinguished by a creative environment with cultural content based on ethno-cultural samples and norms with bright national color, mobility and emotional richness of the educational process. Teachers have the ability to creatively approach the organization of the educational process, namely, to use new methodological developments, to conduct lessons in the context of certain events taking place in the environment; they vary the lesson plan depending on the specific situation, get acquainted with the work of psychologists and, accordingly, restructure the nature of their pedagogical communication with their students, etc.

While solving the second empirical problem, we subjected the obtained empirical data to a one-way analysis of variance (see Tables 2, 3). Data processing methods were carried out using the IBM SPSS Statistics 23 for Windows statistical package: descriptive statistics and the analysis of variance (univariate one-way ANOVA). The Scheffe *a posteriori* method of paired comparisons (Scheffe test) made it possible to carry out pairwise multiple comparisons of mean values while obtaining a statistically significant result.

Table 1 illustrates the data on the severity of the creative potential of the schoolchildren (see Table 1), who received higher scores according to the "Originality index" (the ability to express themselves in unusual activities and situations), and the "Uniqueness index" (the ability to make unconventional judgments and perform unusual actions) from the creative educational environment.

As can be seen in Table 2, there are statistically confirmed differences in the manifestation of such qualities as verbal intelligence, self-confidence, a tendency for self-affirmation, propensity to take risks, social courage, sensitivity, excitability, anxiety and nervous tension in younger schoolchildren from different educational environments.

We have established that younger schoolchildren from **creative and career environments** have the highest rates of verbal intelligence. They master new knowledge and develop abstract thinking faster. Schoolchildren from the **creative environment** are characterized by risk-taking and high social courage to a greater degree. These children are distinguished by dynamism and agency; when faced with non-standard situations, they do not get lost and quickly find a different way to solve the problems that have arisen. Moreover, we recorded low levels of anxiety and nervous tension, which ensures emotional stability in educational and cognitive activities. **Career-type** schoolchildren have a tendency to self-affirmation, a desire for leadership and dominance with excessive motivation, practicality and realism in resolving problem situations. They are characterized by low sensitivity, increased excitability and nervous tension with the need for practical relaxation in the process of activity. The characteristic features of younger schoolchildren from a dogmatic environment are: being better prepared to successfully meet school

TABLE 2 Mean values and standard deviations for indicators of younger schoolchildren's creative potential in terms of variability of educational environments (univariate one-way ANOVA).

Creative potential indicators	Types of educational environments based on vector modeling (V. Yasvin)			
	serene	dogmatic	career	creative
Originality index (The Remote Associates Test (RAT)	0.73 (0.85)	0.76 (0.87)	0.65*(0.81)	0.82*(0.91)
Uniqueness index (RAT)	0.58 (0.30)	0.58*(0.14)	0.51*(0.19)	0.74*(0.08)
Creativity (The Johnson Creativity Inventory)	24.00 (2.35)	23.00 (6.10)	26.00 (3.52)	25.00 (5.62)
Communicative control (Schneider)	5.77 (1.09)	5.20 (1.42)	6.47 (1.29)	5.65 (1.98)

The main effects of the "types of educational environments" factor: originality index $F(2, 69) = \mathbf{12.03}$, $p \leq 0.01$; uniqueness index $F(2, 69) = \mathbf{12.15}$, $p \leq 0.01$; creativity $F(2, 69) = 2.07$, $p \geq 0.05$; Communicative control $F(2, 69) = 2.60$, $p \geq 0.05$ (significant differences are given in bold). An asterisk (*) marks the groups that significantly differ from each other in terms of the Scheffe correction results.

TABLE 3 Mean values and standard deviations for indicators of younger schoolchildren's creative potential in terms of variability of educational environments (univariate one-way ANOVA).

Indicators of personal characteristics (Children Personality Questionnaire – CPQ)	Types of educational environments based on vector modeling (V. Yasvin)			
	Serene	Dogmatic	Career	Creative
Sociability	4.80 (0.83)	5.00 (2.03)	3.77 (1.62)	5.17 (2.59)
Verbal intelligence	5.40* (2.30)	3.69* (1.88)	7.49* (1.48)	7.41* (1.65)
Self-confidence	4.60* (1.67)	7.46* (1.66)	4.56* (1.69)	5.17* (2.05)
Excitability	3.40* (1.14)	6.38* (1.75)	7.84* (1.37)	5.51* (2.13)
Tendency for self-affirmation	5.20* (2.48)	6.07* (1.25)	7.73* (1.28)	4.75* (2.06)
Propensity to take risks	4.80* (1,09)	5.07 (1.03)	6.00* (1.88)	7.15* (1.75)
Responsibility	6.00 (0.70)	5.00 (2.00)	4.60 (1.79)	5.58 (2.22)
Social courage	4.80 (2,38)	4.00* (1.77)	4.62 (2.36)	7.75* (1.55)
Sensitivity	8.00* (1,22)	5.07* (1,89)	3.56* (1.9)	5.72* (2.51)
Anxiety	4.20* (1,09)	7.61* (1.44)	7.05* (1.94)	3.68* (1.81)
Self-control	4.80 (1,48)	4.46 (1.80)	3,54 (2.01)	5.06 (2.08)
Nervous tension	4.00* (0.83)	7.00* (1.44)	7.00* (1.74)	4.00* (1.25)

The main effects of the "types of educational environments" factor: sociability $F(2, 69) = 1.68$, $p \geq 0.05$; verbal intelligence $F(2, 69) = \mathbf{21.36}$, $p \leq 0.01$; self-confidence $F(2, 69) = \mathbf{9.13}$, $p \leq 0.01$; excitability $F(2, 69) = \mathbf{19.78}$, $p \leq 0.01$; tendency for self-assertion $F(2, 69) = \mathbf{23.04}$, $p \leq 0.01$; propensity to take risks $F(2, 69) = \mathbf{5.68}$, $p \leq 0.01$; responsibility $F(2, 69) = 2.09$, $p \geq 0.05$; social courage $F(2, 69) = \mathbf{16.84}$, $p \leq 0.01$; sensitivity $F(2, 69) = \mathbf{11.85}$, $p \leq 0.01$; anxiety $F(2, 69) = \mathbf{26.49}$, $p \leq 0.01$; self-control $F(2, 69) = 2.35$, $p \geq 0.05$; nervous tension $F(2, 69) = \mathbf{33.16}$, $p \leq 0.01$ (significant differences are given in bold). An asterisk (*) marks the groups that differ significantly from each other in terms of the Scheffe correction results.

requirements, however demonstrating low social courage. These schoolchildren more often use standard approaches to solving problems, producing elementary forms of thinking, which is accompanied by variability in mood and a change in mental states. The younger schoolchildren from a **serene environment** are largely exposed to the influences of the external environment, they are distinguished by the absence of strong motives and intentions in achieving goals, low rates of risky behavior combined with a need for support from others.

3. Conclusion

The paper analyzes various types of educational environments in terms of culturally-appropriate components. Based on the results of the dispersion analysis, the study revealed younger schoolchildren's creative potential in the context of educational environment variability, and the relationships between the parameters of the educational environment and the personal characteristics of children.

Thus, in a creative educational environment, to a greater extent than in other environments, the subjects of the educational system provide and actively support the individual development of the child and the disclosure of its creative potential. The priority of the creative educational environment is not only to develop the child's agency and creativity, but also to boost its own need for creativity and self-development as the creation of the self and the formation of the ability to independently set goals and realize its own ideas. The discovered empirical regularity is not a heuristic one in science, it is an independent trend in pedagogical practices. Pedagogical intervention is aimed not so much at meeting the requirements of the teacher, but rather at satisfying the need for creativity by involving schoolchildren in mental, intellectual and communicative activities.

Our study statistically confirmed significant differences between educational environments in terms of younger schoolchildren's creative potential. Thus, in a *creative educational environment*, younger schoolchildren demonstrate higher subjective activity with the possibility of unique achievements in educational and cognitive sphere, the desire

for unusual actions and unconventional judgments due to verbal intelligence. In a *career educational environment*, learners are more prone to self-affirmation, the desire for leadership and dominance. In a *dogmatic educational environment*, schoolchildren most often use standard approaches to solving assigned problems, generating elementary forms of thinking. In a *serene educational environment*, schoolchildren do not have strong motivations and intentions to achieve goals, risk-taking behavior is not typical, and they demonstrate a high need for support from the outside world.

Thus, pedagogical conditions, as components of the educational system, reflect the totality of the educational environment possibilities expressed in the capabilities of the educational process subjects. Vygotsky's ideas not only complement modern ideas about the relationship between learning and the psyche development, but also reveal the problems of the experimental evidence base in other modern approaches. This, in particular, concerns the clarification of the mechanisms in the relationship between learning and mental development in the context of controlled initiation from the outside of the self-organization processes of the cognitive system elements in the subject of education in accordance with the system self-development potential (Pogozhina, 2016).

The limitations of the study apply to the choice of: (1) the subject of the study, in particular, the creative potential was studied in connection with the parameters of the educational environment in different types of primary schools; the effects of external and internal factors in determining the creative potential were not considered; (2) strategies for building groups (arranging a sample) involving 160 junior schoolchildren; it is necessary to increase the sample to prevent internal threats to the validity of the study.

