

EVALUATION OF TABLEXIA – A TABLET APPLICATION FOR TRAINING COGNITIVE ABILITIES OF CHILDREN WITH DYSLEXIA

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Abstract

Current research on dyslexia shows that a number of cognitive skills that are important components of reading and writing are frequently impaired among individuals with dyslexia (European Dyslexia association, 2014). The aim of the present study is to evaluate the effectiveness of the program *Tablexia* on reading and writing skills. *Tablexia* is a free to download modern educational app for tablets which aims at supporting the development of cognitive abilities of children from 5th to 8th grade. In this study a total of $N = 34$ students from 4th to 8th grade (35.3% female) visiting two different special-needs schools in Germany were assigned to an experimental group and a waiting-control group. In order to assess developmental processes, the reading and writing skills and the cognitive abilities of the students were measured at three time points. The reading and writing skills were assessed by means of the Salzburger Lese- und Rechtschreibtest (SLRT II; Moll & Landerl, 2010). The writing part of the SLRT II is limited for students till 5th grade. In order to measure the writing skills of students from 6th grade and higher the Westermann Rechtschreibtest 6+ (WRT 6+; Rathenow, Vöge & Laupenmühlen, 1980) was used. For measuring the cognitive abilities the Kognitive Fähigkeitstest (KFT; Heller & Perleth, 2000) was used. Children have reported *Tablexia* improved their reading and writing skills. But no effect of *Tablexia* could be found. There was a positive development of their skills, but it was not the result of the training. Possible reasons are discussed in this paper and further results are presented.

Keywords: Dyslexia, cognitive abilities, tablet app, cognitive training, *Tablexia*, educational app, dysgraphia.

1 INTRODUCTION

Nowadays internet and technological development are an important and omnipresent part of our everyday life ([1]). Everyone is forced to read and process a huge amount of information and communicate with others in written form ([2]). Therefore the ability to read and write is therefore essential and can influence personal development, quality of life and possibilities in the job market ([3]). On the other hand technology has also the potential to boost reading and writing skills ([2]). Increased demands on the ability to write and read effect especially individuals with dyslexia ([3]). Computer programs and apps for children and adults with dyslexia have been developed and used ([4]). These technical opportunities have the potential to be a motivating aid for people with reading and writing difficulties ([2]). However there are only a few studies that evaluate effectiveness of these programs ([4]).

European Dyslexic Association ([5]) defines dyslexia as a congenital disorder, which is based on a change of certain brain areas that are responsible for cognitive functions such as phonological processing, working memory, rapid naming, sequencing and the automaticity of basic skills. Deficiencies of cognitive functions in these areas differ in each individual with dyslexia ([2]). As a result people develop problems with reading and writing ([5]). Precisely for this reason different cognitive trainings are used as an intervention aim to improve impaired functions ([2]).

Most programs and intervention addressing individuals with dyslexia take place in primary school. In this stage children acquire a lot of skills which are needed in different areas of life and which are fundamental for further learning ([3]). Even older students continue to face difficulties in learning even if they have received appropriate intervention and have been able to improve their literacy skills significantly as a result ([6]). However there is less assistance and support available than in primary school, despite the fact that their problems haven't disappeared and they need to practice their skills further ([7]).

The aim of the present study is to evaluate the effectiveness of the program *Tablexia*, that provides training of the underlying cognitive skills which support reading and writing ([8]). *Tablexia* exists since 2014 and it is available in three languages ([9]). The program has been already used in several schools as well as in pedagogical-psychological counselling offices in two countries ([10]). In our study we decided to evaluate the German version of *Tablexia*, which was developed in 2016 ([9]). Previous survey showed that children like the application and they are able to use it very focused for a longer period of time ([10]). However there hasn't been a study that evaluates this program and examines its influence on reading and writing skills. The application could be an important part of intervention for children with dyslexia. In order to assess developmental processes, the reading and writing skills and the cognitive abilities of the students were measured. To verify the effectiveness of an intervention the results were supposed to be as follows:

Hypothesis 1: During point of measurement 1 and 2 the improvement of experimental group should be bigger than the development of control group, who received no training in this time.

