

## INHIBITORY CONTROL AND LITERACY DEVELOPMENT AMONG 3- TO 5-YEAR-OLD CHILDREN

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### ABSTRACT

In the article, two competences crucial for the development of school readiness have been analyzed: literacy and inhibitory control. The author, availing himself of the premises of Lev S. Vygotsky's theory, views the process of acquiring reading and writing skills as the development of a higher mental function – written speech. Early stages of the development of this function coincide also with the period of forming the so-called readiness to acquire reading and writing skills. It enables treating both the period before and after the beginning of formal training in literacy skills as the time during which the same developmental process operates. In addition, the author analyzes the importance of inhibitory control changes for consecutive stages of written speech development in preschoolers. This one of the most pivotal components of executive functions can be investigated already in two and a half year old children, enabling early identification of groups at risk of school difficulties. Assumptions concerning relationships between inhibitory control and literacy in the process of development were verified in a study of 336 children at the age of 3-5, with the use of Children Card Sort and Literacy Assessment Battery.

KEY WORDS: executive functions, inhibitory control, written speech, literacy development, stages of learning to read and write

### 1. INTRODUCTION

Among cognitive competences recognized as components of school readiness a key position occupy executive functions and preliteracy skills (e.g. Ziv, 2013). It means that an assessment of their development can be conducive to the prevention and early identification of groups at risk of different types of school difficulties (e.g. St. Clair-Thompson and Gathercole, 2006; Roebers, Cimeli, Röthlisberger, and Neuenschwander, 2012). In a long-term perspective, supporting the development

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of executive functions and literacy skills determines the quality of: an essential competence of a contemporary adult person to learn throughout the entire life – a life-long learning ability (UNESCO, 1998), life-course outcome, and general social health (Beswick and Sloat, 2006; Jabłoński, 2009; Kwieciński, 2002).

### *1.1 Inhibitory control as an executive function*

Executive functions constitute the basis of the ability to quickly and flexibly adapt to an ever-changing environment, overcoming habitual, prepotent responses in order to engage in purposeful, goal-directed behaviors (Cragg and Chevalier, 2012). They form, thus, the fundament of one of the most important human capacities. According to Altemeier, Abbott and Berninger (2008), most researchers agree that inhibition is the primary executive function that precedes and enables the development of other executive functions. This function emerges at a very early stage of human development, approximately at the age of 3-4, which has been confirmed by the studies of, for instance, Zelazo et al. (2003). Inhibitory control can be analyzed from two perspectives: behavioral or cognitive (Altemeier et al., 2008; Putko, 2008). In the first case, it denotes refraining from automatic or overlearned behaviors during the realization of a particular task. In the second case, it is understood as an attention mechanism that enables shifting the focus between different stimuli, adequately to the changing conditions of a task situation (Jabłoński, Kaczmarek, Kaliszewska-Czeremska, and Zakrzewska, 2013). The preferred method of investigating inhibitory control in small children is the Dimensional Change Card Sort, first described by Zelazo, Frye and Rapus (1996).

### *1.2 Research on literacy development*

The majority of contemporary studies of the process of literacy acquisition have concentrated predominantly on searching for factors of development and disorders of literacy, rarely undertaking the issue of constructing and verifying developmental models of reading and writing. Three dominant trends could have been observed in the hitherto research: (1) relying on Gough's (1996) model of Simple View of Reading, in which reading comprises two quite autonomous processes of phonological decoding and understanding, (2) investigating separately main constituents of literacy competence: reading and writing, (3) dividing the process of acquiring literacy into two phases – development of preliteracy skills or readiness to literacy, and literacy development. In the light of studies which indicate that: (1) beside phonological awareness, also morphological awareness plays an important role in the development of the ability to read (Nunes, Bryant, Barros, 2012); (2) the developmental processes of reading and writing remain in a reciprocal relationship (Frith, 1985; Snowling, 2000; Ehri, 2005); (3) analyzing the constituents of literacy competence in isolation leads to serious errors in the interpretation of results (e.g. Paris, 2005; Devonshire, Morris, and Fluck, 2013), such an approach to the process

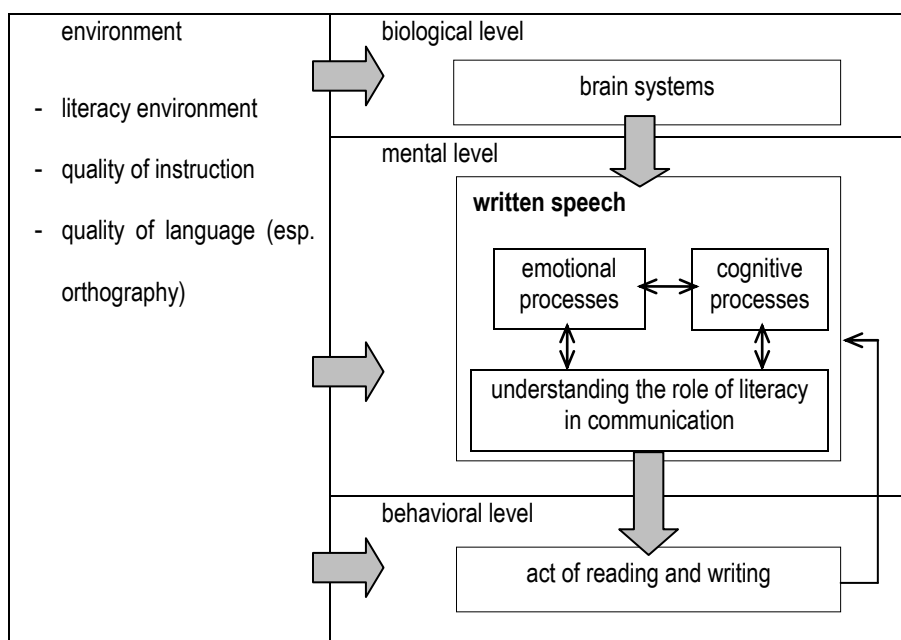
of acquiring reading and writing ability turns out to be an over-simplification of this phenomenon. It also seems that studies of developmental models of literacy are necessary for a proper diagnosis of dyslexia. After all, identification of this disorder consists in verifying whether the boundary between the disorder and the rest of population has been crossed, which in the case of dyslexia is – according to Hume and Snowling (2013) – to a large extent arbitrary.