Research prospects concern the clarification of the mechanisms of the relationship between learning and the mental development of schoolchildren of different ages in the context of controlled initiation from the outside of the processes of self-organization of elements of creativity in accordance with the potential for self-development of a complex self-organizing system of higher mental functions (Vygotsky, 1999, 2005).

Practical value. The results of the study can be used by specialists in the design and evaluation of educational environments; by school psychologists, working with younger schoolchildren in the course of implementation of differentiated, individual approaches in the education system.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the Committee of the Institute of Psychology and Education of Kazan (Volga Region) Federal University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

VK designed and directed the project, and developed the theoretical framework. ES performed the research and conducted a mathematical analysis of the data, performed the analysis, drafted the manuscript, and aided in interpreting the results and worked on the manuscript. All authors discussed the results and contributed to the final manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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EDITED BY
Yulia Solovieva,
Meritorious Autonomous University of Puebla, Mexico

REVIEWED BY
Joaquim Quintino Aires,
Instituto Vegotsky, Portugal
Milda Bredikyte,
Vytautas Magnus University, Lithuania

*CORRESPONDENCE
Margarita Gavrilova
✉ gavrilovamrg@gmail.com

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Russian version of BRIEF2 Teacher Forms: validation study in typically developing children aged 5 to 7 years old

Margarita Gavrilova*, Margarita Aslanova, Kristina Tarasova and Yuri Zinchenko

Faculty of Psychology, Lomonosov Moscow State University, Moscow, Russia

This study aimed to examine the psychometric properties of the Russian version of the Behavioral Rating Inventory of Executive Function®, Second Edition (BRIEF2) Teacher Forms and investigate its dimensional structure. The sample consisted of 178 typically developing children aged 5 to 7 years. Internal reliability analysis indicated high reliability (from 0.87 to 0.95) for the three composite indices and the Global Executive Composite across all age groups. Confirmatory factor analysis revealed that the dimensional structure of the Russian version of BRIEF2 was different among children aged 5 and 6 years compared to children aged 7 years, which is probably because, in Russia, the transition from kindergarten to school takes place upon reaching the age of 7. The results confirm that the Russian version of the BRIEF2 Teacher Form can be used as a valid tool to assess EF in 5- and 6-year-old children, provided that the three BRIEF2 indices are used for clinical interpretation. For 7-year-old children, the BRIEF2 was found to be an insufficiently valid tool to assess executive function.

KEYWORDS

executive function, higher mental functions, BRIEF2, typically developing children, confirmatory factor analysis, Russian version of BRIEF2

Introduction

Although the definition of executive functions (EF) has long been debated, it may broadly be viewed as those "cognitive processes that are required for the conscious, top-down control of action, thought, and emotions and that are associated with neural systems involving the prefrontal cortex" (Müller and Liben, 2015, p. 271). Core EF skills include inhibitory control (resisting habits, temptations, or distractions), working memory (holding and using information), and cognitive flexibility (Miyake et al., 2000). These skills are extensively developed in the early years of a child's life, influencing a child's future outcomes (Tvardovskaya et al., 2022).

For the first time, the term "executive" appeared in the studies of the Soviet neuropsychologist Luria (1966), who was one of the founders of the Cultural-Historical Theory (Goldstein et al., 2014). As a neuropsychologist, he analyzed the functioning of various brain regions during clinical work with victims of brain injury in World War II. Luria stated that the frontal lobes are responsible for governing behavior and performing complex activities, based on the observation of many patients with injuries localized in this region of the brain (Luria, 1966). Thus, in 1966, he gave a definition of EF that is very close to the one shared by many researchers today: "…Syntheses underlying own actions, without which goal-directed, selective behavior is impossible" (Luria, 1966, p. 224). Higher

mental functions, one of the central concepts of cultural-historical theory, are the equivalent of the EF concept (Ardila, 2008). The main difference in this understanding is that Vygotsky and Luria insisted that the executive processes occur through cultural means (e.g., symbols, speech, and writing) (Luria, 1966; Vygotsky, 2016).

EF skills play a key role in the development of academic skills, including word reading, vocabulary, and comprehension of both oral and written language, the acquisition of initial mathematical concepts, the formation of speech skills, and high school performance (Blair and Razza, 2007; Blankson et al., 2012; Gagne, 2017; Veraksa and Veraksa, 2021; Dolgikh et al., 2022; Veraksa et al., 2022). Identifying deficits in children's EF skills is important in preschool and school education (Trushkina and Skoblo, 2022). Assessments using professional tools provide the necessary support for children to develop their EF skills (Brofman et al., 2022). Behavioral rating screening may be a more affordable solution, especially in medium- to large-group settings (kindergarten or school), and the Behavioral Rating Inventory of Executive Function®, Second Edition (BRIEF2; Gioia et al., 2015) is one such tool.

Behavioral rating inventory of executive function

BRIEF2 is a behavioral rating scale designed to assess the "real world" behaviors associated with EF at ages 5–18 years (parent and teacher forms) and ages 11–18 years (self-report form) (Gioia et al., 2015). The BRIEF2-Teacher Form consists of 63 items constituting nine subscales: Inhibit, Self-Monitor, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Task-Monitor, and Organization of Materials. Three composite indices are derived from these subscales: the Behavior Regulation Index (BRI), the Emotion Regulation Index (ERI), and the Cognitive Regulation Index (CRI). The Global Executive Composite (GEC) is an overall EF score comprising three indexes.

BRIEF2 is widely used worldwide in clinical, psychoeducational, and research settings (Jiménez and Lucas-Molina, 2019; Robertson et al., 2020; Cumming et al., 2023) and has been successfully validated in several languages (Muñoz and Filippetti, 2021; Liu et al., 2022; Parhoon et al., 2022; Moura et al., 2023). Many of the existing studies have mainly been conducted on samples from North America (Jacobson et al., 2020) and Europe. However, several studies have validated BRIEF2 as also applicable to non-Western populations: China (Liu et al., 2022), Iran (Parhoon et al., 2022), Chile (Muñoz and Filippetti, 2021), the Dominican Republic (Jiménez and Lucas-Molina, 2019).

Cultural and educational context in Russia

As with other diagnostic tools, the use and validation of BRIEF2 in Russia are marked by several country-specific peculiarities. Of particular importance are the state's multiculturalism and the particularities of the education system. Russia is a multicultural country requiring special conditions for adapting, validating, or standardizing diagnostic tools. There are 190 nationalities in the country, with 80% of the population being Russian (Malkov, 2020). To date, 24 of the Republics of Russia have established republican languages recognized as co-official with Russian (Jankiewicz et al., 2020). Multicultural and multilingual contexts require the translation of a tool into various national languages (Buryat, Dagestan, Tatar, Yakut, etc.).

From the perspective of the education system, an essential issue in validating a tool is the difference in the age period of the transition from ECEC to primary school. In Russia, children start school when they are 7 years old. Before they start primary school, children are enrolled in kindergarten from 3 to 6 years of age. The kindergarten educational programs include classes in reading, numeracy, and writing. However, these activities are different from school classes. Thus, some BRIEF2 items may have differing views on the conditions of education for children before and after the age of 7.

Present study

This study belongs to a body of research investigating the cross-cultural applicability of BRIEF2 and potential cultural differences in everyday children's EF behavior in different cultural contexts. The study aims to analyze the psychometric properties (reliability and validity) of the Russian version of BRIEF2 Teacher Forms in a sample of typically developing children aged 5–7 years and investigate its dimensional structure. In addition, this study explores the interrater reliability between children's BRIEF2 results evaluated by two teachers. The study was designed considering the peculiarities of Russia's cultural and educational context. First, due to the multilingual nature of the state, the validity evidence on the applicability of the Russian-language version of BRIEF2 in this study may extend mainly to monolingual regions. Second, the study involved children aged 5–7 years old to assess the applicability of the Russian-language version of BRIEF2 over existing differences in the age period of the transition from ECEC to primary school.

Methods

Participants

The study included 178 typically developing children aged 5–7 years. The participants attended publicly funded kindergartens and schools. Children aged 5 and 6 years attended kindergartens, and children aged 7 years attended the first grade of school. Forms were filled out by 34 kindergarten and 8 primary school teachers (Table 1).

Procedure

The study was conducted in May–June 2023. In kindergartens, the BRIEF2 was completed by two preschool teachers for each child. In the first grade, the BRIEF2 was completed by a full-time

TABLE 1 Study participants.

Age group	*N*	Age	Girls (%)
5-year-old children	53	5.26 (± 0.32)	51.3
6-year-old children	69	5.48 (± 0.33)	61.5
7-year-old children	56	5.37 (± 0.43)	60.5

teacher. The teacher was asked to assess 6–10 children who were selected randomly based on their order of appearance on the class list (every third child). This measure of sampling was driven by classroom conditions in Russia, where class sizes are typically ∼25–30 students. If teachers completed the form for the whole class, the quality of completion would probably be reduced. The lists given to the teachers were prepared in advance, considering medical and psychological screening information (only children with typical development were included). Another selection condition was that the teacher should have been familiar with the selected children for at least 6 months.