Hypothesis 2: During point of measurement 2 and 3 the control group who used *Tablexia* should improve more than the experimental group, who received no training in this time.

2 METHODOLOGY

2.1 Sample

The total sample consisted of 34 pupils. 35.3% of the children were female, and 64.7% were male. Fourteen of them visited 4th grade, eight 5th grade, six 6th grade, three 7th grade and one pupil was in 8th grade. Participating children visited two different special-needs schools in Eastern Germany (14 vs. 20 participants). There was a dropout of 11 students during the project (29.7%).

2.2 Data collection

There was a recruitment of two special-needs schools in a big city in the east of Germany. The school management decided which children to invite to the project considering relevant factors like reliability, avoiding comorbidities etc. The parents got a letter with all important information about the study, dates, data protection etc. The possibility to ask further questions was offered during a parents' evening. After re-registration, the 34 students of the two schools - which could be acquired - were assigned to an experimental group and a passive waiting-control group. In order to assess developmental processes, the reading and writing skills of the students were measured at three time points. School number one, which was selected as experimental group, started with the training after the first measurement. The training took place twice a week and lasted 40 minutes, in which children used *Tablexia* under the supervision of at least two experimenters. After a period of five weeks – consisting ten training sessions - the second measurement was carried out. Then school number two started with the phase of training. In the waiting period students got their regular fostering of learning. The third measurement included the testing of the cognitive abilities. At the end of the phase of training the students also filled the children questionnaire.

2.3 Instruments

2.3.1 *Tablexia*

Tablexia is a free to download modern educational application for tablets which aims at supporting the development of cognitive abilities. It is designed primarily for children with dyslexia from 5th grade and higher. The program currently consists of six games focusing on training of different cognitive abilities. In these games children can practise their working memory, auditory perception, spatial orientation, visual memory, attention and visual seriality on three difficulty levels. *Tablexia* has an attractive design and provides dyslexia-friendly environment. It was developed in cooperation with psychologist Dr. Lenka Krejčová, Ph.D. from DYS-center Praha o.s., who specializes in specific learning disabilities. The application was optimized for the needs of children with dyslexia by testing on several secondary schools.

2.3.2 SLRT

The reading and writing skills were assessed by means of the Salzburger Lese- und Rechtschreibtest (SLRT II; Moll & Landerl, 2010). The reading part of the SLRT II consists of the Ein-Minuten-Leseflüssigkeitstest. In the course of this the participants have to read out loud words and fantasy words within one minute. After a short period of practice the children have one minute to read as many words as possible without making mistakes. The test takes about five minutes.

The writing part of the SLRT consists of a text with gaps, which the students had to fill out. The needed words were read out by the experimenter. In total there were 48 sentences. This part of the SLRT takes about 30 to 45 minutes.

2.3.3 WRT

Because the writing part of the SLRT II is limited for students till 5th grade, it was necessary to use the Westermann Rechtschreibtest 6+ (WRT 6+; Rathenow, Vöge & Laupenmühlen, 1980) in order to measure the writing skills of students from 6th grade and higher. The WRT also consists of a text with gaps, which has to be filled out by the read out words. This test consists of 40 sentences and it takes about 30 minutes to finish.

2.3.4 KFT

For measuring the cognitive abilities the short version of the Kognitive Fähigkeitstest (KFT; Heller & Perleth, 2000) was used. The test provides information about linguistic thinking, quantitative thinking and nonverbal-figural thinking, including aspects of spatial thinking as well as an overall cognitive performance level. The test takes about 90 minutes.

2.3.5 Children Questionnaire

The children questionnaire collects information from the children about their perceiving and assessment of *Tablexia*. It includes nine items (e.g. “Which grade would you give *Tablexia*?”, “Did you have the impression that *Tablexia* helped you to read and write better?” or “What was your favorite game?”). The questions were read out and the questionnaire was filled out by the experimenters with each child separately.

2.4 Analysis

Most of the variables followed a normal distribution. Therefore, non-parametric tests were used for the statistical analysis.

