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SOUND BASED STRATEGY TRAINING IN MULTIPLICATION

Abstract

The main purpose of the present study was to examine the long-term effects of a previous quasi-experiment that used inner speech as a tool to promote appropriate strategies in multiplication. Results one year after the intervention were published by Ostad and Askeland (2008). This is a follow-up study. The 50-week intervention program was conducted in third and fourth grade and was modelled in accordance to the developmental course of private speech (from audible private speech to silent inner speech). Private speech and task-specific strategy use were examined in the fourth and seventh grade pupils in order to evaluate whether different teaching programmes resulted in private speech and task-specific strategy use differences three years after intervention. While internalization of private speech appeared to stagnate from the fourth to seventh grade in the Intervention-group, the results from more internalized task-specific strategy use indicated that the intervention programme was successful. This study supports the hypothesis that internalization of inner speech at an early stage of development may be associated with more appropriate strategy use, both short and long term. The long term effects are published by Askeland (2012).

THE PRESENT STUDY

Previous research indicates that a teaching programme designed to stimulate private speech internalization may successfully influence children's mathematical competence, reflected in more internalized private speech and more internalized strategy use (Ostad and Askeland, 2008). The purpose of this study is to examine the results of a longitudinal perspective study. The intervention-group (I-group) followed an intervention programme for one year. The aim was to encourage appropriate strategy use in multiplication when inner speech was used as a pedagogical tool. Three years after the intervention ended, when the students went into seventh grade, they were retested. How had the strategy development and internalization of inner speech developed further? Would internalization of private speech in fourth grade differ from internalization of private speech in the fourth grade differ from internalization of private speech in seventh grade in the I-group? Would internalization of private speech in the fourth grade differ from internalization of private speech in seventh grade in the I-group? Would the internalization of private speech in the fourth grade differ from internalization of private speech in seventh grade in the I-group? Would the internalization of private speech in the I-group differ from the internalization of private speech in the C-group in seventh grade? Would strategy use in fourth grade differ from strategy use in seventh grade in the I-group? Would strategy use in the fourth grade differ from strategy use in the seventh grade in the C-group? Would the strategy use in the I-group differ from strategy use in the C-group in the seventh grade?

Ostad and Askeland's (2008) study suggested that there were students in the highest skill level who profited most in the teaching environment where the focus was to internalize the inner voice. This was based on results after a one year long intervention, when the pupils were in the fourth grade.

How have groups, divided into four achievement levels, developed the strategy use over time in the I-group? In this study, the strategy development in different achievement levels in the fourth grade will be compared with corresponding levels in the seventh grade.

How is the strategy use in four different achievement levels in seventh grade in the C-group?

These four groups from the I-group, will also be compared with four groups in the C-group in seventh grade. Would the strategy use in different achievement levels in the I-group differ from strategy use in the different achievement levels in the C-group in the seventh grade?

METHOD

In this study, students in the seventh grade were observed in relation to strategy use and inner speech. In the seventh grade sample, there were 77 students remaining from the I-group, as five students had moved away. A C-group was established for means of comparison. The C-group from the seventh grade consisted of 83 students from three schools.

The teachers in the municipality, where the I-group was established, were offered training and follow up (20 hours) prior to the work with the students. The students worked in two to three sessions of 10-15 minutes in school every week. In addition, the students had homework from the programme 2 or 3 times a week.

The methodological program can be divided into three main parts:

Introduction to multiplication (3 weeks): Multiplication is introduced after addition and subtraction. In this phase it was ensured that the students understood multiplication and knew what the multiplication sign meant. The students solved multiplication tasks from the 2-10 times tables with the help of concretes, pictures and eventually symbols.

Introduction to private speech (3 weeks): In this part the students were introduced to what the inner speech is and what functions the inner speech can

have in a learning process. They were able to practically experience the inner speech. The training was modelled in the private speech internalization perspective that is in accordance with the development course for private speck: from audible to inaudible private speech. Therefore, the students sung wellknown songs, counted, read rhymes with a loud voice, low voice, whispering and finally in silence, as a fully covert, silent, inner speech without any external verbal production or lip/tongue movements. The teacher taught the students to use clear pronunciation and a fit speed.