Measures

A Russian version of the BRIEF2

A Russian version of the BRIEF2 Teacher Form was derived from the English version of the BRIEF2 (Gioia et al., 2015). The BRIEF2 was translated from English into Russian by two professional bilingual experts based on standard translation guidelines and cultural adaptation processes (e.g., Sousa and Rojjanasrirat, 2011). Both translators have experience translating diagnostic tools in the fields of early childhood education and psychology. In the translation process, points were noted where there could be differences in the educational processes of organizations in Russia and the USA. Then, similar questions were addressed to an American specialist in preschool and primary school education. For example, to improve the translation's accuracy, clarification was obtained concerning the "criteria" for well-organized written work of a 5- to 7-year-old child (BRIEF2, para. 21). It is highly probable that the Russian criteria would differ. Next, a series of peer discussions were held with six experts in child development psychology and EF. The discussions included working with the original English manual and two versions of the Russian translation to select the optimal phrasing and refine it. All specialists were proficient in both Russian and English. Then, a native English speaker fluent in Russian translated the Russian-language version into English, and this back-translation was assessed for inconsistencies. After the Russian version of the BRIEF2 had passed the checks mentioned above, focus group interviews were conducted with 12 teachers who work with typically developing children at kindergarten or school. They were asked to share their understanding of each BRIEF2 item and comment on the statements' clarity and comprehensibility. Once the problems identified in the focus group interviews had been fully addressed, the final Russian version of the BRIEF2 questionnaire was used for full psychometric testing.

Data analysis strategy

First, the reliability of the BRIEF2 Russian version was assessed using (a) internal scale consistency (Cronbach's alpha) and (b) interrater reliability between two teachers' reports for a single child, as based on the Cohen's kappa coefficient and a paired samples *t*-Test. Second, Pearson's correlation analysis was performed to analyze the correlation between the nine subscales, the three indexes, and the GEC. Third, construct validity has been analyzed based on the internal structure using confirmatory factor analysis. A CFA was conducted for the total sample and separately for three age groups to test the model fit of the BRIEF2 3-factor and 9-factor models.

Results

Descriptive

Given the variation in educational settings for children aged 5, 6, and 7 years, the primary tool's psychometric properties were evaluated separately for each age group. Table 2 presents descriptions of BRIEF2 nine subscales separately for these age groups. All the data were provided based on the row values for each subscale.

Reliability/precision of the subscales

The internal consistency

The internal consistency was studied using Cronbach's alpha coefficients as a first metric of reliability, separately, for each age group. Cronbach's alpha reliability coefficient ranges between 0 and 1. George and Mallery (2003) suggest that an alpha coefficient value result be interpreted as follows: > 0.9 is excellent; > 0.8 – is good; > 0.7 is acceptable; > 0.6 is questionable; > 0.5 is poor, and < 0.5 is unacceptable.

In the sample of 5-year-old children, the results indicate that the internal consistency of all subscales was good or acceptable (see Table 2). Cronbach's alpha coefficients for each subscale ranged from 0.74 (Initiate) to 0.89 (Emotional Control and Working Memory), and the Cronbach's alphas for each index ranged from 0.95 (Shift) to 0.97. In the sample of 6-year-old children, the internal consistency was good or acceptable for all subscales except the Initiate. Cronbach's alpha coefficients for subscales ranged from 0.57 (Initiate) to 0.89 (Emotional Control), and the Cronbach's alphas for each index ranged from 0.87 to 0.95. In the sample of 7-year-old children, the internal consistency was, in general, lower than that in the previous two age groups. Cronbach's alpha coefficients for subscales ranged from 0.41 (Initiate) to 0.88 (Working Memory). The Cronbach's alphas for each index ranged from 0.83 to 0.97.

The interrater reliability

Next, interrater reliability has been studied based on the Cohen's kappa coefficient as a second metric of reliability and additionally tested using the paired samples *t*-test. This analysis

TABLE 2 Descriptive statistics for BRIEF2 subscales and Cronbach's alpha coefficients.

	5 year old children ($n = 53$)					6 year old children ($n = 69$)					7 year old children ($n = 56$)				
	Min	Max	Mean	SD	α	Min	Max	Mean	SD	α	Min	Max	Mean	SD	α
Inhibit	1.00	2.88	1.59	0.49	0.88	1.00	2.88	1.59	0.49	0.84	1.00	2.38	1.38	0.35	0.80
SM	1.00	3.00	1.67	0.60	0.84	1.00	3.00	1.67	0.60	0.81	1.00	2.60	1.38	0.42	0.78
Shift	1.00	3.00	1.62	0.45	0.85	1.00	3.00	1.62	0.45	0.75	1.00	2.25	1.45	0.33	0.75
EC	1.00	2.88	1.62	0.49	0.89	1.00	2.88	1.62	0.49	0.89	1.00	2.38	1.40	0.32	0.70
Initiate	1.00	2.80	1.46	0.40	0.74	1.00	2.80	1.46	0.40	0.57	1.00	2.75	1.45	0.43	0.41
WM	1.00	1.63	1.59	0.49	0.89	1.00	2.75	1.74	0.47	0.84	1.00	2.38	1.39	0.38	0.88
Plan	1.00	3.00	1.54	0.46	0.84	1.00	3.00	1.54	0.46	0.84	1.00	2.50	1.46	0.45	0.84
TM	1.00	3.00	1.62	0.51	0.81	1.00	3.00	1.62	0.51	0.81	1.00	2.60	1.38	0.43	0.82
OM	1.00	2.80	1.55	0.48	0.75	1.00	2.80	1.55	0.48	0.87	1.00	2.38	1.38	0.35	0.81
BRI	1.00	2.81	1.58	0.51	0.95	1.00	2.75	1.82	0.51	0.87	1.00	2.49	1.38	0.36	0.83
ERI	1.00	2.88	1.55	0.46	0.95	1.00	2.63	1.54	0.49	0.91	1.00	2.31	1.43	0.30	0.83
CRI	1.00	2.62	1.56	0.40	0.94	1.00	2.66	1.67	0.40	0.92	1.00	2.37	1.38	0.35	0.94
GEC	1.00	2.66	1.53	0.41	0.97	1.00	2.53	1.58	0.49	0.95	1.00	2.39	1.39	0.33	0.96

Source: BRIEF2 (Russian version). (a) BRIEF2, Behavior Rating Inventory of Executive Function, Second Edition; (b) mean raw scores range from 1–3; (c) SM, Self-Monitor; EC, Emotional Control; WM, Working Memory; Plan, Plan/Organize; TM, Task Monitor; OM, Organization of Materials; BRI, Behavior Regulation Index; ERI, Emotion Regulation Index; CRI, Cognitive Regulation Index; GEC, Global Executive Composite; (d) α – Cronbach's alpha coefficient.

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TABLE 3 Interrater reliability for BRIEF2 subscale scores reported by preschool teachers.

	5-year-old children ($n = 53$)			6-year-old children ($n = 69$)		
	κ	Z	P	κ	z	p
Inhibit	0.76	5.53	<0.001	0.50	5.41	<0.001
SM	0.81	6.45	<0.001	0.72	8.77	<0.001
Shift	0.52	3.90	<0.001	0.49	5.42	<0.001
EC	0.65	4.60	<0.001	0.67	4.93	<0.001
Initiate	0.50	3.69	<0.001	0.27	3.02	<0.001
WM	0.51	3.75	<0.001	0.45	5.04	<0.001
Plan	0.37	2.96	<0.001	0.45	5.12	<0.001
TM	0.73	6.03	<0.001	0.40	4.77	<0.001
OM	0.54	3.97	<0.001	0.42	4.57	<0.001

(a) Mean raw scores range from 1 to 3; (c) SM, Self-Monitor; EC, Emotional Control; WM, Working Memory; Plan, Plan/Organize; TM, Task Monitor; OM, Organization of Materials; BRI, Behavior Regulation Index; ERI, Emotion Regulation Index; CRI, Cognitive Regulation Index; GEC, Global Executive Composite; (b) α – Cronbach's alpha coefficient.

TABLE 4 Intercorrelations among the nine subscales, three indexes, and GEC of the Russian version of the BRIEF2 teacher forms.

Subscale	1	2	3	4	5	6	7	8	9	10	11	12	13
Inhibit	—												
SM	0.872	—											
Shift	0.844	0.793	—										
EC	0.856	0.841	0.780	—									
Initiate	0.643	0.684	0.725	0.629	—								
WM	0.731	0.660	0.794	0.717	0.708	—							
Plan	0.838	0.789	0.818	0.829	0.710	0.779	—						
TM	0.822	0.780	0.807	0.812	0.716	0.779	0.770	—					
OM	0.832	0.725	0.829	0.737	0.636	0.774	0.773	0.839	—				
BRI	0.962	0.973	0.848	0.876	0.686	0.718	0.843	0.826	0.801	—			
ERI	0.901	0.885	0.940	0.946	0.725	0.800	0.880	0.854	0.829	0.923	—		
CRI	0.873	0.810	0.889	0.832	0.823	0.917	0.903	0.922	0.906	0.869	0.910	—	
GEC	0.944	0.933	0.929	0.914	0.798	0.838	0.924	0.891	0.872	0.968	0.976	0.956	—

(a) SM, Self-Monitor; EC, Emotional Control; WM, Working Memory; Plan, Plan/Organize; TM, Task Monitor; OM, Organization of Materials; BRI, Behavior Regulation Index; ERI, Emotion Regulation Index; CRI, Cognitive Regulation Index; GEC, Global Executive Composite; (b) all correlations are significant at level < 0.001.

was conducted only for 5- and 6-year-old children because, at these ages in the country of study, children attend kindergarten and have regular contact with two preschool teachers. Cohen's kappa coefficient, ranging from 0 to 1, assesses the measure of consistency between the scores of these two teachers from 0 to 1. According to McHugh (2012) recommendations for the interpretation of Cohen's kappa, the value of kappa ≤0.20 indicating no agreement; 0.21–0.39 is a minimal level; 0.40–0.59 is a weak level; 0.60–0.79 is moderate level; 0.80–0.90 is a strong level, and ≥0.90 is an almost perfect level of agreement.

