RELATIONS BETWEEN CHILDREN'S SPATIAL THINKING AND THEIR LINGUISTIC AND COMMUNICATIVE SKILLS

ANNA GUZY* & BERNADETA NIESPOREK-SZAMBURSKA*

**University of Silesia, Poland*

Abstract

In this review we attempt to indicate the relations between the level of children's spatial thinking and their linguistic skills (producing texts, connected with a description of a picture and giving oral instructions).

After introducing theoretical findings connected with the development of competences we present our own research among children aged 5-10.

To show the dependencies between the spatial and linguistic competence of the children we conducted two quasi-experiments. The first task for the children involved producing a description of the arrangement of bricks presented in a picture. In the second one the children were to produce oral instructions which allowed the interlocutor to build an arrangement of Lego bricks (dynamic system).

In results there are shown the analysis of the linguistic expressions used by the pupils to describe the spatial relations in the static description and analysis of the noticed dependencies between the spatial and the linguistic (text-creating) competences. The same order is provided during the analysis of the texts produced by children giving instructions in a dynamic situation.

Conclusions from the conducted research confirm the existence of significant dependencies between the spatial competence and the linguistic skill (including creating texts) of children.

Keywords: spatial thinking, linguistic competence, linguistic skills, text-creating competence, child language

Guzy, A & Niesporek-Szamburska, B (2013). Relations between children's spatial thinking and their linguistic and communicative skills. Contribution to a double special issue on Early literacy research in Poland, edited by Elżbieta Awramiuk and Grażyna Krasowicz-Kupis. L1-Educational Studies in Language and Literature, vol. 13, p. 1-28. http://dx.doi.org/10.17239/L1ESLL-2013.01.08

Corresponding author: Anna Guzy. Philological Faculty, University of Silesia. Pl. Sejmu Slaskiego 1, 40-032. Katowice, email: anna.guzy@us.edu.pl

1. INTRODUCTION

Space is considered to be the basis of any experience(Levinson,1992). Imagining anything without the lengthiness or position in the space is not possible. Therefore, the acquisition of skills on perceiving objects in space is so important for children's cognitive development and therefore it is also relevant for the development of their language.

The relations between skills of organizing space and specific linguistic competences were already sought for in the 1950's (see Geppert, 1966; Piaget & Inhelder, 1967). They are based on more general, well-known theories about how language affects thinking (see Whorf, 1956; Genter, 2003; Bowerman & Choi,2001). Perhaps we think and reason more efficiently about a concept when we have a word for it. And there is some experimental evidence suggesting that spatial tasks have some impact on language. In Poland the influence of spatial imagination on vocabulary of pupils was studied by the squares test[1] Edward Polański and Krystyna Duraj-Nowakowa. The research conducted by them revealed that persons with a higher level of spatial imagination were characterized by a bigger vocabulary (thus a better knowledge of vocabulary referring to spatial relations and a better skill of using collocations). Due to the above the spatial imagination was considered the determinant of pupils' vocabulary (see Polański & Duraj-Nowakowa, 1978: 191). More recent studies indicate that young children easily perform spatial tasks when we give them spatial words to use (Loewenstein & Gentner, 2005). It also turned out that children who listened to the linguistic spatial expressions and tried to copy spatial terms in the language, had higher scores on spatial intelligence tests (Pruden, Levine, & Huttenlocher, 2011).

Linguists', teachers' and psychologists' searches and conclusions have also inspired our own researches conducted in 2008-2009 on a bigger group of children (among 600 younger pupils in urban, rural and housing estate environments) on mutual dependencies between linguistic competences (in producing long written works on a given topic) and spatial competences (imagination and spatial orientation). The research results confirmed the existence of statistically significant dependencies between the spatial and linguistic competences (Guzy, 2010; 2012).

The children know quite a lot about the space, before they even start talking, even though the issue of the spatial competence itself in the subject literature of psychology, pedagogy and didactics is ambiguously described. It is not completely

[1] *Squares test also called Figures Test of Rybakov was a common diagnostics tool evaluating the level of spatial imagination. The test is based on dividing a polygon (it is usually an irregular polygon) by a straight line into two parts in such a way that after being rotated they can be folded into a square. The line of division should alternately join two numbered points on the edge of the figure (see Geppert, 1966: 102-109, Polański & Duraj-Nowakowa, 1978: 172-192).*

clear how a child becomes familiar with space (see Kielar-Turska, 1989). In the second half of the 20th century Rene Zazzo claimed: "to orientate in space means to know directions: left-right, top-bottom" (Zazzo, 1974: 7). It is believed that there is a close relation between the body scheme and the spatial orientation since the spatial orientation occurs in the body scheme, which is spatially organized (left-right, front-back, top-bottom) (see Roberts & Aman, 1993; Głodkowska, 2000). The spatial orientation is defined as "the body's control towards the environment in relation to places, things and people: being aware of sizes and shapes of the surrounding space and the sizes, shapes and arrangement of objects placed in it" (Mihilewicz, 1999: 39). Moreover, "the image of the body is also created because a child better and better understands the spatial relations between his/her body and the elements of the environment" (see Roberts & Aman, 1993; Mihilewicz, 1999: 29). However, Edyta Gruszczyk-Kolczyńska writes about a big uncertainty of creating these relations: "we only know that there are various ways and methods of learning and there are certain rules according to which the knowledge of space is created in a child's mind" (Gruszczyk-Kolczyńska & Zielińska, 2007: 14). Cognitivists add that on the grounds of mental images the image schemas are formed – the foundation due to which in early childhood physical phenomena can be understood (Mandler, 1992). Numerous experiments with children confirm that they can realize abstract relations between various sensory data (visual but also kinaesthetic ones and purely spatial representations), which confirms the role of image and spatial schemas (Libura, 2000).

When a child works out a body schema various structures are involved: peripheral nervous system supplies sensorial and other stimuli, such as superficial and deep touch(proprioceptive), feeling movement (kinaesthetic), feeling pain, stimuli from auricular system (which also affect the condition of muscle tension) as well as sight and hearing impressions. The image of all these types of stimuli and their proper influx from the environment conditions the development of the image of ourselves, which functions inside us"(Mihilewicz, 1999: 35).

A child gradually orientates in space. The period from the birth until the age of about one and a half is the time when he/she begins to understand that he/she exists as a separate element and may distinguish himself/herself from other things and people. In the very beginning the child formulates space on level zero, observes certain dependencies and then attempts to imitate them by movement and actions. Then he/she can distinguish between scenes and categorize them on the basis of spatial information such as above–below (Antell & Caron, 1985; Quinn, 1994; Bowerman & Choi, 2001) and left–right (Behl-Chadha & Eimas, 1995) within the first few months of life. Gradually he/she creates his/her own separateness (see Roberts & Aman, 1993;Głodkowska, 2000). "First the child creates the sense: This is me. This is how I look. I have my name. I know what the parts of my body are called." (Gruszczyk-Kolczyńska & Zielińska, 2007: 14). At six-year old children concepts related to the spatial relations are already very well developed. They can perfectly specify the location and direction of moving objects. They cope much faster

with support and containment relations(expressed by the prepositions: in, on) rather than with proximity and nearness relations. The researchers explain this with more clear distinctness of linguistic and conceptual categories which include the first two relations (see Aguiar & Baillargeon, 1998; MacLean & Schuler, 1989: 23; Plumert & Hawkins, 2001: 36)[2].