3 FINDINGS

Minimums, maximums, means and standard deviations for the amount of right words for every test can be found in table 1 (experimental group) and table 2 (control group). The results show a positive development of the experimental group after using *Tablexia*, which even continues through the waiting period (except for the WRT). There is also a positive development of the control group after the training, as well as through the waiting period (except for the SLRT RT). Comparing the first and the third measurement both groups have better results at the end of the study. You can see this visualized in chart 1 till 4. However, only a few significant differences could be found (see table 3).

Table 1
Experimental group: minimums, maximums, means and standard deviations

	<i>min</i>	<i>max</i>	<i>M</i>	<i>SD</i>
SLRT LT right words (n = 8)				
first measurement	8	37	15.87	9.54
second measurement	7	34	17.88	9.72
third measurement	8	36	19.63	10.38
SLRT LT right fantasy words (n = 8)				
first measurement	4	24	13.62	6.63
second measurement	5	33	15.38	9.40
third measurement	4	36	18.62	11.25
SLRT RT right words (n = 3)				
first measurement	0	6	2.33	3.22
second measurement	0	2	1.00	1.00
third measurement	0	6	3.00	3.00
WRT right words (n = 5)				
first measurement	0	2	0.40	0.89
second measurement	0	3	0.80	1.30
third measurement	0	1	0.40	0.55

Note. *min* = minimum. *max* = maximum. *M* = mean. *SD* = standard deviation.

Table 2
Control group: minimums, maximums, means and standard deviations

	<i>min</i>	<i>max</i>	<i>M</i>	<i>SD</i>
SLRT LT right words (n = 15)				
first measurement	0	53	12.80	13.69
second measurement	1	64	16.93	15.85
third measurement	3	57	18.07	14.31
SLRT LT right fantasy words (n = 15)				
first measurement	2	40	11.80	9.64
second measurement	3	44	15.40	10.24
third measurement	4	36	16.00	8.58
SLRT RT right words (n = 14)				
first measurement	0	17	4.86	5.07
second measurement	0	13	3.86	4.26
third measurement	0	19	6.43	6.78
WRT right words (n = 1)				
first measurement	0	0	0.00	-
second measurement	1	1	1.00	-
third measurement	3	3	3.00	-

Note. *min* = minimum. *max* = maximum. *M* = mean. *SD* = standard deviation.

Chart 1: Means of SLRT LT right words at the three points of measurement for experimental group and control group.