Introduction to multiplication tables (about 32 weeks): The private speech internalization component in these weeks represented only a supplement to the official mathematics teaching plan. The teacher spent two weeks introducing a new multiplication table. Occasionally, they had another additional week to repeat what they had learned. The students worked with the answers in the table and started with 1.n, 2.n, 3.n and so forth. It was important that the students had an understanding of multiplication. The students wrote the tables down in their workbooks. Afterwards, they repeated the task and answered with a loud voice, lower voice, whisper and finally said the multiplication task in silence. This way of working, is in accordance with Vygotsky's (1934/1986) theory of transferring knowledge from the interpersonal to the intrapersonal sphere and of developing from outer to inner verbal control. The students were taught to always say both the task and the answer, whenever they were to answer a multiplication problem. This was to tie together the task and the answer in the storage process. The students were informed why this was important. They were given homework to complete as part of the programme. Information concerning the project was given to the parents of those children participating at parent meetings and by written information. This was done regularly by the classroom teacher, as part of the weekly plans for teaching in the class.

DATA COLLECTION

For more information about data collection, see the article by Askeland (2012).

The categorisation of inner speech includes:

1) *Audible private speech* is the outer verbal production by the help of speech. The speech is audible so that the statements can be understood and thereby transcribed.

2) *Inaudible private speech* is the outer manifestation of corresponding private speech. This speech is inaudible and unintelligible, nevertheless, it can be observed for instance in relation to lip and tongue movements.

3) *Silence or private speech in silence* is speech in silence without any sign of outer verbal production or lip-tongue movement.

The categorisation of strategy use includes:

-*Repeated addition*: The students add an operand the number of times indicated by the other operand. Example: $2 \cdot 4 = \dots$ The students count four fingers two times.

-*Number series*: The students have learned a number series and use this when solving the task. Example: $8 \cdot 3 = ...$ The students say or sing the number series until they come to the right number: 3-6-9-12-15-18-21-24.

Rules: The students have learned a rule about how they can reach the answer. Example: $1 \cdot 4 =$ When we add with one the answer will always be the same as the other operand $4 \cdot 0 =$ When we add with zero the answer becomes zero. -*Decomposition:* The students use a known combination as a base. Example: $3 \cdot 6 =$ The students might know the combination $3 \cdot 5 = 15$ and use this as a base for the answer: 15 + 3 = 18

-Direct retrieval: The students collect the answer, or the task and the answer directly from their long-term memory. The research applied a way of classifying that is anchored in the expressions retrieval strategy, decomposition and backup strategies. The students use a retrieval strategy, when the solution is characterized by them searching for and recalling knowledge as a meaningful unit (Siegler, 1987). Repeated addition, number series and rules are classified as backup-strategies. When the students use a combination of retrieval and backup strategies it is known in literature as "decomposition strategies" (Hoard et *al.*,1999; Ostad, 1997).

PRIVATE SPEECH

1. Comparison of results from the fourth grade and seventh grade in the internalization of private speech in the I-group

The analyses indicated that there was no significant difference between any internalization level of private speech in the fourth and seventh grade (p>0.05).

2. Comparison of results from the fourth grade and seventh grade in the internalization of private speech in the C-group

The analyses indicated that there was no significant difference between the fourth and seventh grade in the category audible (p=0.058). There were significant differences in inaudible (p=0,011) and silence (p=0,003).

3. Comparison of results of the internalization of private speech in the Igroup and C-group in the seventh grade.

The Independent Samples Tests (t-tests for equality of means) were performed to determine whether possible private speech differences between the I-group and the C-group could be identified within any one of the three achievement levels. The Independent Samples T-test did not indicate significant differences in audible (p=0,053) or silence (p=0,266). In inaudible, the test indicated a

significant difference (p=0,015). Finally, the test indicated non-significant differences in the four levels of achievement between the I-group and the C-group.

STRATEGY USE

4. Comparison of results from the fourth grade and seventh grade in strategy use in the I-group



Figure 1: Strategy use among I-group in the fourth grade and the seventh grade, expressed in terms of percentage of occurrence.

Figure 1 gives an overview of strategy use among children in the fourth grade and the seventh grade. The results are based on a total of 1162 answers given by the fourth grade (N=83) and 1078 answers given by the seventh grade (N=77).

A Paired Samples Test was performed to determine whether strategy use among the I-group in the fourth grade differed from strategy use in the seventh grade. The Paired Samples Test indicated that there was a significant difference between the strategy use among children in the fourth grade and the seventh grade. There was a significant difference in all three strategy categories: Backup (p=0,006), decomposition: (p=0,000) and direct retrieval: (p=0,000). Children in the seventh grade used more direct retrieval and less decomposition and backup than children in the fourth grade.