Table 3 presents interrater reliability analysis results for two age groups separately. The lowest level of agreement among teacher reports for children aged 5 years was found in the Plan/Organize subscale. A weak level of agreement was observed for Shift, Initiate, Working Memory, and Organization of Materials. Other subscales showed moderate (Inhibit, Emotional Control, and Task-Monitor) or strong (Self-Monitor) levels of agreement. The level of agreement between teachers' reports for children aged 6 years is generally lower than that for children aged 5 years. The lowest level of agreement was found specifically with the Initiate. Weak agreement was observed on six of the tool's nine subscales (Inhibit, Shift, Working, Memory, Plan/Organize, Task-Monitor, and Organization of Materials). Only two subscales (Self-Monitor and Emotional Control) had moderate levels of agreement.

The paired samples t-test did not find significant differences between the two teachers' reported scores for either of the BRIEF2 subscales ($p > 0.05$).

TABLE 5 Summary of the 3-factor and 9-factor models fit indexes for the Russian version of the BRIEF2 teacher forms.

Model	χ^2	Df	CFI	TLI	SRMR	RMSEA 90% CI)
BRIEF2 3 factors						
5-year-old children	40.2**	24	0.973	0.959	0.027	0.113 (0.04–0.17)
6-year-old children	44.1**	24	0.966	0.949	0.051	0.110 (0.05–0.16)
7-year-old children	106***	24	0.859	0.788	0.081	0.259 (0.21–0.31)
Total sample	100***	24	0.956	0.935	0.027	0.136 (0.10–0.16)
BRIEF2 9 factors						
5-year-old children	8743***	1674	0.201	0.155	0.146	0.282 (0.26–0.28)
6-year-old children	5518***	1674	0.327	0.288	0.164	0.182 (0.17–0.18)
7-year-old children	13310***	1674	0.108	0.056	0.369	0.369 (0.36–0.37)
Total sample	4677***	1674	0.633	0.612	0.108	0.102 (0.09–0.10)

**$p < 0.01$. ***$p < 0.001$.

Intercorrelations

A Pearson's correlation analysis was conducted to analyze the correlation between the nine subscales, the three indexes, and the GEC. The intercorrelation matrix showed that all nine subscales and index scores were moderately to highly correlated. Correlation coefficients ranged from 0.64 to 0.97. All correlations were significant at a p-value of < 0.001 (see Table 4).

Construct validity

The underlying factor structure of the Russian version of the BRIEF2 Teacher Forms was explored using a confirmatory factor analysis (CFA) with maximum likelihood estimation. According to Hu and Bentler's (1999), the goodness-of-fit of the *a priori* models was estimated with the following fit indices: the overall χ^2 statistics, Comparative Fit Index (CFI) > 0.90, Tucker Lewis Index (TLI) > 0.90, Standardized Root Mean Squared Residual (SRMR) ≤ 0.08, Root Mean Squared Error of Approximation (RMSEA) < 0.08.

A CFA was conducted for the total sample and separately for three age groups to test the model fit of the BRIEF2 three-factor and nine-factor models. The relevant information on these eight models is presented in Table 5.

The results of the CFA indicate the best model fit for the three-factor model compared to the nine-factor models (Table 4). Furthermore, the underlying factor structure of the Russian version of the BRIEF2 Teacher Forms varied across different age groups. Thus, the three-factor model showed a good fit, especially for the samples of children aged 5 and 6 years, suggesting that the three-index model was applicable to the Russian version of the BRIEF2 Teacher Forms for both ages. All fit indices in these models responded to the thresholds except RMSEA (the RMSEA >0.08 indicates the insufficient extent to which the model matches the true model with its 90% confidence interval). The three-factor model for the samples of children aged 7 years and the total sample is not accurate enough in terms of goodness-of-fit. However, this factor solution is a better representation of the data than other models.

Discussion

The objective of this study is to analyze the psychometric properties of the BRIEF2 Russian version in a sample of typically developing children in preschool and primary school settings. Reliability (internal consistency and interrater reliability) and validity (the underlying factor structure) of the BRIEF2 Russian version were analyzed as the main psychometric properties.

The internal consistency of the subscales of the BRIEF2 Russian questionnaire was heterogeneous among the three age groups. The highest consistency of the scales is observed when completing the BRIEF2 for children aged 5 years. In this age group, the internal consistency of all subscales was good or acceptable. When the form was completed for children aged 6 years, internal consistency was good or acceptable for all subscales except Initiative (0.57). Finally, in the sample of children aged 7 years (the first grade of school in Russia), the internal consistencies were, in general, lower than that in the previous two age groups but still good or acceptable for all subscales except Initiative (0.41). To summarize, the internal consistency of all subscales was adequate for reliability except for the Initiate. Internal consistency of the Initiate subscales was unacceptable among children aged 6 and 7 years and questionably acceptable in the sample of children aged 5 years. Furthermore, the internal consistency results on the three composite indices (BRI, ERI, and CRI) and the Global Executive Composite (GEC) have indicated adequate reliability (from 0.87 to 0.95).

The interrater reliability analysis results showed that the level of agreement between teachers when evaluating a child decreases slightly as children age. This is observed in the lower levels of agreement when assessing children aged 6 years compared to children aged 5 years. Yet, the two teachers' ratings of most subscales (except the Plan subscale for 5-year-olds and the Initiate subscale for 6-year-olds) were sufficiently consistent.

The confirmatory factor analysis (CFA) results of a construct validity study indicate the best model fit for the three-factor model compared to the nine-factor models. The underlying factor structure obtained in the present study suggests that the Russian version of the BRIEF2 Teacher Forms reflects three types of difficulties rather than nine. This result coincides with

Jacobson et al. (2020), who found three factors in a large sample of children aged 5 to 18 years. Thus, the results indicate that clinical interpretation of the Russian version of BRIEF2 is more appropriate at the level of indices (BRI, ERI, and CRI) rather than subscales.

The sample of this study covered children aged 5 to 7 years to assess the applicability of the Russian-language version of BRIEF2 over existing differences in the age period of the transition from ECEC to primary school in the Russian educational context. It was shown through reliability and CFA analyses that the dimensional structure of the Russian version of BRIEF2 was different for children aged 5, 6, and 7 years. Both internal and interrater reliability and CFA indices of the goodness-of-fit of the a priori model decreased from younger to older children. While the 3-factor model showed a very good fit for the samples at ages 5 and 6 years, the fit indices were poorer at age 7. At the age of 7 in Russia, children enter first grade (see Introduction). This may indicate that the school setting in the Russian education system differs from the preschool setting to such an extent that the children's behavior can no longer be validly assessed using BRIEF2.

Conclusion

The results of the present study confirm that the Russian version of the BRIEF2 Teacher Form can be used as a valid tool to assess EF in children aged 5 and 6 years based on observations of their behavior in kindergarten settings. However, three indices (BRI, ERI, and CRI) should be used instead of nine BRIEF2 subscales for clinical interpretation. For children aged 7 years, the BRIEF2 was a rather insufficiently valid tool for assessing EF based on CFA results.

Limitations

From a future research perspective, we plan to analyze the external validity of the BRIEF2 using a battery of NEPSY-II tests to individually assess children's main EF skills (Korkman et al., 2007). The other important direction for further research should address the limitations of this study. The limitations of the present study are mainly related to sampling. A larger sample may help to obtain more reliable results, and psychometric evaluation of the Russian-language version of the BRIEF2 in a clinical sample is needed to determine its sensitivity to EF assessment in normative and clinical samples. The other limitation of the study is the fact that two teachers assessed children aged 5 and 6 years, while children aged 7 years were assessed by only one teacher. This difference is caused by the peculiarities of the educational system in the country of the study.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Ethics Committee of Faculty of Psychology at Lomonosov Moscow State University. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

MG: Formal analysis, Software, Validation, Writing—original draft. MA: Data curation, Formal analysis, Investigation, Writing—review and editing. KT: Data curation, Investigation, Software, Writing—review and editing. YZ: Conceptualization, Funding acquisition, Project administration, Resources, Supervision, Writing—review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY
Kai S. Cortina,
University of Michigan, United States

REVIEWED BY
Carolyn Palmquist,
Amherst College, United States
Sonja Perren,
University of Konstanz, Germany

*CORRESPONDENCE
Milda Bredikyte
milda.bredikyte@vdu.lt

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Pretend play as the space for development of self-regulation: cultural-historical perspective

Milda Bredikyte* and Agne Brandisauskiene

Educational Research Institute, Education Academy, Vytautas Magnus University, Kaunas, Lithuania

Self-regulated behavior is a prerequisite for learning and success in life. Considerable research confirms that mature forms of play support the development of self-regulation in the early years. This study explores the relationship between (3–6-year-olds) children's pretend play and self-regulation skills. Teachers filled out a *child's play and self-regulation checklist* evaluating the level of children's play and self-regulation skills. The findings revealed that the levels of children's play and self-regulation skills are statistically significantly linked: the better the child performs an assumed role in play activity, the higher the level of their self-regulation. The results also suggest that a child's playing skills, gender, and age predict children's self-regulation skills manifested in play activity.