### *1.3 Written speech: a cultural-historical view on literacy*

In the opinion of Vygotsky (1971a, 2002) the process of development, despite the complexity of changes and variety of its contents, at each particular stage is a certain totality that has its own structure. Investigation of its constituent mental processes in isolation disables full understanding of their essence. Following Vygotsky's line of reasoning, in order to comprehensively explore the determinants and course of the process of mastering reading and writing ability, each time we need to interpret the obtained results in the context of the complete act of using these ability, and in the context of the complete development of literacy competence. In the view of the author of the present article, the essence of reading and writing has been most comprehensively delineated by an approach in which these skills are treated – as Krasowicz-Kupis (2008) suggests – as twin forms of a single process of communication: reception and construction of a written expression on the basis of language. From the perspective of Lev S. Vygotsky's socio-cultural theory, the task of communicating with the use of script requires developing a higher-order behavior, i.e. a higher mental function (Jabłoński, 2002). Vygotsky (1971b) refers to this function as written speech (see also: Cole, 1993; Surd-Büchele and Karsten, 2010). It incorporates two aspects: impressive speech (reading) and expressive speech (writing). The crux of this higher-order behavior is that reactions emerge in it not only in response to sensory stimuli, but also in response to cultural signs (script) and their meaning (here: the meaning of a text). As a consequence, the development of written speech is determined by two main factors: the level of organization of the mental system, and the manner a child understands the function of script in terms of a sign in the process of communication (Jabłoński, 2002). This assumption seems to be concurrent with concepts of literacy based on Piaget's theory (i.e. Gentry, 2000; Ferreiro, Teberosky, 1982, after Read, Treiman, 2012). According to both Piaget and Vygotsky, children spontaneously create their own understandings of reality (i.e. understanding of script which manifests in invented spelling). In fact, however, development of reading and writing is perceived by the two theorists in a completely different manner. For Vygotsky, this process should be directed to the path of cultural development through an intervention of a more competent person. Only a proficient reader and writer (an adult or a child) is able to reveal to the child script as a cultural tool and introduce the rules of reading and writing existing in a given social world. Other dissimilarities result from, for example, different designs of mental system in the two theories, and they will not be analyzed here (see:

Tudge and Rogoff, 1989). Figure 1 presents a scheme of a comprehensive approach to causal influences on the development of written speech based on the three level framework by Frith (1999).

Figure 1. Causal influences on the development of written speech (compiled by SJ, based on Brzezińska, 1992; Frith, 1999; Hume and Snowling, 2013).



Lev S. Vygotsky (2005) points to four significantly different ways of understanding cultural signs which, at the same time, constitute four main steps in the process of their acquisition. With reference to written speech, they determine four stages of written speech development (Jabłoński, 2002).

In the natural stage of written speech development, graphic signs of the script are like elements of a syncretic structure of diverse stimuli with which they co-occur, for instance, as incomprehensible pictures or drawings (e.g. a child is looking at another person who is writing a text and comments: 'you are making small lines, circles and dots'). Unable to recognize the true meaning of writing at this stage, the child only perceives its graphic features, and if s/he hits on the idea of "writing", s/he attempts to reflect those features on a picture. Communication of a verbal message is, therefore, interpreted as that of a graphic image. However, the specific elements of communication are not equally meaningful for the child and the sender. Thus, a key symptom of this stage is the way the child understands impressive (a difference between picture and print, the purpose and procedure of reading) and

expressive (a difference between drawing and writing, a purpose and procedure of writing) aspects of communication with the use of written speech (see tools 1 and 2 in Tables 4 and 5).

During the naive stage, children succumb to an illusion that reading and writing consists principally in using memory. They think that every graphic shape created with the use of written signs has a concrete, inherent name. Thus, it appears to them that to master reading and writing, it is enough to remember all words. Children also know that objects can have their written names and can match objects with their written names as well as utter written names of objects. They initially recognize words based on contextual features (e.g. making out names of various products on the basis of the packaging color, or the graphic design color). Then, children use such clues as graphic features of words themselves (e.g. the shape of their outer perimeters, their length, the shape of the first letter, etc.). An example of a child who is at the naive stage of written speech development, is a child who deems the same the words 'cat' and 'cab', and also captions 'dog' and 'ladybird' placed below identical pictures of a dog. Key symptoms of this stage are: mixing different captions (words) accompanied by the same graphic context (pictures) and mixing different words which have similar shapes for impressive aspect of written speech, and possessing an ability to copy words for expressive aspect of written speech (see tools 3, 4 and 5 in Tables 4 and 5).

In the outer stage of written speech development, children discover, either spontaneously or with the help of older individuals, that written speech is a graphic record of speech sounds, and they become able to read aloud written texts and to write down texts they hear. A characteristic feature of this stage is the fact that the internal operation of formulating or receiving a written message are mediated by external signs, i.e. speech sounds. As a consequence, reading a text out loud is necessary for recognizing its meaning (i.e. asked to recognize a word, the child first spells it aloud or whispers it, before she/he gives an answer). Therefore, a key symptom of this stage is speaking read or written words out loud, before reading or writing them correctly (see tools 6 and 7 in Tables 4 and 5).

