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COGNITIVE AND METACOGNITIVE MECHANISMS USED BY STUDENTS WITH HEARING LOSS DURING COMPREHENSION OF LITERARY TEXTS: INFERRING FROM EXPLICIT AND IMPLICIT INFORMATION

KOGNITYWNE I METAKOGINTYWNE MECHANIZMY WYKORZYSTYWANE PRZEZ UCZNIÓW Z USZKODZENIAMI SŁUCHU W INTERPRETACJI TEKSTÓW LITERACKICH: WNIOSKOWANIE NA PODSTAWIE INFORMACJI EKSPLICYTNYCH I IMPLICYTNYCH

Streszczenie: Celem artykułu było rozpoznanie poznawczych i metapoznawczych predyktorów rozumienia przez uczniów z uszkodzonym słuchem zawartych w tekstach literackich informacji wyrażonych wprost i pośrednio. Analiza regresji wykazała, że u uczniów z wadą słuchu wnioskowanie o intencji autora tekstu na podstawie informacji wyrażonych wprost oraz w sposób pośredni jest tłumaczone innymi predyktorami. Jednocześnie wyniki te potwierdzają, że zastosowanie przez nauczyciela wsparcia ukierunkowującego uczniów z uszkodzonym słuchem na zastosowanie odpowiednich strategii czytania może pomóc w doskonaleniu rozumienia i interpretacji czytanych tekstów.

Słowa kluczowe: uczniowie z uszkodzonym słuchem, czytanie ze zrozumieniem, metakognitywne strategie czytania

Abstract: The aim of this article was to identify cognitive and metacognitive predictors of deaf and hard of hearing students' understanding of explicit and implicit information in literary texts. Regression analysis showed that students with hearing loss's inferences about the author's intentions based on explicit and implicit information are explained by different predictors. At the same time, these results confirm that using teacher support to guide students with hearing loss in using appropriate reading strategies can help improve their understanding and interpretation of the texts they read.

Keywords: students with hearing loss; reading comprehension; metacognitive reading strategies

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Introduction

Written texts, in addition to direct human interactions, are one of the main sources of knowledge about the world. In the model approach to the reading process, the reader is a cognitively active individual who is able to regulate their cognitive resources in order to acquire knowledge contained in texts (Kintsch 2013; Kintsch, Mangalath 2011; Rumelhart 2013). This activity depends on the reader's knowledge of the reading process, on the monitoring of reading comprehension, and the ability to use reading strategies (Jacobs, Paris 1987; Garner 1994). Thus, key cognitive (Singer 1994; Rumelhart 2013) and metacognitive (Ruddell, Unrau 2013) processes are involved in the process of becoming an aware and active recipient of texts.

Representation of a literary text is a dynamic process that requires constant verification of the content expectations. This verification is carried out as a result of the integration of knowledge from three sources: previous and current text fragments and knowledge about the world (Danks, Rittman 1986; Jackson et al. 1997). Text comprehension is, therefore, a step-by-step project (Gadamer,2013; Ricoeur 1989).

One factor that contributes to a consistent representation of the text is inferring from the content explicitly and implicitly expressed by the author (Ingarden 1988; Iser 1980; Searle 1975).

What do we know about the understanding of reading text by deaf and hard-of-hearing people?

The interest in reading by hard-of-hearing and deaf people has increased significantly over several decades. As a result, there are numerous studies, the results of which are not optimistic. Not only do they provide evidence of a significantly lower level of literacy skills in people with hearing loss compared to hearing people (Korendo 2009; Monreal, Hernández 2005; Wauters et al. 2006), they also show that among students with hearing loss, educational activities are not effective in improving literacy (Marschark, Harris 2016).