KEYWORDS

pretend play, self-regulation, child's play and self-regulation (CP&SR) checklist, cultural-historical theory of development, self-initiated and self-organized imaginative play

1 Introduction

There has been a shift in educational thinking and practice in recent decades. Advances in research in several scientific fields brought the understanding that how well students do in school and later in life can be determined by how well they self-regulate (Shonkoff and Phillips, 2000; Duckworth and Seligman, 2005; Blair and Diamond, 2008; Shanker, 2013). As a result, researchers are increasingly focusing on self-regulation in young children. For example, Whitebread et al. (2009), Robson (2010), and Whitebread and Pino-Pasternak (2010) investigated the relationship between self-regulation and metacognition in young children. These researchers argue that we can see many signs of metacognitive and self-regulatory behavior by analyzing video recordings of young children's activities. Such a methodological approach can benefit further research (Whitebread et al., 2009). However, as Robson (2010) points out, research on the emergence and development of early metacognition and self-regulation in young children is at the earliest stages of development. The lack of suitable research strategies, methods, and tools might be the main obstacle to studying these processes. Perry (2019) also emphasizes that scientists studying the development of self-regulation in young children may face the challenge of presenting authentic developmental tasks that would provide opportunities for young children to demonstrate their self-regulation abilities. "Much of the research involving young children is carried out in laboratories using standardized measures that are poor reflections of children's self-regulation in their daily activities" (Perry, 2019, p. 332).

In their study, Vasseleu et al. (2022) seek to find how educators understand children's self-regulation, its development, and practices that support the development of self-regulation in children. The results of this study (Vasseleu et al., 2022) show that teachers tend to concentrate on instances of dysregulation and focus mainly on cases of poor self-regulation, overlooking the rest of the children. However, as emphasized in much recent research (Robson et al., 2020), self-regulation skills are vital to academic success and foundational to successful participation in society (Colliver et al., 2022). Vasseleu et al. (2022) concluded that teachers' professional development needs to focus on seeing all children and finding ways to facilitate and support the development of all children's self-regulation.

Several studies report that self-regulation skills are often learned through high-quality pretend play (Berk and Meyers, 2013). Veraksa et al. (2022), exploring the relationships between play and executive functions, point out that play is one of the child's main forms of activity, where he or she masters new forms of behavior, learns to interact with others, and develops imagination and self-regulation skills. A recent longitudinal study from Australia (Colliver et al., 2022) confirmed that the time spent in free, unstructured play at ages 2–3 and 4–5 years predicted self-regulation abilities 2 years later.

Many studies highlight the role that play has in a child's social-emotional learning (Posner and Rothbart, 2000; Elias and Berk, 2002; Berk et al., 2006; Bodrova and Leong, 2007; Sherwood and Reifel, 2010; Kelly and Hammond, 2011; Hoffmann and Russ, 2012; Berk and Meyers, 2013; Diamond, 2013; Stagnitti et al., 2016; Walker et al., 2020). However, research on the impact of play on children's development and learning is subject to criticism, much of which, as in self-regulation research, relates to the choice of appropriate strategies, methods, and tools.

The debate on the impact of social pretend play on the development and learning of preschoolers (Lillard et al., 2013) emerged over a decade ago, highlighting the problems of play research. This debate (Bergen, 2013; Sutherland and Friedman, 2013; Walker and Gopnik, 2013; Weisberg et al., 2013; Weisberg, 2015) revealed the understanding of how complex the phenomenon of play is and how we are sorely lacking in theoretical explanations and adequate research methods to study and analyze it. The situation in play research has remained relatively the same; the impact of play on separate areas of child development or learning continues to be studied through experimental targeted interventions (Richard et al., 2021; Jaggy et al., 2023).

As a result, in the background, an intense debate continues about what is more important in early childhood: to play more or start early academic teaching and learning. Studies by many scientists have shown that the recent rise of academic pressure during the early years often contributes to lower levels of the quantity and quality of pretend play (Becker et al., 2014), regardless of the general claim that these are the years when children need the most play-based learning opportunities.

As if seeking to resolve this contradiction more recently, a middle-ground perspective has gained popularity, with play as a joint activity of children and adults. This perspective takes many forms, such as "conceptual play" (Fleer, 2011, 2015); "playful curriculum" (Sim, 2015); "guided play" (Weisberg et al., 2016); "purposefully-framed play" (Edwards, 2017); "playful pedagogies" (Broadhead, 2018); "intentional teaching" (Lewis et al., 2019); and "purposeful play" (Moedt and Holmes, 2020). The very general idea of this perspective is that children and adults meet through play to build knowledge together. The knowledge is often but not necessarily understood as children's scientific concepts, language, literacy, mathematics, and social skills.

To avoid ambiguity, we clearly define the theoretical approach of our research and use the concepts of cultural-historical theory to define play and self-regulation. In cultural-historical terms, the forms of play that claim their goal content knowledge for children are defined as *didactic play*. It is the most appropriate form of teaching for young children. However, this is not the *self-initiated* and *self-organized imaginative play* that, according to Vygotsky (2016), creates the zone of proximal development for the child and is potentially the most stimulating for developing children's self-regulation.

In the cultural-historical frame, dynamically developing social imaginary play is the child's first independent activity system, which they feel their own (Hakkarainen, 1999). Because it is a jointly created dynamic system, it binds children together through the play roles, forces them to follow the rules of the roles, and prevents them from falling out of the play quickly. Players are placed in a situation that begins to regulate their behavior, and even without knowing the exact rules of play, they quickly figure them out through play actions. If the play activity interests the children, they mobilize all their efforts to develop it. Perhaps it is this kind of involvement that Vygotsky described: "[I]n play, the child is always above his average age, above his daily behavior; [.] play contains all developmental tendencies in a condensed form" (Vygotsky, 2016, p. 18).

From a developmental point of view, child-initiated play is a precious activity in which the child's interests, motives, and abilities are revealed. By creating meaningful play, the child mobilizes their full potential and often goes beyond everyday behavior. The professional educator must be able to observe, monitor, support, and evaluate the quality of the child's play and participate in children's play as a play partner without taking the lead or taking over the children's play idea. Teacher's participation is sometimes beneficial for the children as he/she can demonstrate new play strategies and ways to extend and enrich the children's initiatives and ideas. In this case, the children learn to play from the adult. However, our research shows (Brėdikytė, 2022) that children and teachers are learning to play from each other when participating in collaboratively created play activities.

Another pedagogical aspect is that the teacher can easily see the children's interest in the play and use it later to plan and organize explorative and intentional teaching episodes in a *didactic play* format. When the teacher offers children meaningful learning activities as a follow-up to their play, they inspire and enrich the children's further play and learning. This continuous flow of initiatives from child-initiated play toward meaningful teacher-led learning, then back to children's independent play, could be the basis for a successful preschool pedagogy (Hakkarainen et al., 2015; Brėdikytė and Hakkarainen, 2017).

As researchers in the cultural-historical paradigm, we emphasize imaginative role-play as a leading activity for child development. For us, imaginary play is the process of creating something new—a movement, an object, an idea, a sense, or a meaning. A child participating in this creative process develops

new psychological formations, which lead them to a qualitatively new level of functioning. From our point of view, this is the primary purpose of *independent, self-organized* play activity. Mature forms of imaginary play develop general abilities in young children: (1) general creativity (creative improvisation, symbolization); (2) motivation; (3) imagination; (4) volition, voluntary behavior (self-regulation); (5) understanding of the other person's point of view; (6) orientation toward the universal meanings of human life, relationships, and activities. Vygotsky called these abilities "psychological functions," and the terms more familiar to readers may be: "cognitive abilities" (Dickinson et al., 2016), "cognitive tools" (Egan, 1997), or tools of mind (Bodrova and Leong, 2007). In addition, children acquire specific academic skills and knowledge more easily during play, but this is instead a by-product and not the primary goal of play activity.

The ambiguous explanations of the significance of childhood play and the resulting diversity of educational practices have inspired us to develop a theoretically based tool to help teachers observe and assess children's pretend play and self-regulation and monitor their developmental dynamics. Our initial assumption that high-level pretend play contributes to the development of children's self-regulation helped us to formulate the primary goal of this research project:

- To explore the relationship between the level of children's pretend play and self-regulation skills.

This study extends the cultural-historical line of research on play, proposing to look at the development of higher psychological functions as social practices. According to Vygotsky and his followers, imaginative play is the activity that creates the optimal conditions for developing these functions. Fleer et al. (2017) argue that such a view is more "pedagogically productive" as it "speaks directly to teachers" practice. Children's independent play is a common social practice in early childhood classrooms.

This study is distinctive among other studies. It explores *self-regulation* as *a social practice* that develops in close kinship with children's *self-initiated* and *self-organized imaginative play*. A cultural-historical perspective on child development informed the choice.

In the following paragraphs, we will define the main theoretical concepts, describe the tool–*child's play and self-regulation* (CP&SR) checklist (**Supplementary Appendix 1**) used for data collection, and explain its parameters. We will introduce the participants in the study, data collection, and analysis processes, discuss the results, and conclude with the implications for further research and practice.

2 The theoretical framework of the research

Our approach to play and child development is based on cultural-historical theory, especially on Vygotsky (2016) and El'konin (2005a,b) writings on play and early development. The main ideas about the child's cultural development and the role of the social environment as the source of development inform our understanding of play, its functions in child development, and how we evaluate play.