Improving the reading and writing technique may be viewed as the first symptom of internalizing and – as a consequence – also automating, the operation of receiving and formulating written utterances. What is internalized at the last stage of written speech development, are the rules of constructing and decoding the meanings of written texts. During the inner stage children become more assured of their new reading and writing abilities, and of the ease and fluency of their use. Key symptoms of this stage are: quiet (that is without the need to reproduce the sound form of the written text) reading and writing, a significant improvement in reading comprehension, and an ability to correctly write down texts (see tools 8 and 9 in Tables 4 and 5) (Jabłoński, 2002).

The difference between the theory of Piaget and Vygotsky mentioned above, is impossible to be clearly seen through the comparison of behavioral characteristics of literacy development stages (also stages in classic models of reading and writing

development – see below). The discrepancy between the two approaches appears to be most visible in the role of social environment in literacy development, which is an issue that will not be analyzed in detail in this paper. In brief, for Piaget, the role of social environment in literacy development consists in learning to read and write through the act self-discovering of the script, whereas for Vygotsky, in acquiring these competences through the process of a gradual structuring of experiences with the script.

An advantage of the model presented above is – naturally, beside the conjoint analysis of reading and writing – treating the stages of development before and after the beginning of formal training in reading and writing as constituents of one and the same process of development. According to the classic models of reading and writing development (e.g. Ehri, 2005), the natural and the naive stage pertain to the period of „pre-„ (e.g. –alphabetic, –literacy, –reading, -writing), or form a part of the process of developing readiness to read and write. Following this line of reasoning, the outer stage can be included in the period of „learning to read”, and the inner stage to the period of „reading to learn”. In the approach presented here, all four stages constitute valuable and integral elements of written speech development. A practical consequence of this is, for instance, the necessity to carry out diagnosis and prophylaxis of reading and writing difficulties much earlier (in the natural and the naive stage of written speech development) than the beginning of formal training in reading and writing (the outer stage of written speech development).

## 2. RESEARCH

According to Christopher et al. (2012), “understanding which cognitive abilities play important roles during reading (...), and whether these relations change depending on the age of the reader can offer insight into why people differ in their reading performance”. In turn, Altemeier et al. (2008) draw attention to the fact that executive functions play a leading role in the integration of visual and linguistic information and the automatic retrieval of linguistic information from memory while learning to read. At the same time, they claim that scant research attention has been devoted to the investigation of relationships between executive functions and typical reading development. The results of longitudinal studies conducted by these authors have shown that executive functions directly influence literacy learning over the initial four grades (of elementary school in US). It seems, thus, that these views can be extended also on the ability to write.

In the study presented below, the main objects of measurement were inhibitory control, occupying – as it has been already mentioned – a special position among executive functions, and written speech. The aim of the study was to: (1) confirm the existence of different levels of the ability to read and write, referring to different stages of written speech development, and (2) check whether different levels of inhibitory control coincide with different levels of written speech development.

### 2.1 Participants

Participants were 336 children between 2 years and 11 months to 5 years and 11 months of age. The majority of children were recruited for the study via preschool institutions they attended. In order to obtain a homogeneously diversified and representative in respect of age and gender sample, the children were assigned to 24 quarterly gender groups (one 2;11-year-old child was placed in the group of boys at the age between 3;0 and 3;2). Thanks to this procedure, a satisfactory homogeneity of the two variables in the sample was achieved (see Table 1).

*Table 1. Distribution of age and gender in the sample*

Age	3;0	3;3	3;6	3;9	4;0	4;3	4;6	4;9	5;0	5;3	5;6	5;9
	3;2	3;5	3;8	3;11	4;2	4;5	4;8	4;11	5;2	5;5	5;8	5;11
Girls	3	17	13	15	15	14	20	17	17	15	12	12
Boys	11	7	20	15	14	20	13	13	11	17	13	12
Total	14	24	33	30	29	34	33	30	28	32	25	24

### 2.2 Procedure

The study discussed in this paper was a part of a larger research project, in which each of the participants took part in two 40-minute research sessions (see author's note), separated from one another with at least one-day break. The analyses presented here pertain to the results obtained during each child's first session, carried out between July 2012 and March 2013. The sessions were conducted by specially trained researchers who possessed a prior experience in working with preschoolers. Before the study, each child's parent received a form with information about the research procedure, on which s/he expressed an informed and voluntary agreement to the participation of his or her child in the study. Each child, whose parent signed the consent, was asked, both before and during the procedure, about his or her willingness to take part in the study. In the case of a negative response, the procedure would be stopped. Each session had the form of an individual meeting with the researcher, and it was conducted in a quiet place, enabling the child to work effectively.

### 2.3 Method

During each research session, the participants were first asked to complete the Children Card Sort (CCS), and then to complete the Literacy Assessment Battery (LAB). Both of these tools have the status of experimental methods, due to the fact

that the works on their standardization and the assessment of accuracy and reliability are still in progress (see: Jabłoński, Kaczmarek, Kaliszewska-Czeremska, Brzezińska, 2012; Jabłoński et al., 2013).

### 2.3.1 Children Card Sort

The CCS was developed on the basis of two divergent versions of the Dimensional Change Card Sort (DCCS): standard version (DCCS-S), designed for younger children, and advanced version (DCCS-A) for older children (Jabłoński et al., 2012, 2013). The CCS differs from both of these versions in respect of the area of application, the type of utilized stimuli and the procedure, yet it preserves the overall idea of their construction. As opposed to the DCCS, the CCS is a means of individual diagnosis of executive functions, in which the sequence of the presented stimuli is strictly defined. The construction of this tool has been presented in Table 2 and 3.

