

The relationship between different components of role play and executive function development at preschool age

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Abstract

The purpose of the study was to examine the relationship between the main components of role play, according to Vygotsky (object substitution, idea of play, play interaction), and executive functions (working memory, inhibition, cognitive flexibility, planning) in preschool age. The study involved 56 children, 5 to 6 years old (29 boys and 27 girls). Play observation was conducted in small groups of two to three children in a playroom in kindergarten with special multifunctional “open” materials. The results revealed significant relationships between planning and the role-play components associated with the stability and level of the play idea, object and space substitution, and the organizing interaction in play. Comparison of the play components in children with low and high levels of executive function showed that children with a high level had higher positional substitution, detalization of idea (the extent to which a child reveals their idea to partners) in play, and a higher general play level than children with low executive function levels. Thus, the study shows that high levels of executive function are related with high levels of play, and this makes play an effective tool for the development of executive functions.

Keywords

preschool age; play; executive functions; imagination; substitution

Introduction

Play is considered an important activity in preschool (Elkonin, 1976; Fisher, 1991; Leontiev, 1996; Pellegrini, 2009; Smith, 2010; Vygotsky, 2004). In playing with substitute objects, operation in the imaginary and conditional space affects the formation of memory, imagination, and arbitrary behavior (Fantuzzo, Sekino, & Cohen, 2004; Ivrendi, 2016; Kelly, Hammond, Dissanayake, & Ihsen, 2011; Lillard et al., 2013; Mikami, 2010; Mottweiler & Taylor, 2014; Sigel, 1970; Slot, Mulder, Verhagen, & Leseman, 2017; Zyga, 2016).

Role play was called “the full or developed form of the play” by Vygotsky’s follower and colleague, Elkonin (1976). Taking the role in play requires one to obey rules and regulations, and it also requires flexibility because it can be abandoned at any time (e.g., when the real situation demands interruption of play). Moreover, preschoolers interact with each other while playing, and, as a result, children begin to take into account the wishes and actions of others, control their behavior, and implement collaborative plans. In this respect, play is traditionally regarded as important for the development of child arbitrariness (Elkonin, 1976) or executive functions (EFs; Carlson, White, & Davis-Unger, 2014; Pierucci, O’Brien, McInnes, Gilpin, & Barber, 2014; Vieillevoye & Nader-Grosbois, 2008). Moreover, according to Leontiev (1996), it can be assumed that, in role play, all components of executive functioning are involved: cognitive flexibility (switching from one role to another—from play to reality), inhibitory control (restraining the attitude to the imaginary situation as a real situation; following the rules of the play), and working memory (e.g., the retention of rules).

According to current research, we are facing simultaneously a decrease in the level of play development and an increase in the variability of play (Smirnova, 2013). The individual characteristics of play vary from child to child: children can demonstrate low levels of play with no object substitution, limited plan of the play, and so on, while for some, play is generally replaced by other activities. Thus, it is important to answer the question: which components of play correspond today to the cognitive development of children generally and executive functioning specifically?

The relationship between executive function and play at preschool age

EF is an umbrella term that encompasses the cognitive processes that allow controlling behavior, making it more adaptive and targeted. Working memory, inhibition, and cognitive flexibility are widely analyzed components of EF (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). The ability to plan one’s own activities is also considered as important component of EF (Diamond, 2006). Numerous studies have shown that the development of EF at preschool age has an impact on the formation of academic and social skills at later ages (Blair & Razza, 2007; Duncan et al., 2007; Espy et al., 2011; Fuhs, Hornburg, & McNeil, 2016).

However, only few studies have examined the correspondence between role-play development and EF. Slot et al. (2017), for example, singled out cognitive, behavioral, and emotional components of self-regulation in play. Cognitive self-regulation manifested itself in planning and in emotional (awareness of one’s own emotions) and behavioral (the ability to obey rules and established agreements) self-regulation. In the

development of play, Slot et al. singled out components such as role acceptance, play substitution of objects and actions, and interaction with peers. Significant interrelations between the level of development of play activity and the level of cognitive self-regulation were revealed. In our opinion, this study raises the question of the internal connection between the development of play and executive functioning.