Research demonstrates that hard-of-hearing and deaf people, compared with hearing people, achieve significantly lower results when it comes to inferring from the information expressed both explicitly and implicitly. Moreover, the research shows that readers with hearing loss have a better understanding of the content that is communicated directly than the content that is expressed implicitly by the author (Walker et al. 1998). Recent research has focused on the differences in perception of explicit and implicit content by deaf readers, as well as the factors that determine comprehension of information that has not been expressed directly (Doran, Anderson 2003; Kyle, Cain 2015). Walker et al. (2015) demonstrates that children and adolescents with significant and profound hearing loss, despite difficulties, are able

to develop competence in both literal and inferential understanding of the content they read.

One reason that makes it difficult for deaf and hard-of-hearing people to understand the text is problem in processing the syntactic structure of the sentence (Kołodziejczyk 2015; Miller et al. 2013). The syntactic deficit, in combination with the poor lexical resource (Muzyka-Furtak 2015), makes it impossible to fully understand the sentences read. Moreover, people with hearing loss have no awareness of the difficulties they experience, or they have only limited awareness. As a result of their overestimating of reading competencies, they either do not activate cognitive and metacognitive mechanisms leading to the use of reading strategies, or they activate mechanisms that are ineffective (Borgna et al. 2011).

Equipping hard-of-hearing and deaf students with the ability to work with texts is one of the basic educational goals – it is impossible to implement the main principles of the educational process without it. In this context, it is particularly important that teachers take steps to activate cognitive and metacognitive strategies for working with text with hard-of-hearing and deaf students. The effectiveness of such actions has been confirmed by previous studies (Aceti, Wang 2010; Benedict et al. 2015; Charlesworth et al. 2006; Ducharme, Arcand 2011; Schirmer et al. 2015).

The present paper investigates one of the aspects of text comprehension in hard-of-hearing and deaf students, that is, inferring from the content that the author expressed explicitly, through metaphors or references to elements of the fantastical world, and implicitly, in a way that forces the reader to search for hidden meaning.

Method

The aims of the study were as follows: 1. To perform a comparative analysis of the skills of students with hearing loss with the skills of their hearing peers in terms of understanding the words that are key for the interpretation of the text, understanding complex sentences, and the ability to infer from the content expressed by the author explicitly and implicitly. 2. To identify differences in the self-reported frequency of reading strategy use by students with and without hearing loss and to establish the relationships between the self-reported reading strategy use and inferring from explicit and implicit content in both groups. 3. To identify predictors of literary texts comprehension in deaf and hard-of-hearing students, and to determine whether the actual use of selected reading strategies has any impact on their understanding of literary texts.

Participants

One hundred people participated in the study – 50 students with prelingual and peri-lingual early hearing loss exceeding 70 dB in both ears and no additional afflictions that could be determined on the basis of medical and psychological

tests and 50 hearing students. The students with hearing loss were aged 13–17 years and they were selected from five special schools for hard-of-hearing and deaf children and adolescents located in five cities (Lublin, Przemyśl, Szczecin, Warszawa, Wrocław). The study used random purposive sampling.

The comparison group consisted of 50 hearing students aged 13–16 without identified learning difficulties due to disability or dyslexia.

Measures

To assess the reading comprehension, self-authored tests were used that included fragments from young adult fiction literature. To test the identification and comprehension of the words that are key to understanding and interpreting the text being read, a proprietary tool was used, constituting a list of 18 words essential for understanding the prepared text fragments. For each word, three definitions were developed, in line with the assumptions of cognitive semantics (Wierzbicka, 1996), only one of which reflected the meaning of a given word. Apart from definitions, synonyms were also provided for each word. The set, therefore, included 30 definitions and 18 groups of synonyms.

For the assessment of complex sentence comprehension, five sentences of varying syntactic complexity were used. All sentences were taken from the same readings, fragments of which were used to test the text reading comprehension. It should be noted that these sentences were not part of the fragments used to create the comprehension tests.

To measure students' self-reported use of reading strategies, the Metacognitive Awareness of Reading Strategies Inventory (MARSI; Mokhtari, Reichard 2002) was used. The MARSI contains 30 items assigned to three factors. The first factor is Global Reading Strategies (GLOB) includes statements about the general analysis of the text being read in relation to both its content and organization. The second factor is Problem-Solving Strategies (PROB). This factor includes actions taken by the reader when the text becomes difficult and the reader encounters problems that impede their understanding of the content. The third factor is Support Reading Strategies (SUP); it concerns the use of auxiliary means, such as taking notes, paraphrasing, summarising, and discussing the text.