Table 2. Design of Children Card Sort

Phase	Number of rounds	Sorting Task
I: Trial phase	2 Demonstration rounds	Cards according to the color
II: Pre-switch phase	7 Test rounds	Cards according to the color
III: Post-switch phase	7 Test rounds	Sorting cards according to the shape
IV: Border phase	2 Demonstration rounds 12 Test rounds (including 6 with border)	Cards with border according to the color, and cards without border according to the shape

Each investigation procedure would start with a verification of the child's ability to differentiate between colors utilized on the cards. In the case of a positive outcome of this verification, the researcher would proceed to the phase of demonstration. The researcher would set next to each other, at a distance of about 30-40 cm, two boxes with target cards attached to them. In line with the suggestion of Zelazo (2006), the presented cards included easy to distinguish and well-known to the children objects. The words "house" and "cat" in the most common grammatical forms occupy 13<sup>th</sup> and 27<sup>th</sup> position, respectively, among 2215 nouns appearing in the vocabulary of 3-year-olds (Szwabe, 2013). Hence, the target cards presented a red house and a blue cat, and the test cards a blue house and a red cat. Next, the researcher would check whether the child could easily place the test cards in the box.



*Table 3. Design of border phase of Children Card Sort*

Card number (according to the order in CCS)	Stimuli description	Task (sorting by:)
15	no border	shape
16	border	color
17	border	color
18	no border	shape
19	no border	shape
20	border	color
21	border	color
22	no border	shape
23	no border	shape
24	border	color
25	no border	shape
26	border	color

During demonstration (phase I), the researcher would explain the procedure, and then ask the child to place the first and second received trial card in the correct box, according to the rule of color match. During consecutive stages (phase II and III), the researcher would present particular cards to the child and would remind the current sort rule. After the end of the phase III, the researcher would inform the child about the new rule of sorting cards, connected with the appearance of cards with borders. During the procedure, the researcher would not inform the child about the correctness of his or her answers. The end result of the test was the number of correctly sorted cards during each of the three phases (II-IV) of the procedure. All children were investigated with the use of the whole set of cards, regardless of correctness of their answers.

### 2.3.2 Literacy Assessment Battery

The LAB was developed on the basis of the author's model of written speech development (Jabłoński, 2002, 2003). It consists of 9 tasks meant for the investigation of different components of written speech (see variables in Table 4) in each of the stages of development.

*Table 4. Design of Literacy Assessment Battery (\*i.e. 'NATI' – natural stage of impressive aspect of written speech; 'OUTE' – outer stage of expressive aspect of written speech)*

Tool number	Tool name	Characteristics of the task	Aids	Variable symbol*	Variable name
1	What is it (reading)?	Subject answers two questions: what is that (print)? what for people read? and follow one instruction: please show me how to read?	A chart with an illustrated tale	NATI	Picture-print discrimination
2	What is it (writing)?	Subject answers three questions: what am I doing (drawing)? what am I doing (writing)? what for people write? and follow one instruction: please show me how to write?		NATE	Drawing-writing discrimination
3	Find the same word	Subject points at the word (name of the object illustrated in the picture) identical with the pattern	5 charts with pictures, each with 1 pattern and 5 pictures with names, some names do not match the objects presented on the pictures	NAVI 1	Visual recognizing names of objects presented on pictures
4	Compare words	Subject is supposed to state whether the two words that s/he sees are identical or different	5 series of cards with single words, in each one card with a word-pattern and 4-5 cards with words to be compared with the pattern	NAVI 2	Discrimination of words

5	Write a word	Subjects writes down on a piece of paper 3 consecutive words s/he hears using a chart	A chart with pictures and words-names, none of the included names matches the presented pictures, but the name of each object is presented on the chart	NAVI 3 NAVE	Object names writing Copying of words
6	Read a word	Subject reads a word and after a while answers the question "What was this word?"	6 cards with single words	OUTI 1 OUTI 2	Word reading Way of reading
7	Write a sentence	Subject writes down on a piece of paper the sentence s/he hears	A card with 3 sentences to be read to the subject	OUTE 1 OUTE 2	Way of writing Sentences writing
8	Split into sentences	Subject marks the end of each sentence, placing there a dot	A card with a short story, sentences do not start with capital letters and do not end with dots	INTI 1 INTI 2	Reading comprehension Reading rate
9	Write a story	Subject writes down constructed by her- himself sentences	A chart with 4 pictures creating a picture story	INTE 1 INTE 2 INTE 3	Grammar Syntax Coherence

Each of the 15 variables measured by the LAB belongs to a set of crucial features of reading and writing, enabling the identification of written speech development stages (Jabłoński, 2003). Hypothetical links between the variables and the stages of written speech development have been presented in a synthetic manner in Table 5. Analysis of the arrangement of the LAB variables reveals that particular tasks are arranged in an order from the easiest to the most difficult, and as such they were presented to the subjects.

*Table 5. Hypothetical profiles of variables in evaluation of written speech development by Literacy Assessment Battery ('-' – low level of variable; '+' – high level of variable)*

Tool number	Tool name	Variable symbol	Stages of written speech development										
			Impressive aspect				Expressive aspect						
			Natural	Naive	Outer	Inner	Natural	Naive	Outer	Inner			
1	What is it (reading)?	NATI	-	+	+	+							
2	What is it (writing)?	NATE								-	+	+	+
3	Find the same word	NAVI 1	-	+	+	+							
4	Compare words	NAVI 2	-	+	+	+							
5	Write a word	NAVI 3	-	+	+	+							
		NAVE								-	+	+	+
6	Read a word	OUTI 1	-	-	+	+							
		OUTI 2	-	-	+	+							
7	Write a sentence	OUTE 1								-	-	+	+
		OUTE 2								-	-	+	+
8	Split into sentences	INTI 1	-	-	-	+							
		INTI 2	-	-	-	+							
9	Write a story	INTE 1								-	-	-	+
		INTE 2								-	-	-	+
		INTE 3								-	-	-	+

The subjects were not informed about the correctness of their answers during the procedure. The overall result was established separately for each variable. It constituted a sum of points achieved for each item of the task connected with the given variable. The criterion of performance assessment for particular tasks was established in such a way, that the higher the score for the given variable, the higher level of written speech development reached by the subject. All children were investigated with the use of the whole set of tasks, regardless of correctness of their answers.