5. Comparison of results from the fourth grade and seventh grade in strategy use in the C-group



Figure 2: Strategy use among C-group in the fourth grade and seventh grade, expressed in terms of percentage of occurrence.

Figure 2 gives an overview of strategy use among children in the fourth grade and the seventh grade in the C-group. The results are based on a total of 686 answers, given by the fourth grade (N=49) and 1162 answers given in seventh grade (N=77). An Independent Samples Test (t-tests for equality of means) was performed to determine whether strategy use of the C-group in the fourth grade differed from strategy use in the seventh grade. The Independent Samples Tests (t-tests for equality of means) indicated that there was a significant difference between the strategy use among children in the fourth grade and the seventh grade in the C-group. There were significant differences on backup (p=0,002) and direct retrieval: (p=0,001). For the decomposition strategy, there were no significant differences among the children in the fourth grade and children in the seventh grade in the Control-group. Children in the fourth grade used more direct retrieval and less backup than children in the fourth grade.

6. Pattern of Strategy use differences by I-group and C-group

Have different teaching programs resulted in significant differences between the I-group and the C-group with regards to students' use of strategy variants: backup, decomposition and direct retrieval?

The results are based on a total of 1162 answers given by the C-group and 1078 answers given by the I-group in the seventh grade. Table 4 provides descriptive information about strategy use observed with the 14 multiplication table.



Figure 3: Strategy use categories among the I-group and C-group children in the seventh grade, expressed in terms of percentage of occurrence.

To investigate whether there was a significant difference in strategy use in the Igroup and C-group, Independent Samples Test were performed. The analysis shows significant differences in all three categories: backup (p=0,000), decomposition (0,019) and direct retrieval (p=0,000).

7. Strategy use categories by children in four achievement levels in the fourth and seventh grade in the I-group.

For information about the division into different levels, see the article by Askeland (2012).

Have different levels in the I-group significant differences in use of strategy variants: backup, decomposition and direct retrieval?





Figure 4: Strategy use into different achievement in fourth grade, expressed in terms of percentage of occurrence. Figure 5: Strategy use into different achievement in seventh grade, expressed in terms of percentage of occurrence.

Paired Samples T-tests were performed to compare results within each level in the fourth and seventh grades. The results show that at the lowest skill level, there were no significant differences in the three strategy variants from fourth to seventh grade: backup (p=0,268), decomposition (p=1,000) and direct retrieval (p=0,179). At level 2 there was significant differences in backup (p=0,028), decomposition (p=0,003), and direct retrieval (p=0,003). At level 3, there were no significant difference in backup (p=0,819). By the decomposition (p=0,003), and direct retrieval (p=0,005) there are significant differences. At level 4 there were significant differences in decomposition (p=0,033), and direct retrieval (p=0,011), but not in backup (p=0,063). Within the three levels with the highest skill level, significant differences were found in the results of decomposition and retrieval.

8. Strategy use in four achievement levels in the I-group and the C-group in the seventh grade

Level 1



Figure 6: Strategy-use categories among children in level 1 from Igroup and C-group. Expressed in terms of percentage of occurrence.

Level 3:



Figure 8: Strategy-use categories among children in level 3 from Igroup and C-group. Expressed in terms of percentage of occurrence.



Figure 7: Strategy-use categories among children in level 2 from Igroup and C-group. Expressed in terms of percentage of occurrence.





Figure 9: Strategy-use categories among children in level 4 from Igroup and C-group. Expressed in terms of percentage of occurrence.

An Independent Samples Test was used to determine if there were significant

differences between I-group and C-group at the different levels. It was found that there were significant differences in backup between the I-group, and the C-group in level1 (p=0,01), level 3 (p=0,001) and level 4 (p=0,01). In level 2 no significant differences were found in back-up (p=0,196).

The results indicate no significant decomposition strategy differences in each of the achievement levels: level 1 (p=0,748), level 2 (p=0,126), level 3 (p=0,102), level 4 (p=0,065).

The results also indicate significant direct retrieval strategy differences in each of the achievement levels: level 1 (p=0,019), level 2 (p=0,039), level 3 (p=0.000) and level 4 (p=0.015).