The development of spatial relations is reflected in the language of the child. In the formulation of cognitive methods for recognizing qualitative relations: relations of subjects locations and describing directions depending on age are already emphasised in kindergarten syllabus (see syllabus comparison presented by Edmund Stuckias a Table 1.). Outside the chart there are dynamic designations connected with the change of objects location and their transformation, such as (*rotate*, *direct*, *turn*), double locations *(on the right hand top)*,necessary when defining space in an event (see Cannon, Levine, & Huttenlocher, 2007).

Table 1. Cognition of qualitative relations by a child

	Acquiring skills of using words describing:	
3-year old children	location of objects in space: on, under, behind, low, high.	direction: forwards, backwards, up, down
	Distinguishing, comparing, naming:	
4-year old children	location of objects in space: between, higher-lower, far-near, further-nearer	direction: ahead, behind, aside
	More precise distinguishing, comparing, naming:	
5-year old children	Location of objects in space: in relation to each other, on the right, on the left, opposite.	direction: to the right, to the left
6-year old children	Developing concepts concerning the location of a subject in space in relation with other objects or in the absence of system of reference and developing the skill of using appropriate designations:	
	location: on, under, outside, next to, between, higher, lower, far near, further, nearer, on the right, on the left, to the right of, to the left ofopposite, inside, on the edge, outside	direction: forwards, backwards, up, down, ahead, behind, aside, to the right, to the left, forwards.

The stage of a child's egocentrism is an important period of developing spatial orientation (see Piaget, 1962). It is the time when a child willingly speaks to himself/herself, he/she uses geometric and nongeometric information describing objects and persons in his/her surrounding, which favours the development of con-

[2] *"Support as well as containment has important functional consequences for how objects interact with each other; that is when a ball (= object) is in a bag (= container), the ball moves when the bag is moved" (see Schneiderheize, 2004: 7).*

cepts of our interest. A child undergoing the stage of egocentrism does not consciously use elements of space, however, he/she gradually prepares himself/herself to move to decentration. It is only in this stage when the child begins to see the world through the eyes of another person. Gruszczyk-Kolczyńska says: „a child slowly realizes that another person is similar to him/her […] and functions in the same environment[…]. When an adult stands next to a child and they look ahead, they see objects in a similar way. However, if one of them turns back, they see different things" (Gruszczyk-Kolczyńska & Zielińska, 2007: 15). In this stage children cannot explain how to get from point A to point B. Before they develop spatial language, children form representations of the geometry of the stable environmental layout, which is used for reorientation; as well as of the nongeometric properties of objects and surfaces in the layout, which is used for finding displaced or hidden objects (see Spelke & Tsivkin, 2001). The breakthrough in the space orientation development is school education, including learning to write. The child gradually develops knowledge of orientation assisted by teachers, by means of tools and experience.

To sum up the considerations regarding the development of spatial orientation let us emphasise that a child learns mainly through experience, senses (touch, his/her own movement) and observations. Upon getting to know space and spatial language he/she will be able to determine the position of object in a new wayand to describe properly particular spatial relations. Before this happens the child will attempt to use the language in a manner consistent with his/her development, knowledge and experiences.

2. METHODOLOGY

The main object of the conducted quasi-experiments was to answer to the question about the influence of spatial thinking on linguistic competences, including text creating competences among children aged 5-10 as well as to determine linguistic means which the examined used to name spatial relations. In order to answer the above questions we conducted two research tests: in the first one the children were to describe a picture with bricks (see Picture 1), and in the second test the pupils instructed another person (a friend, sometimes parents) how to arrange the bricks. The purpose of the first test was to show how children deal with describing spatial relations (e.g. spatial features and properties, shapes of blocks, locations and directions) in a static description and the second one aimed to determine spatial and linguistic competences of a child in a dynamic situation (e.g. in transformations and pointings)[3]. The test also evaluated text formulating competences of the children in giving instructions and their ability to adapt the language to recipients needs (in oral verbal interaction). We decided that the children were

[3] *The second task was based on Wechsler's test (The Block Design Subtest Form the WPPSI-IV, Wechsler, 2004).*

representative for their group if they could understand the topic, they were able to adjust to the pragmatic background (understood the purpose, used appropriate linguistic forms, modified their utterance depending on the recipient and his/her reaction), constructed utterance structure in harmony with the form of instructions (appropriately divided the text: verbally determined the order of the recipient's actions in conformity with the pictograms, reacted to wrong performance, gave the text an appropriate delimitative frame, see Tabisz, 2006)[4].

For our examinations we chose none of many ready-made tools for the measurement of visuospatial abilities[5], although they may be helpful in assessing the competence of the spatial test. However above all they are used for a psychological or pedagogical individual diagnosis and can't be used for the evaluation of particular abilities. Majority of them do not have standards adapted for younger children. Our aim was to describe the relationship between language skills and the ability to naming of spatial relations, which is treated as a manifestation of spatial competence (spatial thinking) of the child. Our research therefore focuses on language skills(language and communication skills), while the second task involved the spatial efficiency as well. Since there are pieces of evidence from experimental studies indicating that the use and cognition of spatial language affects the spatial orientation (Feuerstein, 1980; Gentner, 1988; Szechter & Liben, 2004; Loewenstein & Gentner, 2005), in our research proceedings we are examining spatial thinking of pupils through measuring *the efficiency in understanding and naming spatial relations*.

These quasi-experiments were to answer the following research questions:

1) What is the level of spatial thinking of the research group and what linguistic means do they use to describe the spatial relations.
2) What is the level of text-creating competence of children as regards description and giving instructions?
3) Is there a difference in the level of the analyzed competences between genders and age?
4) Do the examined children modify their instructions depending on recipient (a person of the same or different gender, a person older or younger)?
5) Is there a dependency between the level of the spatial and the text-creating competences of the examined children?

---

[4] *Initially the children who could write were additionally asked to create a written instruction for their friend to construct a proper system of bricks. This task was too difficult for younger children, so it was aborted.*

[5] *E.g.: The Marianne Frostig Developmental Test of Visual Perception (Frostig, 1964; 1966); Raven's Progressive Matrices – Classic Form (RPM-C); Tests for the School Maturity (Wilgocka-Okoń, 1972); The Wechsler Intelligence Scale for Children – Revised Edition (WISC – R, see Wechsler 1974, 2004); Figures Test of Rybakov (Geppert, 1966).*

3. RESULTS AND DISCUSSION

3.1 *Describing spatial relations in a static description and a text-creating competence*

The participants of the first test were 26 pupils aged 9-10 (14 girls and 12 boys) attending form 3 of a primary school.

Picture 1. Description system.

The children were given the following instruction:

> Try to describe as precisely as possible what you can see in the Picture. Take into account all elements and emphasize their position to one another[6].

The time for this task was unlimited and the pupils could describe the Picture for as long as they wanted. It usually took them 3-5 minutes[7].