### 3. RESULTS

During the phase of designing the analysis procedure of the data collected with the use of LAB, the author took into consideration suggestions of Krasowicz-Kupis (1999) and Paris (2005). The former author points to the fact that the development of literacy may not take the same form in all children. The latter author emphasizes, first of all, that each component of the reading and writing process has a different dynamics of the development. As a consequence, along with proceeding to consecutive stages of literacy development, the relative importance of a particular component against a background of all constituents of the ability to read and write changes. If we consider, for instance, five essential component skills for reading development distinguished by Snow, Burns and Griffin (1998; after Paris, 2005), it turns out that two of them (vocabulary and comprehension) start to develop earlier and have a much longer developmental trajectory than the others (alphabetic principle, phonemic awareness and oral reading fluency). Secondly, Paris (2005) observes that at the level of data distributions, this heterogeneous dynamics yields an effect of a longitudinal instability of all statistical variances and correlations. Consequently, in the opinion of this author, parametric statistics such as Pearson correlations and ANOVAs, may be inappropriate for analyzing data derived from these skills.

In order to avoid arbitral classification (for example, based on age) of the investigated children to the comparison groups, the analysis was carried out with the use of hierarchical clustering cases method. To allow for the nonparametric, ordinal character of the variables, mean of Manhattan distance in cluster analysis was used, and for the assessment of significance of differences between the clusters – Kruskal-Wallis test. Several outlier variables were excluded from the analysis – variables measured with the use of the tasks no. 8 and 9 (INTI 1, INTI 2, INTE 1, INTE 2 and INTE 3), because all of the investigated children scored 0 for each of them. Hence, it can be stated that the tasks no. 8 and 9 turned out to be too difficult for the investigated sample. The analyses were conducted on raw data, with the use of SPSS Statistics, Version 21.

#### *3.1 Profiles of written speech*

The results obtained with the use of the Literacy Assessment Battery point to a significant heterogeneity of distributions of the measured variables. This is particularly visible in the values of standard deviations and in the results of skew statistics, presented in Table 6.

Table 6. Descriptive statistics for LAB

Variable	N	Range	M (SD)	Skew	Kurtosis
NATI	336	0–6	3,35 (1,45)	–0,38	0,27
NATE	336	0–8	4,85 (2,03)	–0,50	0,27
NAVI 1	336	0–10	5,77 (1,85)	1,43	0,27
NAVI 2	336	0–25	18,33 (8,00)	–1,35	0,27
NAVI 3	336	0–6	1,93 (1,82)	0,49	0,27
NAVE	336	0–9	3,22 (3,56)	0,51	0,27
OUTI 1	336	0–6	0,49 (1,29)	3,12	0,27
OUTI 2	336	0–18	9,17 (6,85)	–0,03	0,27
OUTE 1	336	0–9	5,05 (3,82)	–0,23	0,27
OUTE 2	336	0–54	1,82 (8,05)	5,20	0,27

As a result of the conducted analyzes, 5 clusters were singled out: cluster no. 1 (n=256), cluster no. 2 (n=67), cluster no. 3 (n=10), cluster no. 4 (n=2), and cluster no. 5 (n=1). As it can be observed in Table 7, distributions of all of the investigated variables measured in the tasks 1-7 of the LAB turned out to be different in the five distinguished clusters.

Table 7. Kruskal-Wallis statistics for all clusters (LAB)

Variable	K-W	df	Variable	K-W	df
NATI	52,09*	4	NAVE	86,24*	4
NATE	61,99*	4	OUTI 1	91,51*	4
NAVI 1	50,55*	4	OUTI 2	91,26*	4
NAVI 2	168,73*	4	OUTE 1	93,20*	4
NAVI 3	99,32*	4	OUTE 2	93,84*	4

\*p<0,05

Due to the small number of subjects in the clusters 4 and 5, further analyzes were carried out on the results obtained by the individuals from the clusters no. 1, 2, and 3. These three clusters, when compared in pairs with the use of Kruskal-Wallis test, proved to be characterized by completely different distributions of the variables tested by the LAB (see Table 8), which additionally confirms the high heterogeneity of the singled out clusters.

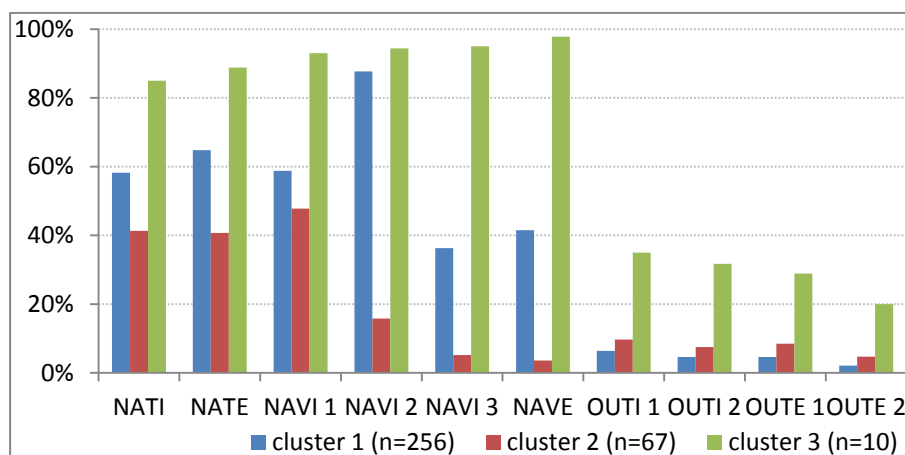
Table 8. Kruskal-Wallis statistics for each pair of clusters (LAB)