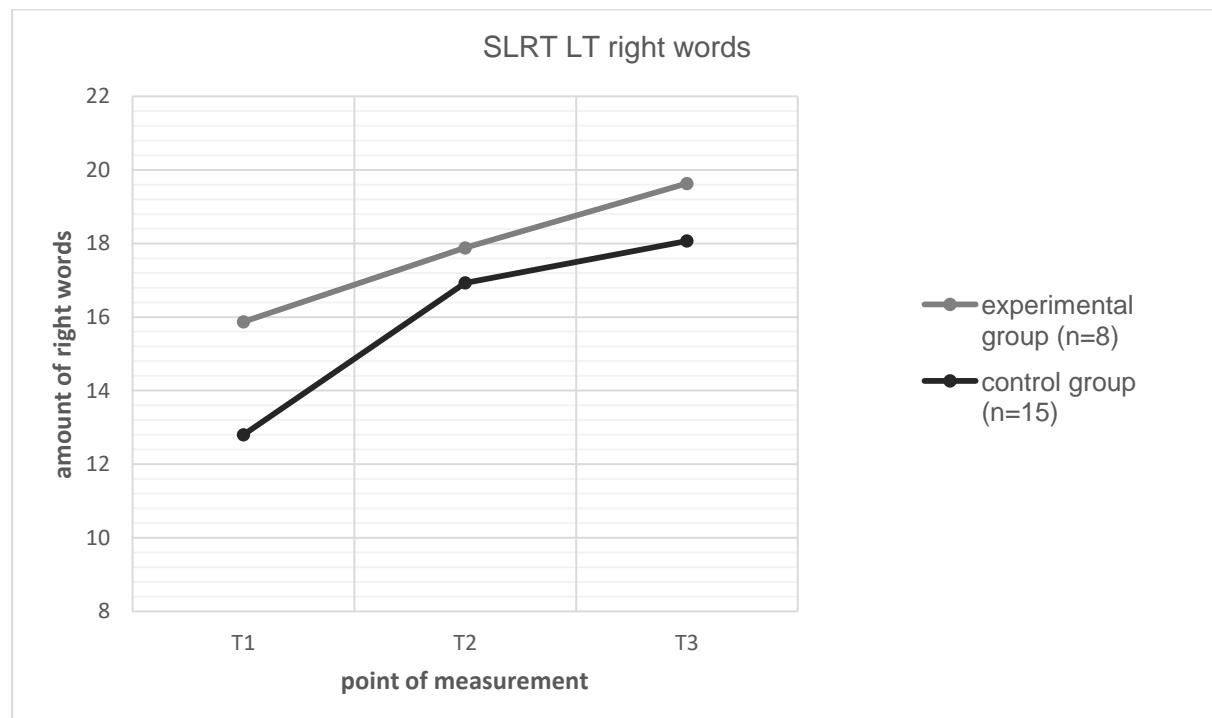


Chart 2: Means of SLRT LT right fantasy words at the three points of measurement for experimental group and control group.

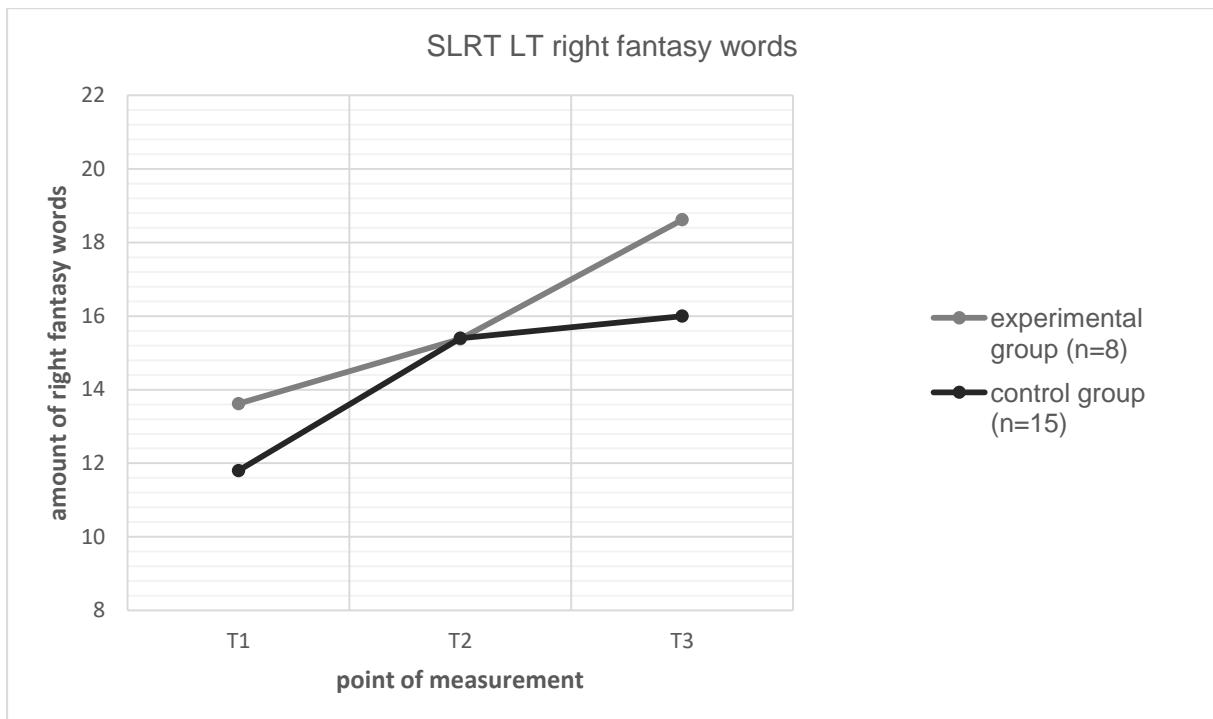


Chart 3: Means of SLRT RT right words at the three points of measurement for experimental group and control group.