Statistical Analysis

The studied variables met the assumptions for the use of Student's t-test in terms of the number of participants in each group, distribution, and homogeneity of variance. The skewness coefficients for the examined variables GLOB, SUP, PROB were within the range (- .138 : .337) and for the remaining variables within the range (-.263 : .337), while the kurtosis coefficients for the examined variables were within the ranges (-.741 : .662), (-.364 : .662), respectively.

Results

In order to answer the question about the differences in the keywords comprehension, complex sentences comprehension, and the self-reported frequency of reading strategy use between the students with and without hearing loss, data were analyzed using the independent samples t-test. The results are summarized in Table 1.

Table 1. Differences in the mean scores obtained by the students with and without hearing loss for the following variables: keyword comprehension, sentence comprehension, GLOB, SUP, PROB

Variable	Students with hearing loss N = 50		Hearing students N = 50		Student's t-test		
	M	SD	M	SD	t	df	p
Key words comprehension	.17	.22	.80	.24	-13.56	98	<.001
Complex sentences comprehension	.58	.22	.90	.14	-8.73	81.30	<.001
GLOB	3.1	.74	3.18	.67	-.54	98	.587
SUP	3.04	.76	2.7	.81	1.97	98	.051
PROB	3.4	.88	3.6	.81	-1.13	98	.262

Note: M = mean; SD = standard deviation; t = Student's t-test statistics; df = degrees of freedom; p = statistical significance. 95% confidence interval for the mean difference

The analysis shows that students with hearing loss achieved significantly lower results than their hearing peers, both in the understanding of the words that are key to understanding and interpreting the text, and in the comprehension of complex sentences. Particularly large differences were observed for word comprehension.

The results also show that students with hearing loss do not differ significantly in terms of the self-reported use of reading strategies from hearing students in any of the three types of strategies – GLOB, SUP, and PROB.

Table 2 presents the between-group differences in inferring the author's intention from the information provided explicitly and implicitly and understanding of the text.

Table 2. Differences in the average results of each group in text comprehension – inferring the intention of the author

Variable	Students with hearing loss N = 50		Hearing students N = 50		Student's t-test		
	M	SD	M	SD	t	df	p
Inferring the author's intention from information expressed implicitly or explicitly – overall result	.31	.20	.66	.18	-9.30	98	< .001
Inferring the author's intention from information expressed implicitly	.22	.22	.54	.27	-6.60	94.11	< .001
Inferring the author's intention from information expressed explicitly (fantasy, metaphor)	.39	.26	.78	.23	-7.90	98	< .001

Note: M = mean; SD = standard deviation; t = Student's t-test statistics; df = degrees of freedom; p = statistical significance.
95% confidence interval for the mean difference

The data presented above show that, compared to their hearing peers, hard-of-hearing and deaf students were less able to infer the author's intention from the content expressed implicitly and explicitly but with the use of metaphor and fantastic content.

To identify potential predictors of reading comprehension, a correlation analysis of the independent and dependent variables was conducted. The results are presented in Table 3.

The results show that the statistically significant correlations between the comprehension of keywords and complex sentences and the text comprehension observed in the group of students with hearing loss concern both the general result of inference of the author's intention and also individual component variables. Such variables include inferences based on information provided by the author implicitly and also expressed explicitly by means of a metaphor or linguistic expression relating to elements of the fantastic world.

Among the group of hearing students, comprehension of complex sentences did not correlate with any of the studied aspects of text comprehension. However, there were correlations between the comprehension of keywords and two of the three aspects of the text comprehension, that is, the overall result of inferring the intention of the author and inferring from implicit information.