Variable	Pairs of clusters			Variable	Pairs of clusters		
	1&2	1&3	2&3		1&2	1&3	2&3
NATI	67,14*	-113,99*	-181,13*	NAVE	95,59*	-123,47*	-219,06*
NATE	86,09*	-104,89*	190,97*	OUTI 1	32,81*	-161,40*	-194,20*
NAVI 1	45,15*	-120,50*	-165,64*	OUTI 2	32,81*	-160,79*	-193,60*
NAVI 2	166,81*	-46,68	-212,49*	OUTE 1	17,40	-161,73*	-179,12*
NAVI 3	99,97*	-131,15*	-231,12*	OUTE 2	15,21	-165,79*	-180,99*

\*p&lt;0,05

The cluster no. 1 (n=256) is the largest of the selected clusters. The children from this group scored high on four (NATI, NATE, NAVI 1 and NAVI 2 above 50%) out the six variables constituting the profile of written speech characteristic of the naive stage (see Table 5 and Figure 2).

Figure 2. Mean results of LAB for transformed variables in clusters number 1, 2 and 3 (transformed variables = percentage proportion of maximal available score for raw variable)

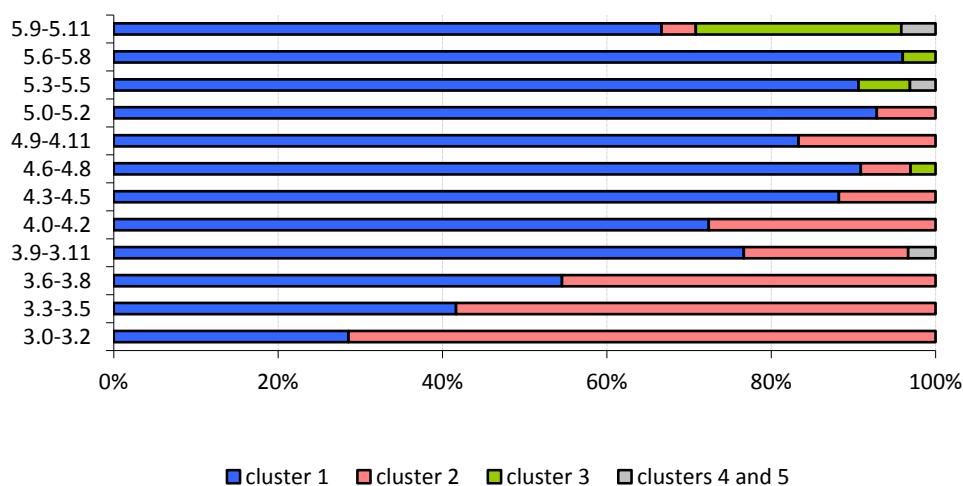


The remaining two variables had lower values (NAVI 3=36.3%, NAVE=41.5%), nevertheless, they were still higher than in the cluster no. 2. The levels of the variables that are hypothetically supposed to increase in the outer stage turned out to be very low in the discussed cluster (OUTI 1=6.4%, OUTI 2=4.6%, OUTE 1=4.6% and OUTE 2=2.1%). The profile of the results that characterizes the first cluster suggests that the subjects who belonged to this group were in the naive stage of written

speech development, with a relatively poorly developed competences associated with writing: object names writing and words copying. These results coincide with the results of previous studies conducted by the author, in which it was found that preschoolers were characterized by an inharmonious development of competences connected with reading in comparison to competences associated with writing (Jabłoński, 2003). The cluster no. 1 is composed predominantly of children between the age of 3.6 and 5.11 (between 54.5% and 96.0% of the population of quarterly age groups) (see Figure 3).

The children from the cluster no. 2 ( $n=67$ ) scored low (below 50%) on measures for all the tested variables. Their results ranged from 3.6% to 15.8% for the following variables: NAVI 2, NAVI 3, NAVE, OUTI 1, OUTI 2, OUTE 1, OUTE 2, NATI, NATE and NAVI 1, and from 40.7% to 47.8% for picture-print discrimination, drawing-writing discrimination and visual recognizing names of objects presented on pictures (see Figure 2). Such a configuration of the results suggests that the subjects from this cluster were in the period of transition between the natural and the naive stage of written speech development. The cluster no. 2 is composed mainly of children between the age of 3.0 and 3.5 (between 58.3% and 71.4% of the population of quarterly age groups). Also individuals from the group of 3.6-5.2-year-olds (between 6.1% and 45.5%), and even from the group of 5.9-5.11-year-olds (1 person) can be spotted in this cluster (see Figure 3).

Figure 3. Size of clusters in age groups.



The cluster no. 3 ( $n=10$ ) is the smallest of the singled out groups. The children from this cluster achieved high scores (between 85.0% and 97.8%) for all of the variables forming the profile of written speech characteristic to the naive stage (see Table 5



and Figure 2). They also obtained the highest results, when compared with the cluster 1 and 2, for the variables which level is hypothetically supposed to increase in a specific way for the outer stage (OUTI 1=35.0%, OUTI 2=31.7%, OUTE 1=28.9%, and OUTE 2=20.0%).

Such a configuration of the results suggests that the subjects from this cluster have achieved the maximal level of skills characteristic to the naive stage and they have entered into the outer stage of written speech development. The cluster no. 3 is composed predominantly of children between the age of 5.3 and 5.11 (between 4.0% and 25.0% of the population of quarterly age groups). One subject from this cluster belongs to the group of 4.6-4.8-year-olds (see Figure 3).

### 3.2 Levels of inhibition

The results obtained in the CCS proved to be consistent with the results of previous studies. Zelazo et al. (2003) claim that the majority of children above the age of 3 are able to sort cards according to one criterion. The analysis of descriptive statistics for the pre-switch phase shows that the majority the investigated children performed almost completely correct during this phase (see Table 9).