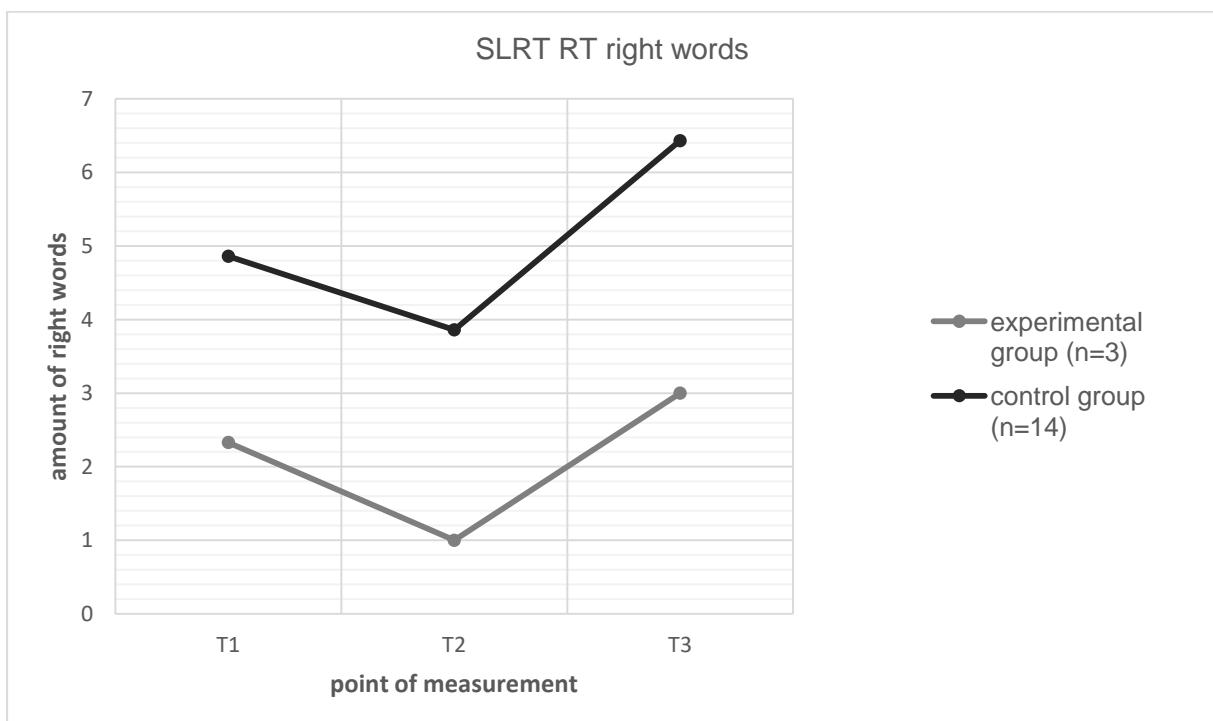


Chart 4: Means of WRT right words at the three points of measurement for experimental group and control group.