[6] *The instruction, intentionally, did not indicate what the pupil should emphasize, i.e. for instance describe the distance between the elements, what is located on the right, left, over or under, etc. This would have suggested the performance. The test was conducted in one form 3 in Dolnośląskie Province in May 2012.*

[7] *The pupils indicated whether they were left- or right-handed. All participants were right-handed.*

Table 2. Results of test 1

Feature	*Girls*	*%*	*Boys*	*%*
A – naming 4 main elements (a well, a piglet, a dog, a "man" with a shovel) without their description and using spatial denominations (about location), i.e. at the top, at the bottom, on the right, on the left, near/next to.	7	50,00	5	41,67
B – naming and describing 4 main elements (a well, animals, a "man"; shape, colour, size), no spatial denominations.	3	21,43	2	16,67
C – naming and describing 4 main elements (appellative, shape, colour, size) and using spatial denominations (about their location, i.e. at the top, at the bottom, on the right, on the left, near/next to).	2	14,29	2	16,67
D – noticing 1 or 2 elements and using spatial denominations about their location.	1	7,14	2	16,67
E – noticing only the superior category – naming the hypernonym (Lego bricks).	0	0,00	1	8,33
F – naming the main category and expressing an opinion about it.	1	7,14	0	0,00
G – failing to perform the task.	0	0,00	0	0,00
Respondents' number	14		12	

As we can see more than 61% children managed to describe the spatial relations in the static situation (categories A and C), the girls did much better (over 64%). Most often the pupils described the nongeometric properties of elements (Spelke, Tsivkin 2001), and they did it rather precisely (categories A and B), e.g.:

> *I can see a dog, a **small** piglet, which is pink, and the dog is black and I can see a man who is holding a shovel and a big well. And there is a bucket **at** the well, which has a roof* (boy, aged 9).

The described elements were also evaluated as for their value for the recipient, e.g.:

> *There is a **nice man** over the dog. He is wearing a **cool hat** on his head and holding a shovel in his hand. Next to him there is a well. At the well there is a pink piglet. Over the pink piglet a brown and **cute doggy** is playing […].* (girl aged 9).

More seldom (particularly in the boys' texts) the descriptions contained information about the positions of particular elements to one another:

> *The man made of Lego bricks is holding in his **left hand** a shovel and he is standing **behind** the horse, **next to** the well. The pig is standing **next to** the horse and **in front of** the well. The well is **next to** the man and **behind** the horse and the pig. The horse is **in front of** the man and **in front of** the well and **next to** the pig*(a girl, aged 9).

From the description of the spatial relations used by the girl we can see that she accepts the strategy of the point of reference. She chooses an element in relation to which she describes the objects. It should also be noted that that she applies a double location of the objects, places the elements in relation to more than one object. 50% girls revealed such an ability and over 41% boys (category A). Con-

sistent with prior research, our results revealed that the spatial configurations used by children became more complex with the age (e.g. they used double locations; see Craton, Elicker, Plumert & Pick, 1990; Schneiderheize, 2004).

This part of the examined group most often started their job by noticing the dog (also identified as a horse) – the element in the right bottom of the Picture. Thus, they perceived the spatial arrangement and applied a certain order to it. The examined children (especially the girls) often determined the size of the described objects. They indicated whether the element was high, short or medium size, which also proves a significant competence in the spatial thinking. Some of them confirmed their competence by additionally determining the size of the objects in comparison to one another, e.g.:

> In front of the cute dog there is a brand new well from which the man takes water for the dog and the pig to drink. *The well is tiny just like the animals*, I mean the pig. (a girl, aged 10).

It is also worth looking at expressions used by the research group to describe the spatial relations in a picture. They have been shown in Table 3.

Table 3. Linguistic means describing spatial relations used by children

Used expressions	Girls	Boys
next to (X is next to Y)	26	17
near X	10	7
in the right, in the left hand (has, is holding)	10	6
X is small/big/tall/short/medium size	11	3
on (head, back)	9	0
over X (over it)	7	5
behind X	3	7
under X (under it)	0	5
in front of X (e. g. There is a dog in front of the feeding trough)	2	4
lower/ higher than X	2	4
on the top/on the bottom	2	0
N= frequency of occurrence of the used expressions	82	58
Number of the used expressions	10	9

As the Table shows, the children relatively often used expressions referring to spatial relations. In descriptions of a static system the children mostly used name verbalizations (prepositional phrases describing contiguity and support (e.g. *on*), occlusion (e.g. *under*), proximity (e.g. *next to*, *beside*) and relations along horizontal axis (e.g. *in front of*, *behind*). We can observe significant differences within a gender. The girls used 82 various expressions while the boys only 58 (the number of the used expressions was approximately the same: 9-10).

Ten children's descriptions end in a general after-thought, e.g.:

I like playing with these bricks,

or information that they are dangerous:

These bricks are used to play a farm. They are small and dangerous for children under 3 years of age, because they may swallow them (a girl, aged 10).

It happened in the works of children who skilfully described the spatial relations.

Such verbal behaviour shows a high text-creating competence (in the scope of a description), which already suggests a mutual dependency between the linguistic competence (text-creating) and the spatial thinking. The high skilfulness occurred in over 61% of the group of 9-10-year-olds (over 64% girls and over 58% boys).

3.2 *Spatial thinking versus text-creating competence. Describing the spatial relationships while giving oral instructions (in a dynamic situation)*

The participants of the test were 9 pairs of diversified gender and age (see Table 3). In single situations adults participated in the interactions, so that we could determine how a child constructs his/her utterance to recipients of different age. Among 16 children, who participated in the test, there were 9 girls (inc. 4 – in a role of the instructor) and 7 boys (5 in the role of instructors). 6 children represented kindergarten age (2 in the role of instructors) and 10 – early primary school age (7 in the role of instructors).

Table 4. Diversity of gender and age of the participants

No.	*Participants of the interaction, relationship*	*Age of the participants of the interaction*
1.	Mateusz – Zuza (siblings)	7 – 5
2.	Mateusz – Ania (son-mother)	7 – 34
3.	Tomek – Grzegorz (friends)	10 – 9
4.	Tomek – Gosia (siblings)	6 – 5
5.	Milena – Marysia (siblings)	8 – 5
6.	Marysia – Wiktoria (siblings)	9 – 10
7.	Wiktoria – Tomek (daughter-father)	10 – 38
8.	Marysia – Magda (friends)	5 – 10
9.	Kuba – Marta (siblings)	10 – 6

The participants' task was to give instructions how to arrange bricks (in an oral form) in conformity with the given instructions. One person in a pair received the instruction how the bricks should be arranged (in a Lego set, see Picture 2.). His/her task was to instruct, as precisely as possible, the person who was arranging the

bricks on how to place the successive elements and arrange the whole spatial set (see Picture 1.). The child-instructor was also asked not to use the words suggesting the addressee that the elements are not properly arranged. If this was the case, the child-instructor should give more precise instructions – until the required arrangements of the elements was achieved[8]. The recipient's task was to arrange the bricks in accordance with the instruction (they were allowed to ask for details of placing the elements, however, not to ask for verification of the correctness of the arrangement, e.g.: *did I do it right*, *is it supposed to be like that?*).

Picture 2. Instruction.

The children's utterances were recorded on a dictaphone or a video camera. The average time of performance was 7 minutes.

The task was not easy, because the children had to overcome some difficulties. The first one was to define the elements because some components of the set (types of bricks) were not objects known from the environment and the look of the others might have different associations (a figure: dog/horse/wolf). Another prob-

[8] *In practice, it turned out that the children almost immediately said that something was arranged wrongly, but they tried to give the instructions again to correct the arrangement.*

lem was the apprehension of the spatial system during the construction, it means a dynamic system developing in space. Finally – the children most often not knowing formal instructions determinants were to adjust their oral interactions in their form. Let us see how the children dealt with the performance of the task.

3.2.1 Spatial competence (thinking)

Describing spatial relations

While giving instructions the children applied various linguistic constructions to orientate in space: both prepositional phrases, adverbial phrases describing the distance and direction of movement, ordinal numbers and verbs of movement (see Table 5).