Ivrendi (2016) compared the development of play and the development of self-regulation in 148 5-year-old children. As part of the study, play was divided into three levels of development: low-level play (single, parallel), interactive play (involving eye contact with a partner, simple social interaction), and competent play (involving full interaction). The results showed a stable relationship between the level of the development of play and the level of EFs.

Fantuzzo and colleagues (2004) studied the relationship between self-regulation in children aged 3 to 6 years and the characteristics of their interaction with peers while playing. Children who demonstrated more-developed communicative skills during a free play (e.g., able to effectively resolve emerging contradictions and not prone to aggressive behavior) had a higher level of emotional regulation development. The study showed that children who played with peers on a regular basis had higher levels of creativity in the development of plot, and more initiative and autonomy during the training sessions.

Thus, the results of several correlation studies have shown a relationship between the level of interaction of children in play and the level of EF (Fantuzzo et al., 2004; Ivrendi, 2016; Mikami, 2010). Studies show that play has a complex structure and includes multiple aspects that are differently related to the components of EF in preschool children, which is reflected in the inconsistency of the data obtained by researchers. In this regard, it is important to carry out studies in which all of the main components of play are taken into account.

Thus, in our study, special attention was given to the level of substitution undertaken and the child's ability to follow the chosen role and to develop role play, which were marked by Vygotsky as (2004) important components of role play. The purpose of our research was to identify relationships between the various components of play and the components of EF in senior preschoolers. The methodological toolkit of the study included two blocks: assessing 1) the level of role-play development and 2) the development of EFs.

Evaluation of role-play components

In contrast to the Penn Interactive Peer Play Scale (Castro, Mendez, & Fantuzzo, 2002) or the Children's Developmental Play Instrument (Chazan, 2009), which are aimed at the social interaction of children, our task was to determine the highest possible level of all components of role play according to Vygotsky (2004).

According to the cultural-historical theory of Vygotsky (2004), the key characteristic of play is the creation of an imaginary situation—the replacement of imaginary objects and events with real ones. Therefore, *play substitutions* (object, positional and spatial) were considered an important component. Substitution in play can occur at different levels. The simplest variant is *object substitution*: the use of one object as another. However, the position of the child in play can not only be role-playing, but also directorial or

organizational when children play out stories with toys or play out events (e.g., “we have flown into space” or “we are in the jungle now”). Therefore, we use the term *positional substitution*—not *role substitution*—in our study. It is not only objects and roles that can be created and replaced, but also whole *play spaces* that model reality. The creation and semantic differentiation of play spaces (e.g., “the house is here and the forest is there”)—the allocation of space and its separation into the areas necessary for play—usually takes place when children are older than 5 years of age and indicates a sufficiently high level of play development.

Another important component of play is the *interaction of children*, which takes place at two levels: organizing (discussion and organization of the play, coordinating its course) and in play (communication with playing positions).

In addition to these traditional play components, we have identified yet another new aspect in the analysis of play, which shifts the focus from an individual to an integral characterization of play. At the center of this integral is the play design, defined as an *idea embodied in play* (Smirnova & Gudareva, 2004). The concept can be understood as a certain image embodied in playing activities and which can relate to different aspects of play. This idea reflects the significant experience of the child, which is portrayed in play and which is in fact its content. These experiences and ideas can occur at different levels of generalization and can be differently embodied in play. Finally, the content of play can have different degrees of stability, which reflect its subjective significance for a child.

In accordance with this, the idea of play was evaluated on the basis of the following components:

1. level of idea—the content of play, as described by the child (it can be a separate object substitution, interaction with peers, or a story)
2. detalization of idea—the extent to which a child reveals their idea to partners
3. implementation—how fully the idea is embodied in the child’s play actions
4. stability—the emotional involvement in playing.

This last component shows that the child has a subordination of motives. The significance of personal experience subordinates the playing actions and sidelines of play. Chaotic and unstructured play, by contrast, reflects the absence of a meaningful idea of play.

Thus, our analysis of play included the following components:

1. level of substitution (object, positional, spatial)
2. interaction (organizing and in play)
3. idea of play (the level, detalization, implementation, and stability of the play idea).