In the cultural-historical tradition, the closest concept to self-regulation is *voluntary behavior* or *arbitrariness* (*произвольное поведение*, *произвольность*, *proizvol'noe povedenie*, *proizvol'nost'*). Vygotsky has shown that arbitrariness is not only a social formation by its origin and content but also by its mechanisms. The child does not adapt to the requirements of society and culture; it initially develops within this society and culture as an active participant.

At an early age, before three, the child is not free from the stimuli around him. Voluntary behavior allows the child to overcome dependence on what they perceive in the "here and now." Voluntary behavior is the child's ability to plan, manage, and evaluate his or her activities and behavior purposefully and consciously. The development of arbitrariness is among the main goals of early childhood education and an important criterion of school readiness.

One of the most prominent experts on self-regulation, Shanker (2013), proposed a detailed description of developed self-regulation, which aligns with the cultural-historical approach. Drawing on the insights of different scholars, he defined "self-regulation as the ability to: (1) attain, maintain, and change one's level of energy to match the demands of the task or situation; (2) monitor, evaluate, and modify one's emotions; (3) sustain and shift one's attention when necessary and ignore distractions; (4) understand both the meaning of a variety of social interactions and how to engage in them in a sustained way; (5) connect with and care about what others are thinking and feeling—to empathize and act accordingly." (Shanker, 2013, xii).

Shanker (2010, 2013) suggests a dynamic systems view of self-regulation and claims that early experiences play a critical role in the organization of the human brain. Because babies are born with a limited capacity to control their impulses, their self-regulation develops by being regulated by caregivers. Self-regulation develops throughout childhood, adolescence, and young adulthood as the challenges to which the child is exposed increase. The most important early experiences are the child's interactions with their closest adults and peers. At a certain point, the child must start to monitor his behavior and activities. We are interested in how such a transition happens through a child's participation in collaborative pretend role play.

Rephrasing Vygotsky (2016), a child's most significant power of self-regulation arises in play. At all stages of play, a child is in a state of conflict between the rules of the play and spontaneous actions. In play, the child acts against his immediate wishes and at the limit of his willpower. Continuing Vygotsky's and Elkonin's line in play research, Smirnova (1998) analyzed the psychological mechanism of how the play role and play plot (sjuzhet) transform the child's behavior. In her opinion, play does this through two main aspects: the child's motivation and the execution of the role. The motivation for play lies in the very process of performing the activity.

Moreover, the execution of a desirable role is emotionally attractive to the child. "Correct" implementation of a role and plot becomes a motive of their activity. Having obtained a desired role, the child is forced to act according to the rules of this role. Why suddenly the child voluntarily obeys these rules? In play, the rule is detached from the child, as if it is taken outside and directed at

the role. In play, the child regulates the "other," not oneself. The in-role position helps the child to monitor and control their behavior through the "correct" execution of the role.

Thus, role-play of the preschooler in a natural form combines two necessary conditions for the development of voluntary self-regulated action–an increase in motivation and self-awareness, assuming a certain amount of reflexivity in the child.

3 Methodology

We have investigated the relationship between the child's play and self-regulation skills. In the following, we will present the study design, describe the participants in the study, and explain how the data was collected and analyzed.

3.1 Participants

The study was conducted in seven daycare centers in Vilnius, Lithuania. The study involved 454 children (50% girls and 50% boys) aged 1.9–7 years (M = 56.64 months; SD = 1.26). Detailed information on the age of the children is given in **Table 1**.

3.2 Ethical considerations

The research was conducted following the ethical rules of the Helsinki Declaration. Verbal consent was obtained from the principal of each ECEC school before the study. Participating teachers sign informed consent. All parents were informed about the study and gave their children written permission to participate. ECEC teachers and children participated in the study voluntarily.

3.3 Data collection

At the beginning of the study, we had to choose how to collect genuine data on children's play and self-regulation. We had to choose who would collect the data: university researchers or daycare teachers working with children regularly and knowing them well. Our conscious decision was to choose the teachers instead of the researchers, who would enter the classrooms as strangers and disturb ordinary life. It was important for this study to obtain the data from playing children within their familiar environment. All 75 teachers received initial training on children's play. In addition, before the data collection, the researchers visited every daycare center, met with all participating teachers, presented the checklist, and explained the parameters in detail. During the meetings, teachers had to evaluate one child from their classroom (a pilot evaluation). After the training, the teachers were asked to observe six children in their classroom for a week and fill out the *child's play and self-regulation* (CP&SR) checklist. Nevertheless, ensuring that all teachers assessing children's play and self-regulation skills had the same conceptual understanding of these phenomena was essential. However, not all teachers were able to attend our training sessions. When this happened, extremely low Cohen's d (Kappa) values were found (e.g., 0.209, 0.379). The analysis did not include these teachers' ratings because they were unreliable. We describe this in more detail in the limitations section.

Most of the teachers in the study worked with mixed age groups of children (1.9–7 years), and many could select children of different ages for the assessment. The requirements for selecting the children for the study were to select three boys and three girls to select children of different ages and play skills if given the opportunity.

3.4 Research tools

The *child's play and self-regulation* (CP&SR) checklist (Brėdikytė et al., 2015) was used to evaluate children's performance. The checklist consists of two parts. The first part of the checklist was meant to evaluate a child's play level.

A group of psychologists from the Center for Psychological and Pedagogical Expertise of Play and Toys of the Moscow State University of Psychology and Education have developed an original observation protocol for evaluating the level of children's free play (Smirnova and Ryabkova, 2013; Ryabkova et al., 2017). We developed our tool in close collaboration with the researchers from this center. It was essential that the tool was theoretically sound and reflected the key structural components of pretend play. Our checklist contains all the same parameters as the observation protocol of our colleagues from Moscow, but we organized them into a convenient format for teachers. Our goal was to develop and validate an observation checklist that assesses pretend play level and self-regulation and provides the teacher with an instrument that would help them gain a deeper understanding of the development of a child's play on the one hand and, at the same time, monitor the dynamics of the play and self-regulation skills in children.

Our (CP&SR) checklist includes seven structural components of play activity proposed by El'konin (1999a,b): (1) play objects, (2) self-position of the child, (3) interactions with a play partner, (4) play space, (5) play actions, (6) the play plot (sjuzhet), and (7) the main content of play. Each parameter of play observation is ranked on four different levels (from simple activity to more complex), e.g., the self-position of the player:

- Child has no role;
- Child has a role but does not keep to the rules of the role or is inconsistent;
- Child has a role and keeps to the rules of the role;
- Child is flexible and freely improvises roles.

The second part of the checklist is meant to evaluate a child's self-regulatory behavior during joint play with peers. Gabeeva (2007), following theoretical ideas from B. D. El'konin, Zuckerman, A. L. Venger, and other cultural-historical scholars, formulated self-regulation criteria for primary school children. We modified Gabeeva's criteria in line with the diagnostic methodologies developed by Galiguzova et al. (2013) for younger children. The second part of the inventory assesses the (3–6-years-old) child's self-regulatory behavior during group play. Neuropsychologist Akhutina, head of the Neuropsychological Laboratory of Moscow State University, carried out an expert evaluation of the checklist.

TABLE 1 Age characteristics of the participants in the study's first phase.

Age of the children	*N*	Min	Max	Mean	Std. deviation
2–3 years old	93	1.9	3.4	2.808	0.3979
3–5 years old	216	3.5	5.3	4.473	0.5339
5–7 years old	139	5.5	7.0	6.117	0.3614

Thus, this second part of the checklist also consists of seven parameters of a child's self-regulatory behavior during joint play activity: (1) readiness to step into group play, (2) ability to coordinate one's activities with those of other children, (3) amount of effort the child puts into creating a play, (4) ability to solve problems that arise during play, (5) child's interest in joint play and their emotional regulation, (6) amount of adult assistance needed during play, (7) resistance toward external disturbances. Each parameter of self-regulatory behavior in play is ranked in four levels, from the lowest to the highest form of behavior, e.g., the amount of effort the child puts into creating a play:

- Does not develop play activity, often disrupts or stops the play.
- Offers no suggestions, accepts them from others, and continues playing.
- Offers suggestions, give orders to others, and continues playing.
- Offers suggestions that require their effort; takes others' suggestions into account; develops the play further.

The *child's play and self-regulation* checklist records the individual child's skills only when they participate in joint play activity with peers. Not all play and self-regulation parameters can be observed in solitary play. As far as developed pretend role-play is concerned, it is a social role-play that is considered as such, as it creates optimal conditions for developing children's play and self-regulation skills. Group play is usually of a collaborative nature and, therefore, a necessary condition for developing high-level play. The group of playing children acts about each participant of play as the organizing factor, sanctioning and supporting the performance of the role taken by the child.

3.5 Statistical data analyses

The IBM SPSS Statistics 26.0 software was used for statistical (quantitative) data analysis: descriptive analysis (frequencies, percentage rank, mean). The exploratory factor analysis (EFA) using the Principal Components Analysis with Varimax rotation was used to summarize the structure of a set of variables of the *child's play and self-regulation checklist*. A Kaiser-Meyer-Olkin (KMO) test and Bartlett's Test of Sphericity were first conducted to verify if the data set was suitable for factor analysis. The KMO index (0.958) and Bartlett's test of sphericity ($\chi^2 = 3359, 3799$, $p = 0.0001$) indicated that the data were suitable for factor analysis. To verify the internal consistency of the checklist, we calculated Cronbach's alpha. The *child's play and self-regulation checklist* has a high rate of psychometric reliability: play part $\alpha = 0.907$, self-regulation skills part $\alpha = 0.894$.