Expressions used by the children when giving and receiving instructions were much more diversified than in the static description of the system (though there the authors were children aged 9 and 10). In the texts of all interactions (when giving instructions) 37 various expressions connected with positions in space occurred. And although both girls and boys showed significant skills, the boys better expressed instructions by making their utterances precise and changing their forms if the recipient did not follow the instruction properly. In case of difficulties they also they more often applied double coding (see Paivio, 1986). The boys' instructions expressly reflected their richer spatial experiences. In describing spatial relations older children did better. The level of appropriate verbalization and proper reaction to it was about 50% for all the children.

Table 5. Expressions and phrases describing spatial relations used in oral instructions

Describing spatial relations (dynamic) in a language	*Girls*	*Boys*
on X	*Put it **on** the third **brick, on** the other this **brick***	*Put it **on** the third **spot**.*
in front of X	***In front of the piglet** put a green element*	*Put it **in front of the boy.***
next to/near X	***Next to the bucket** put the man.* *Now also put the red one **next to the green one**, the green one.*	*Put it **next to the farmer.***
facing/ rear side to X	*Now put it **opposite you**.* *Put it **opposite me**.*	*Put it **opposite the pig**.*
up/ down, at the top/ at the bottom	*Now take the red roof and attach it **to the top**; the shovel **down** a little.*	***At the top** from the right side on the second spot, after the one **at the bottom** from the left.*
lower/higher	*Turn the shovel **lower**, yes, down, so that he can stand.*	*No, put it, **lower.***

closer/ further (*move closer*, *move further*)	*Move it* ***closer****, that much.*	***Put it further*** *there.*
using numerical pronouns (e. g. *a little*, *this much*)	***A little*** *close, that much.*	*Just* ***a little****, that much.*
put *sideways/ aside to X* *on the right/ left side*	*Put it* ***sideways from*** *him.* *Put the dog* ***on the left .*** *Which one is* ***l****eft side*	*Turn this bucket* ***aside****.* *Put the dog* ***on the right.***
rotated/ turned *right/ left*	*And put the roof* ***to the left****.*	*You put it next to this, just on the* ***right****, turned* ***right****!*
position in relation to objects: *there where X is, the* element X towards element Y, *towards X*	*Put it* ***there where the pig is.*** *Just turn the pig* ***towards the apple*** *and that is it…*	*Put it* ***there where you have*** *this* ***brick.*** .
position in relation to persons (participants: instructor, recipient and third parties)	*Put it* ***opposite me.***	*Put it* ***on the side where daddy is.****.*
giving two and more instructions concerning placing the object (precise location)	***On the top right and the second from the left.***	***At the top from the right, on the second place, after the one at the bottom from the left.***
counting the order of the elements: *to the second, to the third X*	*Put it* ***on the third*** *brick*; ***On the second*** *this brick on the left*	*Put it* ***on the third*** *spot*; ***On the second*** *spot*
using verbs changing spatial relations: *rotate, turn, exchange with*	***Turn*** *the bucket.* *No, the pig* ***must change with the dog,*** *the apple must also* ***change ….***	***Turn*** *the wolf.* *Also* ***rotate****…*

3.2.2 Text-creating competence – producing instructions in interactions

Strategies applied to describe components

When beginning to give instructions the children had to deal with the elements of which the construction consisted. The kind of chosen strategies expressly depended on the child's gender (see Table 6).

As the examples in the Table indicate, the boys' strategies – regardless of their age – in descriptions of construction bricks are richer. The girls' verbalizations only refer to the sight perception (with the use of geometric and non-geometric properties of objects, see Spelke & Tsivkin, 2001)while the boys' linguistic strategies also include movement and touch. The boys more often use their previous spatial experience.

Table 6. Denominations used to describe single elements of the construction: Strategies of describing components of the construction

Type of brick	*Girls*	*Boys*
Foundation brick (ob long yellow)	- describing colour and shape: - describing just colour, - describing just shape, - describing colour and shape: *Such flat brick, a cream one, flat cream brick*	- describing the function of the brick in the whole construction: *foundation rectangle* - describing colour and shape (in details): *yellow brick with eight points*
small green and red bricks	- describing colour, shape and size: *a green element*, *two green bricks and one red, you must take a green brick, a small one.*	- referring the denomination to the surrounding and interests (e. g. bricks are lights): *now take the green and red light* - describing the colour and shape of the bricks: *green and red bricks*.
Elements hard to describe for the children (black brick -roof support)	- describing the colour of the elements or comparing it to familiar objects: *Now take this something black*; *Attach a black pipe to it.*	Younger boys: - omitting the name of the element in the description, describing its location: *you take the red roof and put it on that which you placed on the right eye.* Older boys: - describing the colour of the element and referring to familiar objects: *take a black pipe.*

Also when naming (defining) categories of figures occurring in the construction we can observe certain differences in girls' and boys' verbalizations (see Table 7).
When giving instructions the children describe the elements very superficially, in accordance with the needs of the communicative event. When naming non-standard elements, which can be variously identified and named, we observed variety depending on extra-linguistic experience and the child's imagination. Thus, the construction with the red roof is called by the girls *a summerhouse* or *a stall*, and by the boys *an animal feeder* or *a cowshed*. However, the principle of family similarity (Rosch, 1977) enables the recipient a proper recognition of the component. In case of defining standard elements, i.e. animals or a brick man, there are no differences in naming them within a gender. The children describe these elements with little precision, just naming the animal species, sometimes the colour or the name of a man – in accordance with their own image schemas. This strategy is justified, because the animals occurring in the construction are typical (a dog and a piglet) and it would be hard for the recipient to mistake them. For instance, naming

the figure of "a dog" draws on various instructor's image schemas (*horse*, *dog*, *wolf*), and the recipient properly recognizes the figure because the instructor precisely defines the colour. The Lego man does not require more precision in the description. He is a single "human" element in the puzzle, so the addressee has no opportunity to mistake it with another object. The children-instructors probably decided that it is unnecessary to describe it precisely. However, the very names given to this figure (*farmer*, *countryman, chipek* [a neologism]) reveal various event (spatial) experiences of the children, reflected by the language.

Table 7. Defining ready figures occurring in the construction

Construction element	*Girls*	*Boys*
Main element (a construction with the red roof)	stall summerhouse	animal feeder cowshed
Animals	Regardless of gender: brown horse/ dog; horse, dog, wolf; pink pig	
Man	Regardless of gender: farmer; man; chipek [a neologism]; countryman	

Strategies of giving instructions

In Table 8we present basic strategies of giving instructions which the participants used.