All play components were scored from 0 (total absence) to 4 (total presence). Play proceeds extremely dynamically, and, during observation, children have time to play many different plots and show all possible ways of creating play (e.g., experiencing both role-playing and organizing positions, and expressing ideas at different levels and with varying degrees of detail). Consequently, each parameter was given the highest score given the observation. For example, if a child substitutes many items by similarity, they would be scored 3 points, but if they then construct the object needed for play, then they would be scored 4 points for object substitution. The stability and the idea levels were

similarly assessed, while the criteria for the development and implementation of the play idea depended on the assessment of the level of the idea. Thus, if a role interaction took place (“I will be a pirate, and you are my prisoner; I captured you in battle”), then the score given was according to the level of detail (in this case, 3 points were awarded due to the planned chain of actions).

Based on the scores on the play components, a general assessment of the level of play was scored from 0 to 4 points.

Procedure

The observation of play was carried out in a playroom. The aim was to identify children’s ability to play independently, free from the offers of adults or the images embodied in toys. Consequently, no image-bearing toys were provided in the playroom. Among the materials offered to children were multifunctional, “open” materials: fabrics of different textures, a roller of cloth, clothespins, ropes, ribbons, rubber bands, logs and sticks, wooden rings, liners, chestnuts, cones, cardboard boxes of different sizes, and so on (Smirnova & Ryabkova, 2018). All of these materials were freely accessible.

Two or three children from one kindergarten group were invited into the playroom, and the researcher offered them to play while the adult pretended that they were preoccupied with writing. The observation period for one group of children averaged 40 minutes, during which children were video-recorded for the purpose of subsequent analyses.

Executive function measurement

The following methods are Russian versions of the subtests of the neuropsychological complex, NEPSY-II (Korkman, Kirk, & Kemp, 2007), based on the cultural-historical approach, and correspond with the cultural background of the sample (Cheie, Veraksa, Zinchenko, Gorovaya, & Visu-Petra, 2015).

Working memory

The Memory for Designs subtest measures the level of development of a child’s visuospatial working memory for novel visual material. The stimuli included four grids with four to eight colored designs on each (for children aged 5–6 years, we used Subtests 2–5 with four, six, six, and eight designs on the page). The child was shown a grid of designs for 10 seconds before it was removed from view. The child selects the designs from a set of cards (correct cards and distractors) and places the cards in a grid in the same locations as was shown earlier. For each trial, points were scored separately for the four parameters: 1) the Content score assesses the child’s ability to recall which designs were shown for each trial (2 points when child used the correct design, 1 point for distractor card, 0 points if the child did not place any card); 2) the Spatial score assesses the child’s ability to recall where a design was shown for the trial (1 point if a card is located in the correct place in the grid, 0 points if the correct place is empty); 3) the Bonus score reflects the child’s ability to recall which designs were in which locations for that trial (2 points when the correct card is placed in the correct location in the grid); and 4) the Total score for each trial is the sum of the Content, Spatial and Bonus scores. The maximum number of points varied across trials (max. 20, 30, 30 and 40 points in Trials

1-4, respectively), reflecting the number of designs that had to be correctly reproduced (max. total score = 120).

The Sentence Repetition subtest reveals the level of development of a child's verbal working memory. The stimuli included 17 sentences of increasing length and complexity. The child was read a series of sentences and asked to recall each sentence immediately after it is presented. The accuracy of the repetition of the sentence was estimated from 0 to 2 points (max. total score = 34).

Cognitive flexibility and inhibition

The Inhibition subtest allows assessment of the level of inhibitory control. The stimuli included rows of black and white squares and circles. The first task was naming: the child was asked to name the shapes on the page as soon as possible. The second task was inhibition: the child was required to name figures contrary to those actually depicted (e.g., say "circle" instead of "square"). The researcher then calculated three indicators for each task: 1) the number of self-corrected errors (max. 40); 2) the number of uncorrected errors (max. 40); and 3) the completion time of each task (max. 180 seconds in the naming task, and max. 240 seconds in the inhibition task).