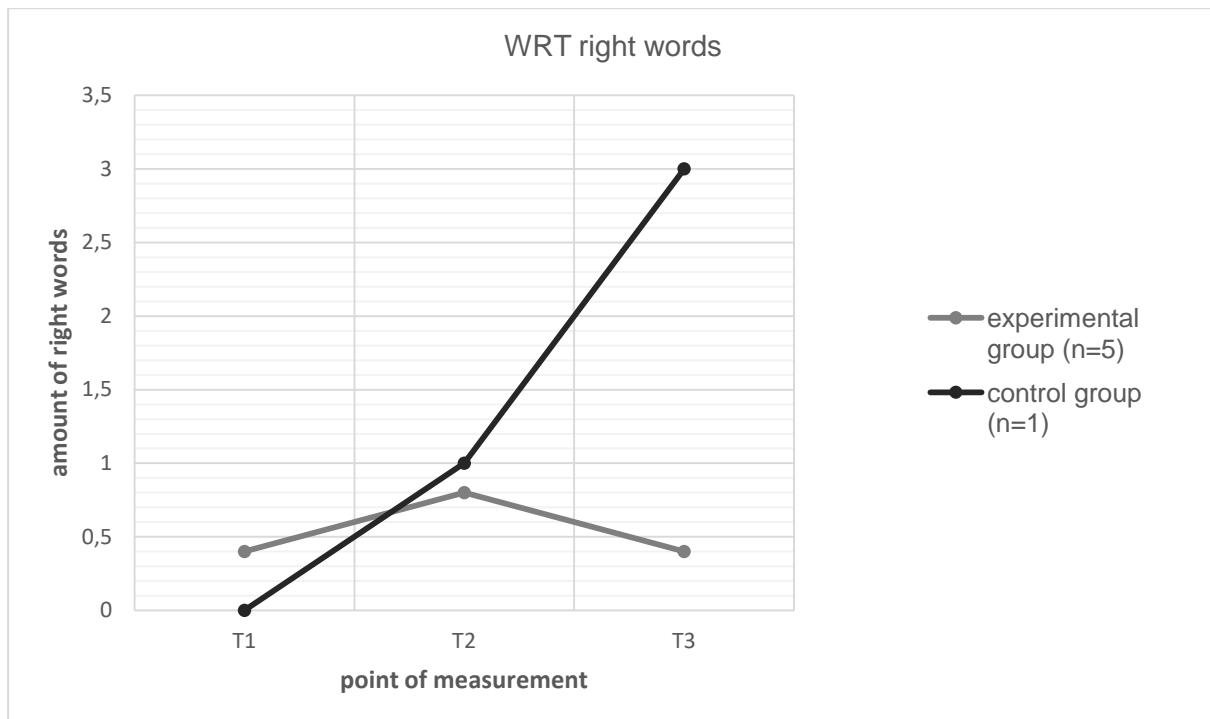


Table 3
Wilcoxon-test and effect size Cohen's d

	1. vs. 2.(d)	2. vs. 3. (d)	1. vs. 3.(d)
SLRT LT right words			
experimental group (n = 8)	-0.96 ^{n.s.} (0.21)	-1.41 ^{n.s.} (0.17)	-1.70 ^{n.s.} (0.38)
control group (n = 15)	-3.08 * (0.28)	-1.55 ^{n.s.} (-0.75)	-3.30 * (-0.38)
SLRT LT right fantasy words			
experimental group (n = 8)	-1.19 ^{n.s.} (0.22)	-1.27 ^{n.s.} (0.31)	-2.00 ^{n.s.} (0.54)
control group (n = 15)	-2.83 * (0.36)	-0.70 ^{n.s.} (-0.06)	-2.99 * (-0.46)
SLRT RT right words			
experimental group (n = 3)	0.00 ^{n.s.} (-0.56)	-0.82 ^{n.s.} (0.89)	-1.00 ^{n.s.} (0.22)
control group (n = 14)	-0.86 ^{n.s.} (-0.21)	-1.95 ^{n.s.} (-0.45)	-1.31 ^{n.s.} (-0.26)
WRT right words			
experimental group (n = 5)	-1.41 ^{n.s.} (0.36)	-0.82 ^{n.s.} (-0.40)	0.00 ^{n.s.} (0)
control group (n = 1)	-	-	-

Note. z values with Cohen's d. * = significant differences with $p < .001$. ^{n.s.} = no significant differences.

Beside the results of the tests a very important parameter is how the children perceived *Tablexia*. In table 4 you see that the children liked *Tablexia* a lot and they had the impression that it improved their reading and writing skills.

Table 4
Selected information from the children questionnaire (n = 23)

	<i>frequency</i>	<i>percent</i>
"Which grade would you give <i>Tablexia</i> ? From 1 (very good) till 6 (not sufficient)."		
1	14	60.9
2	6	26.1
3	3	13.0
"Did you have the impression that <i>Tablexia</i> helped you to read and write better?"		
No.	3	13.0
Yes.	17	74.0
I don't know.	3	13.0
"Can you imagine using <i>Tablexia</i> on your smartphone or tablet in the future?"		
No.	8	34.8
Yes.	13	56.5
Maybe.	1	4.3
I don't know.	1	4.3
"Are you going to recommend <i>Tablexia</i> to your friends?"		
No.	4	17,4
Yes.	16	69,6
I don't know.	3	13.0

Correlations between the single test variables and the performance in the KFT were examined with Pearson correlation. A value below 0.1 represents an insignificant, from 0.1 a small, between 0.3 and 0.5 a medium and from 0.5 a big correlation. The results in table 5 show positive correlations between the single test variables and the KFT, mainly on a medium and high level. Except for SLRT LT second and third measurement, there are no significant differences.