Table 8. Strategies used when giving/producing instructions

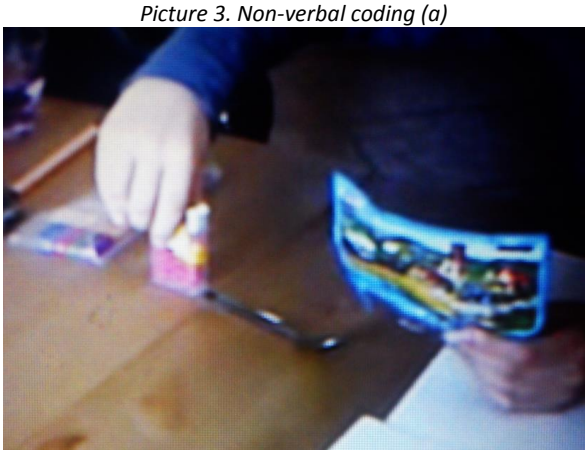
Applied strategy	*Examples*
Modification of given instruction depending on age (the younger the recipient the more precise the instructions).	(1) *Take the foundation, a big cream brick and put it on the table in front of you.* (2) *Take a big cream brick.*
No copying effective ways of providing information heard from other people in case of older children (over 7)	(6) *Now put in front of you an oblong yellow brick with 8 convex beads and then find two green dots and one red one. The red one should be in the bottom row in the second place from the right, above it at the top the green one and at the bottom on the left side from the red one another green one (slantwise from the one in the top row).* (7) *Attach 2 green and one red dots to the yellow brick, two at the bottom and one at the top.*
Copying effective ways of providing information heard from other people	(5) M arranges bricks, Mi gives instructions: [Mi]: *It must be a circle. The piglet must be* ***a kind of a circle****.*

in case of younger children (under 7)	(8) M gives instructions [M]: *And put this farmer next to the basket.* ***He must be in a circle like that****. I can't say that*.
Providing information in an abbreviated manner, not precisely (not precise description of the position where bricks should be placed, not knowing words the spatial relations).	(2) Mother is unable to arrange the bricks properly. The child does not inform her so she asks for it herself: *But where should I attach this brick, on the right, on the left at the bottom or at the top?* ***You must tell me more precisely****!*
Correcting wrong utterances regarding the spatial information about an object	(3) *You must put it* ***on the left****! I mean no,* ***not on the left****, on the right,* ***I got it wrong****!*
Moving to partly nonverbal coding (pointing, especially by younger children) when there are difficulties in describing shapes of the objects or in their descriptions	(5) *Now take* ***this something*** *and put it* ***here****!* (1) *Now take the thing and* ***put it here****!*
Correcting utterance if the instructions given are ineffective.	(2) *You take the foundation, you take a green circle and put it on the top on the second position from the right, under that at the bottom from the left, at the bottom you place a red brick on the 2 position next to the red one, which you had put, you put another green one, on the left!* ***But the bottom one****!* ***On the left****! Right!*
Repetition of instruction if the task is being done wrongly.	(1) *Zuzia,* ***listen once again****.*
Using nonverbal communication elements informing about the proper execution of the task	(1) Nodding.
Using verbal confirmations informing about proper performance of the task.	(1-9) ***Yes, good, that's it****! It's ready now!* ***Yes, it must be like that!***
Recipient's help to a younger instructor in naming spatial relations (the person arranging bricks is older and has a higher spatial competence)	(8) Instructor: *But I don't know which is his left and which is his right.* Recipient: ***Then turn yourself like him****, then it will be like with you.*
Description of spatial relations using image schemas known to the recipient	(5) *It must be* ***a circle****. The piglet must be a kind of a circle… No,* ***a circle, like for „an old bear is sleeping soundly" you must stand****. No, you must make a circle of this summerhouse or whatever it is. And add this wolf so that there is a circle. Marysia,* ***a circle, a circle****, but not so much of a circle. Well, let it be like that.*
Using simple movements while giving instructions (nonverbal coding, using one's own body, gestures)	(1-9) Tilting the head to side in which the element is to placed. Turning the hand to imitate the rotation of a brick by a certain angle.
Using elements / objects to show the change of position (non-verbal coding, symbolization by means of objects)	(5) *Look, you must do that! Imagine this is the construction* [points to the teaspoon], *and this is the brick…* [takes a tic-tac box]: *And you must do this…* [demonstrates how to change the position of elements]
Linear description in accordance with items in the instruction:, from 1-5, next giving instructions connected with arrangement of the whole system.	Pairs 1-9.

When analysing the applied strategies we noticed the following four regularities:

1) The children were very willing to efficiently pass the information. Both the older and the younger behaved in such a way as to enable their recipient a proper construction of the brick system. Initially they tried to give verbal instructions, but when this strategy failed, the children moved to nonverbal coding. Additionally, they used facial expressions and gestures. Successive failures made the children use the so-called symbolization: they used objects (e.g. a pen, a teaspoon), to present the operations which should be carried out on bricks, e.g. *This brick cannot be like that* (Picture 3.), *but like that, on the side* (Picture 4.). These behaviours show that even preschoolers, watching spatial activities were able to spontaneously defeat intermodality transfer (even though the researches show otherwise; see Plumert, Ewert & Spear, 1995).

Picture 3. Non-verbal coding (a)



Picture 4. Non-verbal coding (b).

2) The children who were instructing other children and then an adult gave the latter fewer tips. Thus, they appropriately estimated skills (competences) and abilities of the recipient. Consequently, they gave a more precise description of the elements and actions to younger addresses. They take into consideration the needs of him/her (Plumert et al.,1995).
3) Younger children repeated the instructions for arranging elements which they had heard before. In that way the sender's spatial talk enriches children's spatial activity and language (see Cartmill, Pruden, Levine & Goldin-Meadow, 2010). They also adopted the double coding strategy (by means of words and gestures).
4) In case of pairs: „a younger person gives instructions– an older one arranges bricks", the recipient, the older child, participated in the interaction: helped and asked in several ways, when the younger child was unable to give a more precise instruction:
    - Moved the brick/ element and asked: which position is appropriate?
    - Asked extra questions: but in the right or left hand?
    - Asked a question about the proper execution of the task: is this right?
    - Prompted how the position of an object could be described:

> [instructor]: *But I do not know which is his right and which is left.*. [addressee]: ***Then turn like him, then it will be like with you***(the child turned round and compared the position of the object in her right hand and in the right hand of the brick figure).

Text-creating competence in giving instructions

The analysis of the instructions reveals that the children mastered the genre schema of this form of utterance. Regardless of the age they well understood the purpose of the whole interaction and their roles. They applied the structure instruction: they provided information from specific to general ones, in accordance with the presented pictograms. Their utterances had a certain order verbally indicating the order of actions to be performed:

> [Mi]: **First** you must take a flat yellow brick, a cream one...
>
> [Mi waiting for reaction]
>
> [Mi]: **Now** attach two green and one red bricks to it.

The children also often included the interaction in an appropriate delimitative frame:

> Beginning: **First** you must take – End: I think it is the same now, just turn the pig towards this apple. **That's it!**

Each time they verified the transferred contents:

> [M attaches wrongly]
>
> [Mi]: ***I will tell you how, I will tell you how***.[counts aloud]: *one, two three, to the third on the top...*

[M does it wrongly]

[M]: *But where, which brick?*

Additionally, the children tried to confirm the proper performance of the task:

[Mi]: You must attach to the third point at the top. Now you are doing it **well**, there at the bottom.

When giving instructions they often attempted to precede questions about what should be done next and asked to prepare specific elements:

Now you must prepare two yellow bricks or: **in a moment you will need** a small green element.

In most cases the instructors reacted to the linguistic behaviour of the persons arranging bricks. They attempted to precisely explain the position of the elements. For this purpose they not only used words, facial expressions and gestures but also objects. The children referred to image schemas mastered on the grounds of previous experience: one girl explained the position of the bricks in a circle by referring to "as when playing »old bear«". An extra element which facilitated the communication and efficiency of the instructions was the confirmation of proper execution (both verbal and nonverbal).