The Dimensional Change Card Sort (Zelazo, 2006) is aimed at determining the level of cognitive flexibility. Children were required to sort a series of bivalent test cards (containing pictures of red rabbits and blue boats)—first according to one dimension (color), second according to another dimension (shape), and third according to a more complicated rule with an additional dimension (e.g., cards with/without borders that also required the use of the dimension from the first or second sort, respectively). The accuracy score for each of the series was then calculated (max. total score = 24).

Planning and control

The Compose a Story on a Series of Pictures test (Belopolskaya, 2008) is used to assess a child's ability plan. This task included the main stages of building a coherent utterance: orientation in the situation and its comprehension, construction of the utterance program, lexical and grammatical unfolding, and external speech. According to neuropsychological studies, these parameters are associated with the work of the third of three functional "blocks" of the brain, responsible for planning and control (Akhtutina & Pylaeva, 2012; Luria, 1962). When analyzing the results of this assignment, we assessed the ability to plan rather than the level of speech development.

In this technique, the child was shown three pictures in random order and asked to look carefully at them. The child needed to determine the sequence of events (to find the beginning, middle, and end of the story) and create a coherent story about what happened. Each child was presented with two different sets of cards. The evaluation was based on the correct order of pictures, semantic completeness, and the length of the stories (from 0 to 2 points). If the child independently and correctly determined the logical sequence of the pictures and created a coherent story, they were scored 2 points. If the child made a mistake in the sequence, but corrected the error (by themselves or with the help of an adult), or the story was sketchy caused the child difficulties, they were scored 1 point. If the child broke the sequence, did not understand errors, or the story

was reduced to the description of individual parts of symbols, then they were scored 0 points.

Procedure

Before play observation, the measurement of EFs was conducted in a setting familiar for children: a quiet room in the kindergarten building. All tests were carried out during two individual meetings with each child (each lasting 20–25 minutes).

Sample

The study took place in March–April 2017 and involved 56 children from three Moscow kindergartens who were between the ages of 5 and 6 years (the older group); among them were 29 boys (51.8%) and 27 girls (48.2%). All participants were monolingual native speakers of Russian and from middle-class families. The children's parents gave their written informed consent for their children's participation in the study. The study and consent procedures were approved by the Ethics Committee of the Faculty of Psychology, Lomonosov Moscow State University (Project No. 2018/27).

Results

Correlations between play components and executive function components

The correlational analysis allowed us to detect a correlation cluster, with the ability to compose a story being in the center (see Table A.1 in the Appendix). The ability to compose a story was significantly positively correlated with several components of play: object ($r = .636, p < .001$) and space ($r = .379, p = .019$) substitution; organizing interaction ($r = .425, p = .008$); and the stability ($r = .478, p = .002$) and level of the idea ($r = .485, p = .002$).

The level of object substitution was positively correlated with verbal working memory (Sentence Repetition subtest: $r = .350, p = .009$). Additionally, a correlation between the naming time in the Inhibition subtest and the detalization of the idea in play was found ($r = -.273, p = .042$): the less time a child spent on naming figures in the task, the greater their information processing speed and cognitive flexibility.

There were no significant correlations between play components the results of either the Memory for Designs subtest or the Dimensional Change Card Sort test. Traditional components of play such as role acceptance (i.e., positional substitution) also showed no correlation with the EF components.

Differences in play components between low and high executive function levels

As a result of the cluster analysis of the EF tasks, two groups of children were identified (using the K-means method): low ($n = 27$) and high ($n = 29$) EF. These two groups had no differences in the levels of verbal working memory or cognitive flexibility, but significantly differed in the levels of visuospatial working memory and inhibition (see Table A.2 in the Appendix).

It was found that children with high EF levels had significantly higher levels of positional substitution and detalization of ideas in play as well as higher general levels of play compared to children with low EF levels (see Table 1).

Table 1

Mean scores for play components in preschoolers by level of executive function.

Component	Level of EF, <i>M</i>		<i>U</i> *	<i>p</i>
	Low	High		
Positional substitution	2.00	2.69	246.00	.012
Detalization of idea	1.63	2.17	259.00	.022
General play level	2.70	3.41	276.50	.054

*Mann–Whitney’s *U* test.