Table 9. Descriptive statistics for CCS

Phase of test	N	Range	M (SD)	Skew	Kurtosis
I: Trial phase	336	n/a	n/a	n/a	n/a
II: Pre-switch phase	336	0-7	6,92 (0,53)	-9,17	99,58
III: Post-switch phase	336	0-7	5,55 (2,47)	-1,52	0,68
IV: Border phase	336	4-12	7,41 (1,47)	0,96	1,47

In turn, during the phase III of the study, those who performed best were the 5-year-olds, whereas those who scored lowest were the 3-year-olds (see Table 10). It is not surprising, given research conclusions that point to the fact that only 3-year-olds and some of 4-year-olds have problems with switching to the task of sorting cards according to a different criterion (here: shape).

The fourth phase of the study was performed by all of the investigated children on a comparable level (see Table 11), which is consistent with Zelazo's (2006) claim that tasks where appear framed cards are too difficult for children below the age of 7.

Table 10. Distribution of results in post-switch phase of CCS for age groups

Age group	N	Range	M (SD)	Skew	Kurtosis
3-year-olds	101	0-7	4,32 (3,03)	-0,54	-1,51
4-year-olds	126	0-7	5,68 (2,32)	-1,64	1,17
5-year-olds	109	0-7	6,55 (1,31)	-3,91	16,25

Table 11. Distribution of results in border phase of CCS for age groups

Age group	N	Range	M (SD)	Skew	Kurtosis
3-year-olds	101	4-11	6,93 (1,29)	0,33	0,59
4-year-olds	126	5-12	7,46 (1,24)	1,27	2,75
5-year-olds	109	4-12	7,80 (1,74)	0,86	0,27

The comparison of performance in the CCS in the three clusters established on the basis of the analysis of the LAB results (see above), confirms that the clusters do not differ in terms of the performance levels in the phase II – as it has been already mentioned – the majority of children executed this task correctly. Differences between the clusters can be observed, though, in respect of the results of the phases III and IV (see Table 12).

Table 12. Kruskal-Wallis statistics for all clusters (CCS)

Variable	K-W	df
I: Trial phase	n/a	n/a
II: Pre-switch phase	7,49	4
III: Post-switch phase	30,01*	4
IV: Border phase	9,73*	4

\*p&lt;0,05

When we take a closer look at the differences, we can notice that, first of all, they occur exclusively between the clusters 1 and 2, and the clusters 2 and 3, and, secondly, they pertain only to the post-switch phase of the CCS (see Table 13). The distribution of the results for border phase is comparable, which has already been mentioned above.

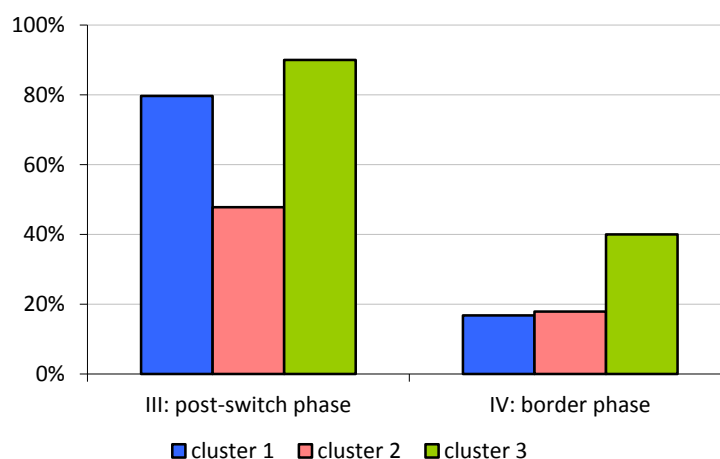
Table 13. *Kruskal-Wallis statistics for each pair of clusters 1, 2 and 3 (CCS)*

Variable	Pairs of clusters		
	1&2	1&3	2&3
I: Trial phase	n/a	n/a	n/a
II: Pre-switch phase	n/a	n/a	n/a
III: Post-switch phase	55,45*	-34,68	-90,12*
IV: Border phase	31,00	-50,17	-81,17

\*p<0,05

The results of the CCS obtained by the children who belonged to different clusters suggest that the children from each cluster differ from one another in terms of the levels of inhibitory control. The children from the cluster no. 2 attained results that indicate that they possess a lower level of inhibitory control (47.8%) in comparison with the subjects from the cluster no 1 (79.7%) and the cluster no. 3 (90.0%) (see Figure 4, the post-switch phase). Despite the fact that the overall indicator of differences in the distributions of the border phase results for the three clusters is statistically significant (see Table 12), when more accurate analyzes are carried out (comparison of the clusters in pairs), this significance disappears (see Table 13). Thus, it seems that the difference between the results obtained in this phase by the children from the cluster no.1 (16.8%) and no. 2 (17.9%), on the one hand, and the subjects from the cluster no.3 (40.0%), on the other hand, is located on the verge of statistic significance. This may suggest that the children from the cluster no. 3 have already reached the maximal level of one-time inhibition of a learned reaction (post-switch phase), and they have already commenced the process of developing the ability to execute inhibition more frequently and with reference to a multiple type of executed task change (the border phase), characteristic of older children.

Figure 4. Mean results for transformed variables in clusters number 1, 2 and 3 (transformed variables = percentage proportion of maximal available score for raw variable).



#### 4. DISCUSSION

The first main objective of this study was to confirm the existence of different levels of reading and writing competences, referring to different levels of written speech development in preschoolers. The analyses conducted on the whole sample, without assigning arbitrarily the participants to particular subgroups, confirmed the existence of three characteristic profiles, which possess specific features that can be interpreted in the context of the stages of written speech development. The first of these profiles (cluster 1) is typical of the naive stage of written speech development, with relatively poorly developed skills associated with writing. The second profile (cluster 2) refers to the period of transition between the natural and the naive stage of written speech development. The last profile (cluster 3) is characteristic of children who had already completed the naive stage and have just enter the outer stage of written speech development.