To determine how the dependent variable (children's self-regulation in play) is predicted by the independent variables (child's gender, age, and play skills), a multiple regression analysis was performed. The data were also assessed for multicollinearity (variance inflation factor VIF < 4). The regression model was considered appropriate when the coefficient of determination $R^2 > 0.20$ (Hair et al., 2019). A significance level of $p < 0.05$ was used for statistical analysis.

4 Results: Relationships between child's play and self-regulation skills

In this section, we will present the study's results, which aim to explore the relationship between the level of children's play and self-regulation skills.

The study results of the 454 children show that *play* and *self-regulation* abilities are related. All relationships between these two variables are statistically significant, and most of them are of moderate strength. Correlation estimates are presented in **Table 2**.

All play criteria are reliably related to the general self-regulation score, which shows children's general self-regulation during play (Kendall's correlation coefficients τ from 0.419 to 0.638). Analysis of the different play parameters showed that the *child's position* in the play, i.e., the performance of the role during play activity, is mainly related to all self-regulation abilities and their overall assessment. The estimate of this play parameter with the overall self-regulation estimate is 0.641. The other four parameters–*interactions with a play partner*, *play space*, *play actions*, and *the main content of the play*, are more significant than 0.511, except for the correlations with the ability to manipulate the *play objects* (Kendall's $\tau = 0.476$) and *the play plot* (Kendall's $\tau = 0.419$). Thus, the research results confirm that the child's behavior during play is controlled by their commitment to the assumed role, and this skill is related to the child's self-regulation. It can be assumed that the higher the child's play skills related to the level of the child's position in the play, the higher the estimates of the child's self-regulation skills will be. A child's in-role play position requires him to follow specific rules related to self-regulation (e.g., the ability to coordinate one's activities with those of other children or regulate one's emotions, etc.).

The following three parameters of play are associated with medium-strength relationships with the child's self-regulation: *the main content of play* (Kendall's $\tau = 0.539$), *play actions* (Kendall's $\tau = 0.545$), and *interactions with a play partner* (Kendall's $\tau = 0.551$). Attention should be paid to the last two–*the interactions of a play partner* and the *play actions*. The first sign that a child understands the rules of play and a role is

TABLE 2 Correlations between the level of play and self-regulation skills (Kendall's tau-b rank correlation coefficients).

SR criteria → Play level criteria ↓	Readiness to step into group play	Ability to coordinate one's activities	Amount of effort the child puts into creating a play	Ability to solve problems that arise during play	Child's interest in joint play and his emotional regulation	Amount of adult assistance needed during play	Resistance toward external disturbances	SR_rang_sum
Play objects	0.413***	0.374***	0.382***	0.398***	0.402***	0.458***	0.422***	0.476***
Self-position of the player	0.569***	0.511***	0.553***	0.495***	0.512***	0.528***	0.533***	0.641***
Interactions with a play partner	0.470***	0.489***	0.484***	0.468***	0.406***	0.438***	0.498***	0.551***
Play space	0.442***	0.374***	0.433***	0.374***	0.363***	0.465***	0.480***	0.502***
Play actions	0.487***	0.389***	0.502***	0.435***	0.429***	0.495***	0.475***	0.545***
Play plot	0.342***	0.368***	0.321***	0.328***	0.300***	0.409***	0.344***	0.419***
The main content of play	0.460***	0.393***	0.471***	0.433***	0.413***	0.447***	0.459***	0.539***
Play rang_sum	0.553***	0.475***	0.520***	0.482***	0.471***	0.546***	0.539***	0.638***

***$p < 0.0001$.

when they start controlling play partners. In their play actions, the child sees specific models of role behavior and, telling a play partner how to behave, he "discovers" the rules of the role. Thus, compliance with the rules is closely related to the parameters of *interactions with a play partner* and *play actions*, which, according to the research data, is significantly related to the self-regulation skills of the playing child. The connections of other parameters, such as play objects, play space, and play plot, with the child's self-regulation skills are weaker, although statistically significant.

Searching for connections between children's pretend play and self-regulation, we also performed exploratory factor analysis with the principal component extraction method and Varimax rotation (Table 2). According to the two-factor model, the first factor consists of seven statements describing the child's self-regulation during play. Their factor loadings range from 0.628 to 0.790. The second factor consists of statements describing the parameters of the child's play. Their factor loadings vary from 0.595 to 0.814. This two-factor model explains 62.76 percent of variations (Table 3).

It is necessary to note that the *self-position of the child* (play parameter) falls under both factors according to the factor analysis. In the first factor, the child's self-regulatory behavior, its factorial weight is 0.666; in the second, in play, it is 0.459. As noted earlier, the role and the associated rules guide the child's play actions, supporting their self-regulation. When "taking on" a specific role, the child embodies a particular behavior. In this way, the in-role position becomes a "key" that helps to understand

TABLE 3 Factor structure of the checklist for the evaluation of the level of play and self-regulation skill.

Items groups	Factors	
	1 (self-regulation)	2 (play)
Amount of effort the child puts into creating a play	0.790	
Child's interest in joint play and his emotional regulation	0.770	
Ability to coordinate one's activities with those of other children	0.754	
Ability to solve problems that arise during play	0.725	
Readiness to step into group play	0.723	
Resistance toward external disturbances	0.671	
Self-position of the child	0.666	0.459
Amount of adult assistance needed during play	0.628	
The play plot		0.814
Play objects		0.762
The main content of play		0.753
Play space		0.713
Play actions	0.465	0.606
Interactions with a play partner	0.513	0.595

the mechanism of formation of self-regulation in play. Therefore, the factor analysis only confirms this close connection when the child's self-position (play parameter) also falls among the self-regulation criteria.

This first self-regulation factor includes the child's *play actions* and *interactions with a play partner*, which reveals the importance of the participation of other children. However, their weights in the self-regulation factor are lower (0.465 and 0.513) than the play skills factor. However, it should be noted that these variables are also related to the child's self-regulation process during role performance, and the factor analysis also illustrates this.

5 Results: The child's play skills predict their self-regulatory behavior in play activity

Multiple linear regression analysis was performed to determine whether and how children's play skills, age, and gender can predict children's self-regulatory skills in play. Firstly, it shows no multicollinearity problem, as the VIF of all variables has a variance inflation factor of less than 4 (VIF < 4). The results of the regression model (**Table 4**) show that 69.6% of the dependent variable can be predicted by independent variables ($F = 90.629$, $p < 0.0001$).

Further improvement of the regression model resulted in retaining only statistically significant independent variables (**Table 5**). These are the child's gender, age, and the five pretend play parameters (self-position of the player, interactions with a play partner, play space, play actions, and the main content of play). The resulting coefficient of determination ($R^2 = 0.681$) showed a very slight decrease: 68.1% of children's self-regulation skills in play can be explained by the child's age, gender, and the five pretend play parameters.

The linear regression equation is written as follows:

$$\text{Child's self-regulation in play} = 4.732 - 0.817\text{G} + 0.365\text{A} + 1.854\text{SP} + 0.910\text{IP} + 0.488\text{PS} + 0.827\text{PA} + 0.664\text{MC}$$

G, child's gender; A, child's age; SP, self-position of the player; IP, interactions with a play partner; PS, play space; PA, play actions; MC, the main content of play.

Thus, 68.1% of children's self-regulation skills manifested in play are predicted by their play skills (self-position of the player, interactions with a play partner, play space, play actions, and the main content of play) together with the child's gender and age. Of these predictors, the strongest predictor of self-regulation in play is the self-position of the player.

6 Discussion

It is well known that the theoretical framework defines the main concepts and research methods and allows conclusions and generalizations to be drawn, which can be made within the framework of the chosen theory. Our study defines the theoretical position very clearly. We underline that our tools, results, insights, and generalizations should be understood and interpreted in the context of cultural-historical and conceptually close theories. This is especially relevant to the concept and classification of children's play activity and the interpretation of self-regulation, which we presented in the paper's theoretical part.

From a cultural-historical theory perspective, high-level developed pretend play is only possible with the child's self-regulation. From this theoretical perspective, we should discuss play as an *activity system*. Moreover, as with any human activity, play activity proceeds in two directions: it is turned to the external actions to construct the object of activity—play, and simultaneously, on the internal/mental actions that help to build the external object, joint play. So, a child at play is simultaneously the subject and the object of their activity, or as Kravtsov and Kravtsova (2010) and Kravtsova (2014) emphasized, the dual subject of play.

Thus, from the perspective of cultural-historical theory, our research only confirms the theoretical postulate. Regarding early childhood education praxis, which is often not based on specific theoretical perspectives and an understanding of early childhood development, the tool we have developed is important as it incorporates the child's externally visible learning in the form of play actions, and the formation of their internal mental structures–self-regulation.

Children's self-initiated play is significant from a developmental point of view because it is the first independent system of children's activities in which they learn to agree on ideas and coordinate their actions while working toward satisfying result. Collaborative play is a very challenging activity that requires the maximum effort of the children and helps them to form structures of thought that are not possible when the child is playing individually or under adult guidance. These activities fundamentally differ because they help children develop different skills and thinking strategies. Children's independent activities requiring collaboration are the most conducive to developing self-regulation.