As regards the static description we could notice in the instructions much more linguistically varied, although not always precise, descriptions of particular elements positions. The children did not describe in details the look of the bricks used in particular stages of constructing. They just named them. It proves their skills to adapt to a required form of utterance, which enables the sender a direct observation and verification of the recipient. The children also modified their instructions when they were ineffective. Then they tried to describe the position of the elements more precisely and they used a double location. The observation of interactions also enabled us to notice that the verbal canal of a message (*logogen*) at children was intensified by nonverbal coding (*imagen*, see Paivio, 1986).

At older children (over 7) we observed the specialization in naming the spatial relations. At younger participants, who were unable to accept another person's point of view, the description of position was difficult, e.g. a shovel in the figure's left hand. Results of other surveys indicate that young children who are able to distinguish their left and right sides often cannot identify the left and right sides of others. Researchers suggest that children may have difficulties with the use of terms *left* and *right* appropriately even between the age of seven to eleven (see Roberts & Aman, 1993). The lack of competence in this scope (accepting other person's point of view) of the recipient also resulted in wrong position of an element. The children whose language of description was more precise (double location of objects, a description of shapes, size, colour and distance between the elements) sooner achieved the intended purpose – appropriate arrangement of bricks by the addressee.

Thus, we may conclude that there is a strict connection between the text producing competence (in giving instructions) and the spatial thinking. We observed a positive correlation: the better the instructor's orientation in the transmitted spatial system and more precise his description of the spatial relations, the location of the object – the more efficient the instruction was. The better developed the recipient's spatial language the faster he/she followed the instructions and built the whole system.

The analysis of the obtained children's productions and comparing them to the pattern system lead to the conclusion that the realizations were very close to the pattern, however no pair managed to reflect it accurately (see Picture 1). The majority of the pairs (6 out of 9) managed to preserve correct distances between the positions of the particular elements (*to the right/ to the left, in the man's right/ left hand,* see examples of productions, see Pictures 5, 6).

Picture 5. Ready production of pair 8.

Picture 6. Ready production of pair 5

4. CONCLUSIONS FROM THE RESEARCH

Current studies have been focused on the contribution of adults' spatial language to the lexical source of children and mutual influence of the language, spatial thinking and spatial efficiency. Language studies have most often been divided from examining the language proficiency in non-verbal spatial tasks (see Hermer-Vasquez, Moffet & Munkholm, 2001; Pruden, Levine & Huttenlocher, 2011).

Our aim was to go one step further than that: an indication on the interaction of language and spatial activities in one task, the execution of which could also indicate a higher language competence (in term of becoming a part of genre form of expression).

In task 1: we meant for integrated examination of the ability of decoding spatial relations from the picture, naming them, and possible handing over to the spatial relation in the linguistic form of the description.

In task 2: we wanted to examine, firstly, whether children are able to notice and to describe dynamically changing spatial relation. Secondly, whether children are able to adopt a recipient's point of view and to adapt the language of the description to him. Thirdly, whether the children are improving the spatial thinking, using in their own description – after changing the role – spatial language of the predecessor. Finally–weather the children's form of expression takes the logical form of instruction– genre associated with instructing the recipient.

Performing both tasks could confirm the influence of spatial thinking and the spatial language on higher linguistic competence – text-creating competence.

And indeed, on the grounds of the conducted research we may conclude that:

1) The analysis of the written description of spatial relations in the static system is confirming the existence of the significant dependency between the spatial

and the linguistic (text-creating) competence of the examined children. Over 61% children succeeded in defining the spatial relations in their descriptions. To make the static description more precise the children use quite complex spatial systems: use double location of objects (to more than one object). This skill was shown by 50% girls and 41% boys. The examined group, when describing the static system, mainly used name verbalization (prepositional phrases). Additionally, significant differences could be observed within genders: the girls used 82 times spatial terms and the boys only 58 times (the number of applied expressions 9-10 was approximately the same). Also the girls (over 64%) much better completed the task. And while describing they more often applied to the strategy of the reference point, which indicates the higher spatial competence.

2) When creating an oral instruction in a dynamic system the high level of the spatial competence both on the level of imagining relations and transformations and on the level of verbalization and communication with the recipient, correlated with a higher linguistic and communicative competence (including – text producing one: children created an efficient instruction with a properly segmented construction – with an explicit frame: signalling the beginning and the end). Regardless of the gender the children could understand the topic of the task and they cared for a high efficiency of the interaction (to achieve the purpose). The children who better dealt with the description of the spatial relations faster achieved the intended purpose (appropriate arrangement of bricks by the addressee) by:

- using richer and more diversified expressions naming the spatial relations (here the boys were better and generally – older children);
- adjusting their utterances to the addressee (precise information for a younger addressee);
- reacting to wrong performance (changing the message, repetitions, applying double coding or – in extreme cases – extraverbal code);
- supporting a younger instructor (behaviour of older children);
- younger children learnt to instruct under the influence of an effective pattern heard from another person, which was definitely favoured by the situation of an interaction while arranging bricks.

3) A higher level of spatial competence (thinking) together with its reflection in linguistic skills was revealed by the children with reference to two-dimensional space (when describing static instruction 61% proper performances). When giving oral instructions the performance considered appropriate was a little lower (about 50%). However, when producing an utterance in the interaction the children had an opportunity to correct each other's actions and linguistic expressions. They used a much richer repertoire of linguistic means. We may say that spatial acting in a dynamic situation with an interlocutor had an educational influence on linguistic and communicative skills of the children. And what's new in our study: connecting active spatial action of children (arranging

blocks) with the spatial speech finally inspiring them to produce the fortunate genre form.

4) There is a visible difference in the scope of the spatial thinking depending on the gender: the examined boys better dealt with a dynamic description and the girls with the static one. Previous data from studies indicates usually boys' supremacy. (see Tzuriel & Egozi, 2010).
5) The research confirmed previous observations (see Polański & Duraj-Nowakową, 1978; Loewenstein & Gentner, 2005; Pruden, Levine & Huttenlocher, 2011)that the children whose spatial competence is better developed are usually also characterized by a better vocabulary (in our case it was connected with using more spatial expressions and the skill of producing a fortunate text). And spatial expressions could in turn predict children's later spatial skills (see Pruden, Levine & Huttenlocher, 2011).

REFERENCES

Aguiar, A., & Baillargeon, R. (1998). 8.5-month-old Infants' Reasoning about Containment Events. *Child Development, 69*, 636-653. http://dx.doi.org/10.1111/j.1467-8624.1998.tb06234.x

Antell, S. E. G., & Caron, A. J. (1985). Neonatal Perception of Spatial Relationships. *Infant Behavior and Development, 8*, 15-23. http://dx.doi.org/10.1016/S0163-6383(85)80013-8

Behl-Chadha, G., & Eimas, P.D. (1995). Infant Categorisation of Left–Right Spatial Relations. *British Journal of Developmental Psychology, 13*, 69–79. http://dx.doi.org/10.1111/j.2044-835X.1995.tb00665.x

Bowerman, M., & Choi, S. (2001). Shaping Meanings for Language: Universal and Language-Specific in the Acquisition of Spatial Semantic Categories. In M. Bowerman, & S. Levinson (series Eds.), *Culture and Cognition: Vol. 3. Language Acquisition and Conceptual Development. Language* (pp. 475-511). Cambridge: Cambridge University Press.

Cannon, J., Levine, S., & Huttenlocher J. (2007). A System for Analyzing Children and Caregivers' Language about Space In Structured and Unstructured Contexts. Chicago: The University of Chicago.