DISCUSSION

In the two highest skill levels related to the categories 'inaudible' and 'silence' in the fourth grade, it was found that there was a significant difference between the I-group and the C-group. However, there was no significance found in any of the skill levels in seventh grade. An interpretation of this can be that over time, the groups have become more similar in internalisation degree of inner speech. It is possible that the ceiling effect can be the reason why there were no equal significant differences in the seventh grade. Both groups used silence in about 80% of the tasks in this study. Former research shows that the category of silence receives more dominating space at the expense of the audible category among students without difficulties in maths throughout the school. In Ostad and Sorensen's (2007) research, the students without mathematical difficulties used silence in 65% of the tasks in the sixth and seventh grade. However, among the students with mathematical difficulties it seems that the private speech internalising stagnates in the early development phase. The students in the Igroup had a faster progression in the internalisation process of private speech. They had reached a high level by the end of fourth grade which was significantly different from the control group. Nevertheless, the difference was not significant in the seventh grade.

It seems that the private speech internalisation came to an end with the I-group, and no significant differences could be found between the I-group and the C-group. Despite this, findings show that the I-group has moved more clearly towards more internalised category of strategy than the C-group, who had not had a training programme with a goal of internalising inner speech.

It is a hypothesis that the I-group has reached more appropriate strategies because they on an earlier stage than the C-group had internalised speech. According to Torgersen (1999) the effect of the phonological memory system can influence the students' performance when it comes to recalling arithmetic basic units directly from the knowledge stored in the long-term memory, and that mathematical competence has a function of effectiveness in the production of task related private speech (Harris 1986; Meicherbaum & Goodman 1971; Ostad and Askeland 2008). Studies have shown that private speech in direct relation to the solution process is positively correlated with the professional performance of the students. This also applies to performance over time (Azmitia, 1992). This study supports the hypothesis that internalising of inner speech at an early stage in the development can be linked with more expedient use of strategy both in long term and short term. This results do not show anything about causality. The research shows that there is a significant difference between the I-group and the C-groups' use of strategy in the fourth grade and seventh grade.

It is interesting to note that the intervention programme seems to have had an effect on the strategy development in the long term. This should influence the teaching method in mathematics. On an early stage the students should be taught about the use and internalisation of inner speech. Students in the first half of primary schools should get systematic training of inner speech and use of strategy.

More research is needed in this field to identify the psychological forces that are components of inner speech. In the collected material it is possible to study how the intervention program has influenced the different student groups. This is important information and should be researched further.

Reference list

Askeland, M. (2012). Sound-based strategy training in multiplication. *European Journal of Special Needs Education*, 27 (2), 201-217.

Harris, K.R.1986. "Effects of cognitive-behavior modification of private speech and task performance during problem solving among learning-disabled and normally achieving children". *Journal of Abnormal Child Psychology* nr.14, 63-76

Hecht, S.A. (1999). Individual solution processes while solving addition and multiplication math facts in adults. *Memory and Cognition*, 27, 1097-1107

Hoard, M.K., D.C. Geary & C.O Hamson 1999, "Numerical and arithmetical Cognition: Performance of low- and avergrade-IQ Children". *Mathematical Cognition* nr.5(1), 65-91.

Mabbot, D.J. & Biaantz (1992). Developmental change and individual differences in children's multiplication. *Child Development*, 74, 1091-1107.

Meichenbaum, D. & J.Goodman, J.(1971). Training impulsive children to talk to themselves: A means of developing self-control. *Journal of Abnormal Psychology* nr.77, 115-126.

Ostad, S.A. (1997). Developmental differences in addition strategies: a comparison of mathematically disabled and mathematically normal children. *British Journal of Educational Psychology* 67, 345-357.

Ostad, S.A. and Askeland, M.(2008). Sound-based number facts training in a private speech internationalization perspective: Evidence for effectiveness of an intervention in grade 3. Journal of Research in childhood education. Volume 23. Number 1, 109-124

Ostad. S.A. and Sorensen P.M. (2007). Private speech and strategy-use patterns. Bidirectional comparisons of children with and without difficulties in developmental perspective. *Journal of Learning Disabilities*, 40 (1), 2-14.

Siegler, R.S. (1987). Strategy choices in subtraction. In J.A. Sloboda and D. Rogers (Eds.), *Cognitive processes in mathematics* (pp. 81-106). New York: Clarendon Press/Oxford University Press.

Torgersen, J.K. (1999). Phonologically based reading disabilities: Toward a coherent theory of one kind of learning disability. In *Perspectives on learning disabilities*, ed. L. Spear-Swerling and R.J Sternberg, 231-62. New Haven, CT:Westview Press.

Vygotsky, L.S. (1934/1986). *Thought and language (A. Kozulin, Trans.)*. Cambridge, MA: MIT Press. (Original work published 1934.)