Discussion

The aim of this study was to identify relationships between the main components of role play and EF in senior preschoolers. Here, we will first consider the results of correlation analysis between EF and play components, and then the features of play in children with high and low EF levels. Next, we will analyze the revealed relationships of each of the play components separately.

The correlation analysis showed that *the ability to compose a story* (i.e., the ability to analyze, plan, and control) was significantly associated with several components of play, including object and space substitution, organizing interaction, and the stability and level of the idea.

Object substitution was evaluated on the basis of the place occupied by the object in the child’s plot-making. The highest scores on this parameter were obtained by children who constructed the desired object in accordance with their idea—that is, independently creating the means of play. The independent productive activity that serves the goals of play is related to the ability to maintain connections—between the play action and the object necessary for play—to plan and develop the plot.

Space substitution in play implies the ability to differentiate the space and the ability to create and designate meaning zones, which is also associated with the ability to plan and control. In one example, a group of boys, making believe that they were ancient people whose lives were connected with hunting, fishing, gathering, cooking, and night rest, divided their space into a forest, river, cave, and a fire (apart from housing). Such a complex composition of actions and unfolding of plot requires the presence of an internal plan for the division of space into semantic zones—a complex space substitution.

The organizing interaction of play was evaluated on the basis of how much children managed to reconcile and combine, in play, the different (sometimes opposite) intentions of the players. For example, one girl wanted to “play grow up,” while the other pretended to be Fay Winx (a fairy character): they conflicted because of the choice of the theme of play. One of them considered how to combine both desires: “Mom will put her daughter to sleep, and fairies will come to her in a dream, so she too will become a fairy.” Thus, the

need to discover the connection between individual actions is directly related to the ability to imagine a story for playing together. Both situations require the development of an internal plan of action.

The level of the idea is also related to the ability to compose a story. A simple renaming of an object does not involve a story behind it, nor does the renaming of a role. At the same time, for interpersonal interaction, a common field of activity that sets the tone for this interaction (e.g., the roles of doctor and patient assume that someone is sick, and the plot is built around this premise) is needed. The circumstances that are proposed require a child to be able to control actions in the game.

Finally, the connection between the ability to compose a story and the *stability of the idea* seems particularly important because it reflects the ability to retain the general context of unfolding events and to build an integral plot. Conversely, it also reflects the subjective significance of the play idea, which the child preserves for a long time. It also generates the internal image (the integral representation in the internal plane), which allows children to maintain the integrity of the situation and read their meaning in the proposed tasks. The connection identified in this study (between story composition and idea stability) may indicate that play reflects and manifests not only intellect and fantasy but also the significant motivations of the child, which are retained, objectified in playing actions, and subordinate to their situational momentary motivations. Vygotsky emphasized that the beginning and source of play is not individual desires but “generalized affects,” and such affects produce stable ideas, internal actions, and images—that is, imagination (Vygotsky, 2004). Conversely, when the affective sphere is underdeveloped, play does not develop (Vygotsky, 2004).

It could be predicted that the level of object substitution in the preschoolers’ play would be positively correlated with verbal working memory. The basis of object substitution is the separation of meaning from the object; that is, it is always mediated by the word. The highest ratings for this parameter were obtained by children who designed the desired object or used substitutes for similarity. Low scores were given to children who used the object in accordance with their direct function (e.g., a stone as a stone, a band was tied on the hair). In both cases, children are required to keep the meaning of the word in working memory and establish meaningful connections.

Comparison of the development of play components in children with low and high EF levels brings additional information about the connection between play and EF in preschool age. We found that the level of positional substitution was higher in children with high EF than in children with low EF. This can be interpreted as indicating that children with a higher EF level are better able to imagine themselves in the role of another person or character and to follow it. Positional substitution is considered to be of greatest importance for play development (Elkonin, 1976; Vygotsky, 2004).