The study's results explore the relationship between the level of children's play and self-regulation skills, confirming that *play* and *self-regulation* skills are related and that the relationships between these two variables are statistically significant. Analysis of the different play parameters revealed that the *self-position of the child* in the play, i.e., being in-role position during play activity, is related to all self-regulation parameters and their overall assessment.

Multiple linear regression analysis revealed that children's self-regulation skills manifested in play could be predicted by five play parameters: the self-position of the player, interactions with a play partner, play actions, the main content of play, play space, and the child's gender and age. The older the children, the higher their play parameters; boys showed slightly weaker play parameters than girls. Furthermore, again, the strongest predictor of self-regulation in play is the *self-position of the player*.

This is in line with El'konin (1999a,b, 2005a,b) and other scholars' claim that *role*, together with the *play plot* (sjuzhet), is one of the main structural components of pretend role-play activity. Taking a play role is challenging for a young child. Being in a role requires the child to have at least a minimum level of self-regulation. More is needed for children to interact successfully with each other in their roles. Children in a role must monitor each

TABLE 4 Multiple linear regression with children's self-regulation skills in a play as dependent variable.

Independent variables	Standardized coefficients B	*t*	*p*-value	VIF
Constant	4.370	6.327	0.000	
Gender	−0.069	−2.255	0.025	1.081
Age	0.090	2.616	0.009	1.388
Play objects	0.074	1.687	0.093	2.277
Self-position of the player	0.329	6.977	0.000	2.611
Interactions with a play partner	0.149	3.308	0.001	2.390
Play space	0.072	1.597	0.111	2.389
Play actions	0.153	3.362	0.001	2.436
Play plot	−0.004	−0.104	0.918	2.192
The main content of play	0.141	2.993	0.003	2.601
F	90.629			
p	0.0001			
R^2	0.696			

For gender, 0 signifies "girl" and 1 "boy".

TABLE 5 Multiple linear regression with children's self-regulation skills in a play as dependent variable.

Independent variables	Standardized coefficients B	*t*	*p*-value	VIF
Constant	4.732	6.854	0.000	
Gender	−0.081	−2.710	0.007	1.042
Age	0.092	2.699	0.007	1.346
Self-position of the player	0.337	7.157	0.000	2.555
Interactions with a play partner	0.155	3.466	0.001	2.323
Play space	0.090	2.075	0.039	2.163
Play actions	0.157	3.430	0.001	2.431
The main content of play	0.152	3.335	0.001	2.394
F	112.435			
p	0.0001			
R^2	0.681			

For gender, 0 signifies "girl" and 1 "boy."

other's compliance with the rules of the role and co-construct the play events together, coordinating their actions and ideas.

Our previous study (Brėdikytė et al., 2015) found low play skills; only 30% of 3- to 6-year-old children achieve high-level play in each age group. This is confirmed by other researchers' studies (Smirnova and Gudareva, 2004; Smirnova and Ryabkova, 2013; Ryabkova et al., 2017) and emphasized by many practitioners. Smirnova and Ryabkova (2013) performed a study that examined 112 children in the age group 5–6 years old in Moscow and revealed that only 3% of children showed a high level of pretend play.

The trend today, the decrease in play levels described in Ryabkova et al. (2017, 95) study, results in "children's inability to create the imagined situation—to accept and hold the role, to develop a plot, or to create play space. Children cannot play meaningfully and peacefully during free play time—they are romping, fighting, and pushing. Moreover, instead of playing together, the teachers are filling the children's free time with relaxing exercises or resorting to disciplinary actions." This is a typical situation in a classroom where children are not used to playing regularly. The ability and desire to engage in pretend role play is not an inborn ability of children. Developing high-level play demands certain conditions, including adult participation and support. In today's situation, the teacher's competencies to understand play, support, and create play together with children are extremely important.

6.1 Limitations of the study

One of the limitations of our research might be that we study children's self-regulation processes only in play activities and do not include everyday situations to see if the self-regulation acquired in play is transferred to other situations. It was a deliberate choice because, as already Vygotsky (2016, p. 18) pointed out: "In play a child is always above his average age, above his daily behavior; in play it is as though he were a head taller than himself." Researching the transfer of acquired self-regulation skills to other life contexts

requires a different research design for data collection and analysis. The role of adults in supporting transfer is critical, and they should also be included in the unit of such analysis.

The uniqueness of our study is that the teachers collected the data. There were many reasons for this, and we discussed them in the methodology section. We want to stress that this was a conscious decision reinforced after the researchers visited the kindergarten groups. Although our concern was that we would use video cameras and film the children, the children's lives were disturbed by the appearance of two strangers in the group looking around, wondering, and sometimes seeming confused. After the first few visits, we realized we could not collect data ourselves. We wish to record the children's highest achievements when playing with friends and expressing themselves freely. Who, if not the teacher, knows the children in her group best and can observe their play undisturbed? You cannot artificially create such situations, even less so for scientists who know children very little. We agree that this is a limitation of our study, but we realized that the researchers would not be able to capture authentic children's play with just a few visits to the classroom. It should also be emphasized that we tried to ensure that the teachers assessing the children's self-regulation and play skills had the same conceptual understanding of the phenomena. Cohen's d (Kappa) criterion was used to analyze the data to determine the inter-rater reliability of the results (both teachers assessed the children in the group). In the case of extremely low Cohen's d (Kappa) values (e.g., 0.209, 0.379), the second teacher's ratings were not included in the analysis because they were unreliable. This result can be explained by the fact that these teachers did not participate in the project training. A qualitative analysis of their ratings showed that the teachers needed to understand the content of the criteria of play and self-regulation, their dynamics, and their interrelationships.

The choice (teacher or researcher) may have led to significant differences between our results and our Moscow colleagues. However, we believe that a child cannot unintentionally demonstrate the highest level of play and the lower level quickly. Therefore, the teachers only observed six children while collecting the data; each child was observed for at least 1 week, allowing the teacher to observe a child for a more extended period without rushing. We know the data teachers collected can only be considered partially accurate.

However, given that our study aimed to investigate the relationship between play and self-regulation rather than to measure and compare children's abilities accurately, the fact that the trained teachers gathered the data from their classrooms does not diminish the relevance of the results. Still, this should be considered when interpreting the data from our study. Also, given that only 454 children and 75 teachers participated in our research, we must be cautious in making broader generalizations.

6.2 Implications for practice and further research

The child's play and self-regulation (CP&SR) checklist is intended for ECEC professionals to understand better the structure of play activity and its key parameters. It is already used in Lithuania and included in university student training materials and teacher narrative play guidelines. The checklist can be a helpful tool to observe and assess children's play and self-regulation skills. It also enables monitoring the development of the essential new formations of preschool age: imagination, elements of voluntary behavior, and symbolic function. Educators must recognize and understand the formation process of the child's self-regulation.

The (CP&SR) checklist can be used for further research exploring children's play and self-regulation. Further research in this area is needed to clarify how the self-regulatory skills of the young child are formed on an interpsychic level (between people) and how they become internalized and transferred to the child's daily activities as a regular part of the human personality.

7 Conclusion

The study's results suggest that children's levels of play and self-regulation are statistically significantly related: the better a child plays, the higher their level of self-regulation. The results of the regression model show that 68.1% of children's self-regulation skills manifested in play are predicted by their play skills, especially the following parameters of play: self-position of the player, interactions with a play partner, play space, play actions, the main content of play and the child's gender and age.

Data availability statement

The original contributions presented in this study are included in this article/**Supplementary material**, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the Vytautas Magnus University Education Academy Ethics Committee has approved the study. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

MB: conceptualization and writing—review and editing. MB and AB: methodology, investigation, and writing—original draft preparation. AB: formal analysis. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1186512/full#supplementary-material

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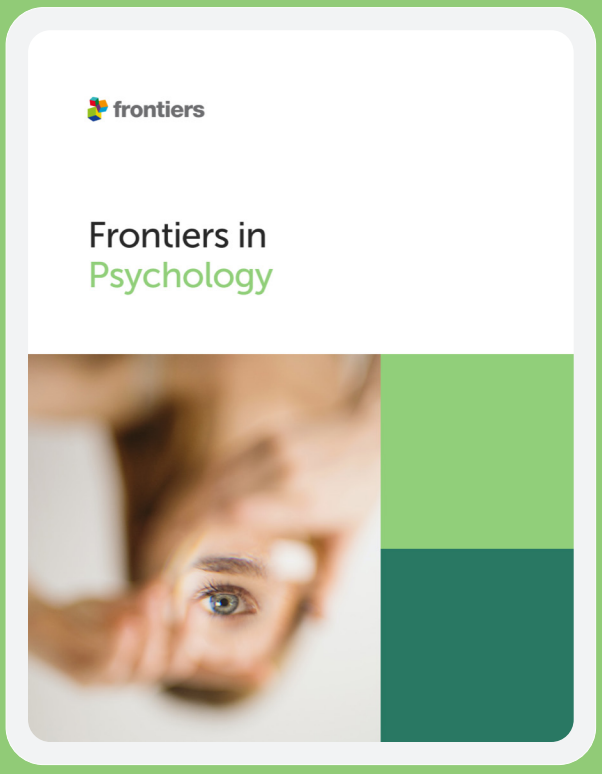

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