Cartmill, E., Pruden, S.M., Levine, S.C., & Goldin-Meadow, S. (2010). The Role of Parent Gesture in Children's Spatial Language Development. In K. Franich, K.M. Iserman, & L.L. Keil (Eds.), *Proceedings of the 34th Annual Boston University Conference on Language Developmen*t (pp.70-77). Somerville, MA: Cascadilla Press.

Craton, L.G., Elicker, J., Plumert, J.M., & Pick, H.L., Jr. (1990). Children's Use of Frames of Reference in Communication of Spatial Location. *Child Development, 61*, 1528-1543. http://dx.doi.org/10.2307/1130762

Feuerstein, R. (1980). *Instrumental Enrichment: an Intervention Program for Cognitive Modifiability*. Baltimor: MD University Park Press.

Frostig, M. (1966). *Developmental Test of Visual Perception*. Palo Alto, CA: Consulting Psychologists Press.

Frostig, M., & Horne, D. (1964). *The Frostig Program for the Development of Visual Perception*. Chicago: Follett.

Gentner, D. (1988). Metaphor as Structure Mapping: The Relational Shift. *Child Development, 59*, 47-59. http://dx.doi.org/10.2307/1130388

Gentner, D. (2003). Why We're so Smart. In D. Gentner & S. Goldin-Meadow (Eds.) *Language in mind: Advances in the Study of Language and Thought* (pp. 195-235). Cambridge, MA: The MIT Press.

Geppert, M. (1966). *Kształtowanie wyobrażeń i pojęć uczniów w świetle pedagogiki [Creating images and concepts of pupils in the light of pedagogy]*. Warszawa: PWN.

Głodkowska, J. (2000). *Pomóżmy dziecku z upośledzeniem umysłowym doświadczać przestrzeni. Orientacja przestrzenna w teorii, diagnozie i rozwoju dziecka [Let's help the child with mental disability to*

experience space. Spatial orientation in theory, diagnosis and development of a child]. Warszawa 2000: Wydawnictwo APS.

Gruszczyk-Kolczyńska, E. & Zielińska, E. (2007). *Dziecięca matematyka. Książka dla rodziców i nauczycieli [Children's mathematics. Book for parents and teachers].* Warszawa: WSiP.

Guzy, A. (2010). Kompetencja tekstotwórcza a wyobraźnia i orientacja przestrzenna uczniów klas III [Text producing competence versus imagination and spatial orientation of pupils of forms 3]. In B. Niesporek-Szamburska & M. Wójcik-Dudek (Eds.), *Dziecko-język-tekst [Child-language-text]* (pp. 110-122) Katowice: Wydawnictwo Uniwersytetu Śląskiego.

Guzy, A. (2012a). Kompetencja przestrzenna – nowy determinant kompetencji językowej [Spatial competence – a new determinant of linguistic competence]. In D. Czajkowska-Ziobrowska & J. Wiśniewski (Eds.), *Obszary akademickiej wiedzy naukowej. Pedagogika społeczna. Tematy do dyskusji na XXI wiek [Fields of academic scientific knowledge. Social pedagogy. Topics for discussions at the end of 21st century]* (pp. 56-68). Poznań: Akademicki Instytut Naukowo-Wydawniczy „Altus".

Guzy, A. (2012b). Kompetencja przestrzenna uczniów a ich umiejętności językowe [Pupils' spatial competences versus their linguistic skills]. In B. Niesporek-Szamburska (Ed.), *Wiedza o języku i kompetencje językowe uczniów [Knowledge of a language and pupils' linguistic competences]* (pp. 239-252). Katowice: Wydawnictwo Uniwersytetu Śląskiego.

Hermer-Vasquez, L., Moffet, A., & Munkholm, P. (2001). Language, Space, and the Development of Cognitive Flexibility in Humans: The Case of Two Spatial Memory Tasks. *Cognition, 79*, 263-299. http://dx.doi.org/10.1016/S0010-0277(00)00120-7

Kielar-Turska, M. (1989). *Mowa dziecka. Słowo i tekst [A child's speech. Word and text].* Kraków: Wydawnictwo Uniwersytetu Jagiellońskiego.

Levinson, S. (1992). Primer for the Field Investigation of Spatial Description and Conception. *Pragmatics, 2*, 5-47. http://dx.doi.org/10.1075/prag.2.1.02lev

Libura, A. (2000). *Wyobraźnia w języku. Leksykalne korelaty schematów wyobrażeniowych CENTRUM-PERYFERIE i SIŁY [Imagination in a language. Lexical correlates of image schemas CENTRUM-PERYFERIE i SIŁY]*. Wrocław: Wydawnictwo Uniwersytetu Wrocławskiego.

Loewenstein, J., & Gentner, D. (2005). Relational Language and the Development of Relational Mapping. *Cognitive Psychology, 50*, 315-363. http://dx.doi.org/10.1016/j.cogpsych.2004.09.004

Maclean, D. J., & Schuler, M. (1989). Conceptual Development in Infancy: The Understanding of Containment. *Child Development, 60*, 1126-1137. http://dx.doi.org/10.2307/1130787

Mandler J., 1992, How to build the baby; II, Conceptual primitives. *Psychological Review, 99* (4), 587-604. http://dx.doi.org/10.1037/0033-295X.99.4.587

Mihilewicz, S. (1999). *Schemat ciała i orientacja przestrzenna u dzieci z porażeniem mózgowym w młodszym wieku szkolnym [Body schema and spatial orientation of children with cerebral palsyat early school age]*. Wrocław: Dolnośląska Szkoła Wyższa Edukacji

Paivio, A (1986). *Mental representations: a dual coding approach*. Oxford. England: Oxford University Press

Piaget, J. & Inhelder, B. (1967). *The Child's Conception of Space.* New York: W.W. Norton.

Piaget, J. (1962). *The Language and Thought of the Child*. London: Routledge & Kegan Paul.

Plumert, J.M., & Hawkins, A.M. (2001). Biases in Young Children's Communication about Spatial Relations: Containment versus Proximity. *Child Development, 72* (1), 22-36. http://dx.doi.org/10.1111/1467-8624.00263

Plumert, J.M., Ewert, K., & Spear, S.J. (1995). The Early Development of Children's Communication about Nested Spatial Relations. *Child Development, 66* (4), 959-969. http://dx.doi.org/10.2307/1131791

Polański, E. & Duraj-Nowakowa, K. (1978). Z badań nad uwarunkowaniami zasobu słownikowego uczniów [From research on conditioning pupils' vocabulary]. In J. Kram, E. Polański (Eds.) *Z Teorii i Praktyki Dydaktycznej Języka Polskiego [From Didactic Theory and Practice of Polish Language]* Katowice, 2, 172-194.

Pruden, S.M., Levine, S.C., & Huttenlocher, J. (2011). Children's Spatial Thinking: Does Talk about the Aptial World Matter? *Developmental Science, 14*, 1417-1430. http://dx.doi.org/10.1111/j.1467-7687.2011.01088.x

Quinn, P.C. (1994). The Categorisation of Above and Below Spatial Relations by Young Infants. *Child Development, 6*5, 58–69. http://dx.doi.org/10.2307/1131365

Roberts, R.J., Jr. & Aman, C. (1993). Developmental Differences in Giving Directions: Spatial Frames of Reference and Mental Rotation. *Child Development, 64*, 1258-1270. http://dx.doi.org/10.2307/1131338

Rosch, E. (1977). Human categorisation. In N. Warren (Ed.), *Studies in Cross-cultural Psychology* (vol. I, pp. 1-49). London: Academic Press.