Table 3. Pearson correlation (r) of variables – KC, CSC, GLOB, SUP with variables from the range of inferring the author's intention in the group of students with hearing loss (HLS) – (N = 50), and hearing students – (HS) (N = 50)

Variable		Keywords comprehension (KC)	Complex sentences comprehension (CSC)	GLOB	SUP	PROB
Inferring the author's intention from information expressed implicitly or explicitly – overall result	HLS	.420**	.479**	.116	-.139	.304*
	HS	.479**	.154	.201	.125	.400**
Inferring the author's intention from information expressed implicitly	HLS	.338*	.313*	.132	-.165	.193
	HS	.435**	-.002	.098	.015	.203
Inferring the author's intention from information expressed explicitly (fantasy, metaphor)	HLS	.354*	.465**	.066	-.073	.299*
	HS	.262	.250	.209	.183	.406**

*p<0.05

**p<0.01

With regard to the relationship between the self-reported reading strategies use and inferring the intention of the author, the only significant correlations related to PROB. In both groups, the PROB correlated with the overall result of inferring the author's intention and with inferring the author's intention on the basis of information provided explicitly using metaphor and linguistic means relating to elements of the fantastic world.

These results show that inferring the author's intention within a text differs depending on the way the content is expressed (explicitly or implicitly). To deepen the knowledge about the mechanisms determining this aspect of reading comprehension, regression analyses were conducted.

The first model tested relates to the overall result obtained by students in the tasks assessing the inferring of the author's intentions. It was assumed that, in this case, complex sentence comprehension would be a direct predictor, while the comprehension of keywords would play the role of a mediator. Model 4, with one mediator variable, was analyzed (Hayes, 2018). Both the model that takes into account only the complex sentences comprehension as an independent variable $F(1, 48) = 14.31$; $p < 0.001$, and the one that takes into account both the mediator and the independent variable, are well fitted to the data $F(2, 47) = 9.73$; $p < 0.001$. The first model explains 23% ($R^2 = 0.23$) of the variance of the dependent variable, while the second model explains 29% ($R^2 = 0.29$). Thus, the model with an intermediary variable, i.e., words comprehension, is better able to predict the percentage

of variance in the overall score of inferring the author's intentions than the model with a single predictor of complex sentences comprehension (Table 4).

Table 4. Statistics specifying the percentage of variance explained by R^2 of both models – the main-effect-only model, and the model including the mediator

Model	R	R^2	Standard error of the estimate	F	df1	df2	p
1	.479	.230[a]	1.960	14.313	1	48	< .001
2	.541	.293[b]	1.838	9.728	2	47	< .001

Predictors in the model: complex sentences comprehension.
Predictors in the model: complex sentences comprehension, words comprehension.

The analysis of standardized regression coefficients shows that, prior to the introduction of a mediator into the model, the value of the coefficient determining the strength of the direct effect of complex sentence comprehension on the overall result of inferring the author's intentions is $\beta = 0.48$, $p < 0.001$. After introducing word comprehension skills into the model as a mediator, complex sentence comprehension remains an important predictor, but the value of the coefficient decreases, $\beta = 0.37$, $p = 0.008$. This indicates partial mediation of word comprehension ($\beta = 0.27$, $p < 0.05$) in the relationship between the independent and dependent variables.

In order to assess the influence of reading strategies on the relationship between the independent and dependent variable, taking into account the intermediate role of word comprehension, testing Models 5 and 14 were utilized (Hayes, 2018). Results indicated that no type of strategy determines the relationship between complex sentence comprehension and the overall result of inferring the author's intentions. There was also no effect of reading strategies on the relationship between word comprehension and the overall result of inferring the author's intentions.

As already noted, it is assumed that some factors and mechanisms are responsible for inferring the meaning of the content that the author conveyed indirectly, and other factors are responsible for understanding the information conveyed by metaphorical expressions and elements relating to the fantastic world. It can, therefore, be assumed that the models of text comprehension in both cases will also be different.

In order to identify predictors of inferring the meaning of information indirectly expressed by the author, the results obtained after entering the data into Model 4 were analyzed (Table 5).