Coincidentally, the results obtained with the use of the LAB confirmed the thesis put forward by Krasowicz-Kupis (1999) that the development of ability to read and write does not progress equally in all children. This is markedly visible in the age diversification of the three clusters. It is also worth stressing that this diversification would not be observable, if it were not for the purposive sampling, consisting in assigning the subjects to several subgroups characterized by a small (quarterly) age range. Such a procedure of recruitment makes it more probable to reveal all possible profiles characteristic of developmental changes of high dynamics.

The issue of whether the totality of the observed results diversification can be interpreted in terms of certain developmental regularities, remains an open ques-

tion that requires, *inter alia*, further examination of the quality of the LAB tool and conducting normalization studies. Although the author invited to the study only preschoolers who had no diagnosed disorders, still some children with discrete developmental irregularities could have been included in the sample. Thus, it cannot be ruled out that the results of the LAB partially reveal the children who are in the need of therapeutic intervention (e.g. the children in the period of transition between the natural and the naive stage of written speech development /cluster 2/ who have already reached the age of 5) (see also Brzezińska, 2004).

It should also be noted that in the investigated sample certain indicators of a disharmonious development of competences associated with reading and competences connected with writing (cluster 1, especially the values of NAVI 3 and NAVE) could have been observed. This phenomenon can be attributed to, at least, three sources: (1) incorrect calibration of the tool, (2) different developmental trajectories of reading and writing, or (3) application of different teaching instructions in the sample. The first hypothesis can be verified by means of conducting further enhancement works on the LAB, about which the author has already talked above. The second hypothesis appears to be fairly probable, because Frith (1985) and Ehri (2005) emphasize that the processes of reading and writing skills progression do not have equal dynamics, and that the developmental changes pertaining to one of them can be the factor that triggers changes in the other. The mutual relations between the two fundamental aspects of communication with the use of written speech – reception and sending – require further studies within a paradigm that would examine and analyze them jointly. The third hypothesis seems rather unlikely, because preschoolers do not undergo – at least in Poland – formal training in reading and writing skills (for instance, as a part of kindergarten education). Nevertheless, it cannot be excluded that kindergarten educational programs or home environments may in some cases excessively accentuate developing certain constituent skills of written speech, and disregard other. Hulme and Snowling (2013) draw attention to the fact that parents often engage with their preschool children in various activities that introduce them to the world of written speech, e.g. „code-focused” activities – teaching children letter-sound relations and how to recognize printed words, or “meaning-focused” activities – reading stories aloud and discussing them with the child.

The second objective of the discussed study was to verify whether different levels of inhibitory control coincide with different levels of written speech development. The results obtained by the subjects indicate that the earlier stages of written speech development coincide with a lower level of inhibitory control (see the results of the LAB and the CCS for the cluster no. 2), and the later stages with a higher level of this control (see the results of the LAB and the CCS for the cluster no. 3). Of course, these results do not allow us to infer about casual relationships between inhibitory control and written speech in the process of development. This would require further studies in the longitudinal paradigm. A separate issue is also the question about the degree to which the CCS measures inhibitory control (a de-

tailed analysis of this problem has been presented elsewhere – see Jabłoński et al., 2013). However, if we put aside (yet do not ignore) psychometric problems, it seems that the present study has confirmed the suppositions of researchers who claim that the importance of inhibitory control varies depending on the stage of literacy development. For example, Christopher and colleagues (2012) have suggested that “it is likely that children in the earlier stages of “learning to read” (before the age of 8) may require different cognitive processes or have different patterns of relations between the cognitive and reading constructs”. The aforementioned Altemeier et al. (2008) speak directly about the necessity to distinguish a lower and higher level of literacy skills and, adequately, a lower (including inhibition) and higher level of executive function engagement at different stages of literacy development. This corresponds to the model of written speech development in which the task of receiving or sending a written message becomes, with progressing to the consecutive stages of development, more and more difficult, and requires using more and more advanced specific (e.g. word reading) and non-specific (e.g. rapid automatic switching) competences. For, with the development, the child’s understanding of the function of written speech as a sign in the process of communication becomes more and more complete.

## 5. CONCLUSION

It appears that the perspective of viewing literacy development as the process of written speech development, of which early determinants need to be traced to the sphere of executive functions, creates new possibilities of preventing, diagnosing and treating school readiness disorders. First of all, adopting such a perspective involves looking upon the preliteracy period not only as the time of preparation of necessary reading and writing skills, but also as the developmental phase during which the ability to communicate with the use of written speech already works, although in a primitive form. This, in turn, implies changing the approach to the process of diagnosing these functions before the beginning of formal training in reading and writing skills. The new diagnosis ought to take into consideration not only efficiency of single functions, but also the efficiency of their coordination and integration for the purpose of receiving or sending a written message at each stage of written speech development.

Secondly, due to the fact that the basic executive function of inhibitory control develops approximately at the age of 3-4 and it can be measured even in a 2,5-year-old child (Zelazo, 2006), its level can serve as a prognostic indicator of the efficacy of learning how to read and write (Altemeier et al., 2008). It enables providing earlier support to children, especially to those at risk of school difficulties.

Finally, discovering the role of executive functions in the process of literacy development may be an inspiration to introduce new strategies of both reading and writing teaching, and treating difficulties in acquiring these competences. For example, an effective treatment of dyslexia may require more explicit instruction on

self-regulation strategies for engaging and applying executive functions during reading and writing (Altemeier et al. 2008).

For the perspective on the development of reading and writing skills outlined above to materialize, it is necessary to carry out further studies of the relationship between executive functions and literacy at the stages prior to those on which researchers have focused so far.

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