Schneiderheize K. (2004). *The Acquisition of the Concept of Space*. Chemnitz: Technical University of Chemnitz.

Spelke, E.S., & Tsivkin, S. (2001). Initial Knowledge and Conceptual Change: Space and Number. In M. Bowerman, & S. Levinson (series Eds.), *Culture and Cognition: Vol. 3. Language Acquisition and Conceptual Development. Language* (pp. 70-97). Cambridge: Cambridge University Press.

Stucki, E. (1992). *Metodyka nauczania matematyki w klasach niższych [Methodology of teaching mathematics in lower forms]. Part 1*. Bydgoszcz: Wydawnictwo Uczelniane WSP .

Szechter, L.E., & Liben, L.S. (2004). Parental Guidance in Preschoolers' Understanding of Spatial-Graphic Representations. *Child Development, 75*, 869–885. http://dx.doi.org/10.1111/j.1467-8624.2004.00711.x

Tabisz, A. (2006). *Kompetencja tekstotwórcza uczniów na przykładzie rozprawki [Pupils' text-creating competence on the example of essay].* Opole: Wydawnictwo UO.

Tzuriel, D., & Egozi, G. (2010). Gender Differences in Spatial Ability of Young Children: The Effects of Training and Processing Strategies. *Child Development, 81*, 1417-1430. http://dx.doi.org/10.1111/j.1467-8624.2010.01482.x

Wechsler, D. (1974). *Manual for the Wechsler Intelligence Scale for Children—Revised*. New York: Psychological Corp.

Wechsler, D. (2004). *The Wechsler Intelligence Scale for Children—Fourth Edition*. London: Pearson Assessment.

Whorf, B. (1956). *Language, thought and reality*. Cambridge, MA: MIT Press.

Wilgocka-Okoń, W. (1972). *Test gotowości szkolnej [The school readiness test]*. Warszawa: PZWS.

Zazzo, R. (1974). *Metody psychologicznego badania dziecka [Methods of psychological examination of a child]*. Warszawa: Państwowy Zakład Wydawnictw Lekarskich.

APPENDIX A

Transcript of selected recordings

Pair 5.
Milena [Mi], aged 8 – Marysia [M], aged 5 Mi gives instructions
[Mi]: First you must take the flat yellow brick, the cream one...
[Mi waiting for reaction]
[Mi]: Now attach two green bricks and a red one to it
[M attaches wrongly]
[Mi]: I will tell you how, I will tell you how [counts aloud]: one, two three, to the third on the top...
[M does it wrongly]
[M]: But where, which brick?
[Mi]: You must attach to the third point at the top. Now you are doing it well, there at the bottom.
[M]: But to which one?
[Mi]: Here you had it right, this one but at the bottom, on a slant.
[M]: Where, here?
[Mi]: No, not here, here! Now put the red one next to the green one, next to the green one. Not here, not here! Next to the green one. Now take such two bricks...
[Mi did not have to describe them, because M took the right ones]
[Mi]: Attach them to the side. Now take something black. Now take the bucket and attach it to the side...
[done wrongly by M]
[Mi]: No to the side.
[done wrongly again]
[Mi]: No, to the other side…
[done wrongly again. Mi is looking towards the observer hoping for help. Finally she uses gestures]
[Mi]: Look here, on this side…
[Mi is showing on which side it should be placed. One more time M does it wrongly. Now Mi is using a teaspoon and a tic-tac box, which is within her reach, to show the proper position of the element].
[Mi]: Look, you must do like that! Imagine this is the construction [points at the teaspoon], and this is the brick…
[Mi is taking the tic-tac box]: And you must do that…
[Mi is showing how to change the position of the elements]: This brick cannot be like that (Picture 1), but aside (Picture 2).
[Mi]: Good. Now take the red roof and attach it to the top, now assemble the man...

[Mi, when the man is being wrongly assembled]: put the hat to the front and give him a shovel in one hand. Now put him next to this bucket. Good...
[M wants to place the man, but it is not possible because the shovel is sticking too high. Neither she nor Mi do not correct this wrong position. The man falls down when she attempts to put him, laughter]
[Mi]: Lower the shovel, downwards so that he can stand. Now next to him like that, look...
[Mi uses the teaspoon and the tic-tac box again to describe the position, this strategy proved effective, Picture 3.]
[Mi]: Here is the pig and he is here. Put it a little to that side...
[Mi tilts her head to the left]: A little closer, that's right. And give it a red brick, put it closer down, near her snout.
[M]: Yes, is it an apple for it?
[Mi]: Now this dog or horse, I do not know what it is, put...
[M puts wrongly]
[Mi]: It must be a circle. The piglet must be a kind of a circle...
[M assembles it wrongly]
[Mi]: No, a circle, just like you must stand for „an old bear is sleeping soundly". No, you must make a circle of this summerhouse or whatever it is. And add this wolf so that there is a circle. Marysia, a circle, a circle, but not so much of a circle. Well, let it be like that.
[the observer's question to Mi]: Are you sure that you can see the same in the photo, Marysia?]
[Mi]: No, the pig must change with the dog, the apple must change as well, right. Put the dog a little further, not so much, that's enough, move the farmer with the shovel a little, good. Now I think it is the same. Just turn the pig towards the apple. And that's it!

Pair 7.
Wiktoria [W], aged 10 – Tomek [T], aged 38; W gives instructions
[W]: Put the oblong brick. Attach the green element to the other one, the brick on the left.
[W, after wrong performance]: Not like that, the green element. This is not an element. Attach the red one to the green one, and the red one over the green one.
[W, after wrong performance by T]: Not like that. Attach the sticking ones on both sides.
[W]: Attach a black pipe to it. Attach the bucket on the right side...
[T does it wrongly]
[W]: Not like that, not like that, not like that, not like that... How on the right, on the right side of what? On your right side...
[W]: Attach the roof to the pipe. Now put it in opposite to you. Put the dog on the left.

[W]: Which side is left? Put the pig in front of the house, in front... sideways. Good. Put the green element in front of the pig. Put the man next to the bucket. He is holding a shovel in his left hand and his right hand is down.

Pair 8.

Marysia [M], aged 5 – Magda [Ma], aged 10; Marysia was earlier performing the instructions given by Milena and now is giving instructions

[M]: First you must take a flat cream brick then you must take a green brick, a small one and attach it to the third top point.

[M]: Next the green one to the second bottom point, then the red one next to the one that is at the bottom.

[M]: Next you must take two big cream bricks and attach them on the sides. And a black one and you put it on these bricks.

[Ma]: At the top or bottom?

[M]: And you must take a blue basket and attach it to it, to the cream brick...

[done wrongly]

[M]: Sideways, like that. And then put the roof on the black brick …

[no reaction to the wrongly placed roof, which is slightly shifted to the left]

[M]: Now place the man. And then take the next red one and put it under the pig's snout.

[M]: And put this farmer next to the basket. He must be around like that. I cannot say it. Yes, but a little closer to the basket.

[M]: Which side should the pig be? Place the shovel in the farmer's hand.

[Ma]: In his right or left hand?

[M]: But I do not know which is his right and which is his left hand.

[Ma]: Then turn like him and it will be the same as with you.

[M]: And the wolf next to the pig.

[Ma]: On his right or left side?

[M]: On the left and a little further, not like that. Yes, a little more further to the right, not like that. The head to the left and the legs to the right. Not like that, slantwise. That's right. And that's the end!

[Observer to M]: Is it correct now?

[M]: No, the farmer's head towards the piglet.