Table 5. Statistics summarizing the model fit

Model	R	R^2	Standard error of the estimate	F	df1	df2	p
	.313	.098	0.701	5.216	1	48	.027

Predictors in the model: complex sentences comprehension.

Dependent variable: inferring the author's intention from the information expressed implicitly.

The analysis of standardized regression coefficients shows that only the model with one predictor, $F(1, 48) = 5.22$, $p = 0.027$, complex sentence comprehension $\beta = 0.313$, $p < 0.05$, is well suited to the data.

This model explains relatively little, only approximately 10% ($R^2 = 0.098$) of the variance of the dependent variable. This low percentage of the variance explained may be due to the fact that a more complex inference than simply complex sentence comprehension is necessary to "read between the lines".

Model 1 (Hayes, 2018) was used to discover whether any of the reading strategies self-reported by the students with hearing loss affected the relationship between the independent and dependent variables. Of the three obtained, the only significant model is the one in which the relationship between complex sentence comprehension and the inferring of information conveyed in an indirect way is conditioned by SUP, $F(3, 46) = 4.46$; $p = 0.008$. After taking into account the moderator, the change $R^2 = 0.09$, $p = 0.03$ was statistically significant, and the resulting model explains 23% ($R^2 = 0.23$) of the dependent variable variance (Table 6).

Table 6. Statistics specifying the percentage of variance explained by predictors in the R^2 dependent variable in the Model

R	R^2	Standard error	F	df1	df2	p	Statistics of change				
							R^2	F	df1	df2	p
.475	.225	.628	4.458	3	46	.008	.085	5.019	1	46	.030

Predictors in the model: complex sentences comprehension, SUP

Dependent variable: inferring the author's intention from the information expressed implicitly.

Interestingly, the analysis indicates that the relationship between complex sentence comprehension and the understanding of the information conveyed in an indirect way is statistically significant only for the low level of the self-reported frequency of SUP use. In the other two groups, despite the self-reported average and high frequency of strategy use, no relationship between the independent and dependent variables was found. The fact that an increase in complex sentence comprehension leads to an indirect increase in the understanding of the content conveyed indirectly ($B = 0.39$, $p = 0.002$), but only in this group of students, may

be due to the fact that the students with higher linguistic competence do not need to use reading strategies to infer the implicit intentions of the author of the text.

In the assessment of mechanisms for understanding the texts containing explicit information (fantasy, metaphor), a model with complex sentences comprehension as a predictor was well suited to the data ($\beta = 0.46$, $p < 0.001$).

The model obtained is statistically significant $F(1, 48) = 13.24$, $p < 0.001$ and explains 22% of the variation of the dependent variable $R^2 = 0.22$ (Table 7).

Table 7. Statistics summarizing the model fit

Model	R	R^2	Standard error of the estimate	F	df1	df2	p
	.465	.216	.866	13.235	1	48	< .001

Predictors in the model: complex sentences comprehension.

Dependent variable: inferring the author's intention from the information expressed explicitly.

In order to determine whether students' self-reported use of reading strategies determines the relationship between complex sentence comprehension and understanding of the content containing metaphors and fantastical elements, data from Model 1 testing were used for analysis (Hayes, 2018). Somewhat surprisingly, none of the strategies condition the relationship between the independent variable and the dependent variable.

An independent samples t-test was performed to verify whether the researcher's support through the reading process by activation of cognitive and metacognitive mechanisms increased the effectiveness of inferring meaning from the text (Table 8).

The results confirm that accompanying the student in the interpretation of the text and a reflexively planned process of reinterpreting the meanings significantly improve the effectiveness of working with the literary text. Furthermore, the magnitude of the effect is large in all cases.