Table 5
Pearson correlations

Instrument	KFT
SLRT LT right words	
first measurement	.28 ^{n.s.}
second measurement	.30 ^{n.s.}
third measurement	.39 ^{n.s.}
SLRT LT right fantasy words	
first measurement	.32 ^{n.s.}
second measurement	.43 [*]
third measurement	.46 [*]
SLRT RT right words	
first measurement	.38 ^{n.s.}
second measurement	.21 ^{n.s.}
third measurement	.25 ^{n.s.}
WRT right words	
first measurement	.63 ^{n.s.}
second measurement	.65 ^{n.s.}
third measurement	.71 ^{n.s.}

Note. ** = significant correlations with $p < .01$. * = significant correlations with $p < .05$.
n.s. = no significant correlations.

4 CONCLUSION AND IMPLICATION

Effects of *Tablexia* on reading and writing skills of children with dyslexia at two special-needs schools in Germany were examined in this study. No effects of *Tablexia* could be found. There is a positive development of the reading and writing skills during the study, but according to our results it was not the result of the training. Therefore our hypothesis could not be confirmed. This can be caused by multiple reasons. For example the sample consisted only of 23 children due to the specificity of our target group and the high number of dropouts. Even if there was an effect of *Tablexia* on reading and writing skills, because of the small sample size it could be hardly found. This study is part of our master thesis and therefore we had to deal with limited resources. Moreover, it is possible that there are factors – like cognitive abilities – who lead to a different profit of the training for different children. The results of this study show that there is a positive correlation between the performance in the tests and the KFT, which measures cognitive abilities. Children who scored higher in the KFT had better results in the tests. For examining this difference more research with larger sample sizes is needed.

Another reason might be that the tests used to assess the reading and writing abilities are not optimal but unfortunately there is no better substitute in German language. SLRT has one parallel test version and WRT has none. Therefore a learning effect can be expected. This can be the reason why there was a progress found after the waiting period in both groups. In addition WRT is dated, therefore some words can be difficult for the children and therefore lead to worse results in the test. Our data show an extremely poor performance in WRT, which questions the suitability of the test for children in our sample. The data have to be handled accordingly.

Additionally *Tablexia* was designed for students from 5th and higher. In our sample 41.2 % of the students visited 4th grade. Maybe no effect of the training could be found, because of the age of the children. We also noticed that it was harder for the younger children to understand some games.

Moreover, we experienced during the training period as well as during the testing that the motivation of the children was fluctuating and depending on various external factors and group dynamics. The study took place after school in early afternoon, which can also negatively influence the concentration and motivation of children ([11]). Another aspect to influence motivation is that the time interval of measurements was the same for every school, but the times of measurement were different. So for example the experimental group was tested before autumn holidays, control group after holidays. The motivation of the children can also be lower in the testing situation in general and particularly when doing the same tests three times. Moreover some of the children needed more support, attention and praise in the training phase which can also affect the results.

In addition the results show that there is a considerable improvement of the reading and writing skills of the children in the course of the study. The children receive a good support outside the program (e.g. the fostering in the special-needs schools, additional support outside the schools). This can be also a reason why there was no additional improvement.

Although the results did not confirm our hypothesis these findings are still important to regard. According to the results of the children questionnaire most of the children consider the program to be helpful and they enjoyed using it. They feel to have made progress in writing and reading and they state they would use *Tablexia* again and would recommend it to their friends.

In summary further research with larger samples, more resources and better instruments is needed. Although we could not find any effects, children have fun using *Tablexia* and consider it to be helpful. The program contains a number of motivational components appealing to children of this age and it provides repetition of positive feedback about their performance ([8]), which is particularly important for children with dyslexia who tend to have lower self-esteem ([3]). It is also available for free and easily accessible for the children [9]. *Tablexia* can therefore be applied as supplement of intervention as well as entertaining motivational tool for children with dyslexia.

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