Additionally, children with a high EF level had higher *detalization of idea in play* (that is, explicitly stated by one child to the play partner) than children with a low EF level. Our observations show that children with high EF levels discuss the next step in their play with their play partner (e.g., “Let’s play like you’re crying?”), while children with low EF levels express their ideas tersely (e.g., “We have an accident,” “I’m a princess”). This component of play therefore reflects a child’s ability to plan the play and the behavior in general.

Furthermore, children with high EF levels also had a higher *general play level*, which confirms the assumption of a connection between EF development and play in preschool age and is in agreement with the results of previous studies (Fantuzzo et al., 2004; Ivrendi, 2016; Mikami, 2010). Thus, these results suggest that role play is an important activity for developing the arbitrariness of children's behavior in preschool age (Elkonin, 1976).

Knowing of the effectiveness of role-playing for the development of EF of the child means that it can be actively used in the educational process in kindergartens. However, the daily routine in Russian kindergarten leaves only 20-minute intervals for free play between other activities, which is not enough for its full deployment. It is also important to change the attitude of the teacher to children's play: many educators limit the activity of children or make many comments, which also hinders the development of free role-play in kindergarten.

Limitations and future directions

This study did not take into account the composition of children's families (e.g., the number of siblings), the characteristics of child–parent relations, playing preferences, or the habits of children (e.g., the frequency of use of video games), which could influence the development of play.

In terms of the procedure for monitoring play, it is important to note that, when compiling groups of children for observation, friendly relations between them were not taken into account. It can be assumed that, had the children been put into groups with close friends, the play of individual preschoolers might have developed differently. It is also worth noting that “open” materials may not always encourage children to develop pretend play, and a potentially more successful option for observation would be the use of costumes that allow children to play different roles (Smirnova & Ryabkova, 2018).

Conclusion

Our study showed a significant relationship between the level of play development and EFs in preschool children, which shows the importance of children's play at preschool age. The ability to plan and control one's own behavior is most pronounced in play of senior preschoolers, which is expressed in the embodiment of a complex, detailed plan of play, successful interaction with peers while playing, and the active use of substitute objects. Thus, our study shows that a high level of EF development is related with high level of play, and this makes possible the assumption that play is related to the development of EF.

However, we can acknowledge that a role play, in its traditional understanding by Vygotsky, generally ceases to be a leading activity in senior preschool age. Formal learning tends to be presented in a massive way for children starting from the age of 5 years, which takes away the time needed for free role-play. At this time, the spontaneous development of the play becomes increasingly difficult, and the development of play requires adult facilitation. It is necessary to pay attention to how communication between children is organized: is there enough time for it, do children have materials for role play (e.g., costumes), and do they communicate with each other directly rather than only

through a teacher? Conversely, a teacher can organize role-play activities for children and use play methods in education instead of traditional learning activities.

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Appendix

Table A.1

Significant relationships between aspects of role play and children's tests of executive function.

EF component	Organizing interaction	Substitution level		Idea		
		Object	Space	Level	Detailization	Stability
Verbal working memory		.350 (.009)				
Inhibition					-.273 (.042)	
Planning	.425 (.008)	.636 (<.001)	.379 (.019)	.485 (.002)		.478 (.002)

Note. Values refer to Spearman's r , with p values in parentheses. Only significant results of the correlation analysis are shown. Verbal working memory as measured by the Sentence Repetition subtest; Inhibition, by the Naming subtest (time); Planning, by the story composition subtest. EF = executive function.

Table A.2

Cluster analysis results of executive functions indicators

Indicators	Level of EF		U^*	p
	Low ($n = 27$)	High ($n = 29$)		
Working memory				
Visuospatial	59	97	32.00	<.001
Verbal	21	20	316.50	.217
Cognitive flexibility	19	19	338.50	.382
Naming				
Uncorrected errors	1.1	0.5	248.50	.009
Time (seconds)	52.5	42.7	213.50	.003
Inhibition				
Uncorrected errors	5.9	1.9	219.00	.004
Time (seconds)	72.7	58.8	191.50	.001

Note. Visual working memory as measured by the Memory for Designs subtest; Verbal working memory, by the Sentence Repetition subtest; Cognitive flexibility, by the Dimensional Change Card Sort subtest (total score). EF = executive function.

*Mann-Whitney's U test.