Discussion and Conclusion

The analyses confirm the assumption that the type of task given to students in relation to the text alters the configuration of predictors that successfully predict the inference of the author's intentions. Especially noteworthy are the differences observed in models where inferring from information conveyed indirectly and inferring from the content containing metaphors and fantastic elements are dependent variables. If students work with a text in which the content is transmitted indirectly, the SUP determine the relationship between the independent and dependent variables. This may indicate that when students encounter a problem in understanding the text, they actually try to use SUP, such as adjusting the pace of reading, returning to previous fragments of the text, or making a summary and reflecting upon the content being read. The fact that this applies only to situations

Table 8. Differences in mean results obtained by the subjects for individual variables in terms of reading comprehension

Variables	Students with hearing loss (N = 50)				t	df	p	d
	Pretest	Posttest						
	M	SD	M	SD				
Inferring the author's intention on the basis of explicit and implicit content – the overall result	.31	.20	.57	.29	-7.77	49	< .001	1.10
Inferring the author's intention from information expressed implicitly	.22	.22	.48	.33	-6.20	49	< .001	0.87
Inferring the author's intention from information expressed explicitly (fantasy elements, metaphor)	.39	.26	.67	.30	-7.60	49	< .001	1.07

Note: M = mean; SD = standard deviation; t = Student's t-test statistics; df = degrees of freedom; p = statistical significance, d (Cohen's d) = effect size.

where the self-reported frequency of strategy use is low may result from the fact that a higher level of linguistic competence, and therefore a higher awareness of difficulties in understanding complex sentences, makes it possible to use reading strategies more reflexively, although perhaps only occasionally. Among students who reported an average and high frequency of SUP use, the most likely reason why these strategies do not condition the relationship between complex sentence comprehension and inferring information expressed implicitly is poor linguistic awareness. In this situation, even though the use of the strategies is not just a declaration, it still does not affect the relationship between the dependent and independent variables. It is difficult to expect any strategy to be effective if students are unable to identify a problem that prevents them from understanding the text (Borgna et al. 2011). It is also likely that they are not aware of their lack of understanding of what they are reading.

The ability to infer from a text containing metaphors or fantastic elements is explained by a slightly different model. In this case, complex sentence comprehension is the best predictor. This seemingly surprising result has a logical explanation because, in this particular case, the information that was key to solving the tasks was usually contained in one sentence. To link pieces of information, the students did not need to make a complex analysis of the structure of the sentence, or refer to previous parts of the text; it was enough for them to identify the content that did not correspond to their previous knowledge and experience. Thus, the higher the level of linguistic competence that allows the student to understand sentences,

the easier it is for them to confront their meaning with the accumulated knowledge. At this point, control over comprehension of the text is taken over by the cognitive mechanisms responsible for combining and confronting pieces of information obtained during reading with the knowledge and experience of the reader.

In the general model of discovering the author's intentions, the predictors of the dependent variable are both complex sentence comprehension and word comprehension. Thus, word comprehension mediates the relationship between sentence comprehension and the overall result of inferring the author's intentions. The assumption put forward in relation to each of the individual aspects of inferring the author's intentions was partially confirmed. In the case of the overall inference of intentions, the assumption was only valid for the mediatory role of word comprehension in the relationship between sentence comprehension and the dependent variable; the assumption of the moderating role of the self-reported reading strategies was not confirmed. When considering intentions expressed implicitly, word comprehension does not play a mediating role. SUP, however, were a moderator in the interaction between the independent and dependent variables.

There are two possible reasons for this partial confirmation of the assumptions. First, the use of strategies may be purely declarative, while deaf students do not use them when faced with a reading problem. On the other hand, it is also likely that they are aware of the difficulty in understanding the meaning of the text, and they not only declare but also use reading strategies; however, their level of linguistic competence is too low to increase the effectiveness of reading.

At this point, the role of the teacher as an intermediary between the reader and the text becomes particularly important. The above research seems to provide evidence that the reflective approach of the teacher to the text and the reader, in this case to a student with hearing loss, determines the effectiveness of the reading process. The results suggest that hard-of-hearing and deaf students can achieve a much better understanding of the content they read when they work with a teacher who uses specific strategies, both meta-textual and related to the organization of working with the text, to direct their inferring processes, than when they try to meet the challenges posed by the text on their own. These results are in line with previous findings (Ducharme, Arcand 2011; Benedict et al. 2015).

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