Attention, working memory and early mathematical skills in toddlers

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Author: Y. Haster, 3622029
First supervisor: J. E. van ‘t Noordende, MSc.
Second supervisor: dr. W. D. Schot

Preface

Hereby presented is the master thesis ‘Attention, working memory and early mathematical skills in toddlers’. This graduate research is conducted for the masterprogram Orthopedagogics at the University of Utrecht, subprogram within the Master Pedagogical Sciences. I have enjoyed participating in this study, especially the directing of the tests with the toddlers was a highlight for me. I have learned many things about myself and about the way I participate in a research study.

In this preface, I would like to thank my thesis supervisor, Jaccoline van ‘t Noordende, for guiding me while writing this thesis, for giving lots of feedback and for giving me the opportunity to participate in this challenging research. Furthermore, I would like to thank my sister for giving feedback and my friend Ernst for studying together and motivating each other.

Abstract

Introduction: This study aims to gain insight into the mediating effect of working memory on the relation between selective attention and comparing/counting. Literature shows that both working memory and attention have an important influence on the development of early math skills, measured in comparing/counting. **Method:** Participants were 50 children between 2 and 3 years old from the municipality of Utrecht. **Results:** A significant correlation between comparing and counting was found. The results have also shown a significant relationship between the Six Boxes Task and comparing. Attention, however, appeared to have no significant effect on comparing and counting, which means that mediation could not be performed. **Discussion:** The results of this study are mostly insignificant, which indicates there is no mediation of working memory on attention and early math skills. The results are discussed considering research and theory in order to determine applications for practice and further research.

Keywords: working memory, selective attention, early math

Attention, Working Memory and Early Mathematical Skills in Toddlers

In the school age population, 4 to 7% of the children experience mathematical difficulties (Commodari & Di Blasi, 2014). These difficulties can often be explained by poorly developed early math skills. Early mathematical skills however, can be positively influenced by several factors, such as attention and working memory. Therefore, this study will focus on the mediating effect of working memory on the relation between attention and early math skills.

Mathematics are not only taught at school, but children learn them everywhere. Children encounter the concept of numbers from birth, through modeling and play. Math problems however, can be very obstructive for everyday life, which is reflected in difficulties in problem solving or in medical decisions (Reyna & Brainerd, 2007). In other words, mathematical skills are considered essential for both work and school, as well as for tasks of everyday living (Reyna & Brainerd, 2007).

As mentioned above, underdeveloped early math skills appear to be an important predictor of mathematical difficulties. Hannula (2005) found that especially basic counting skills and arithmetic knowledge have an important influence on the development of mathematical difficulties. Counting and arithmetic knowledge are embedded in the eight early mathematical skills, studied by Van de Rijt (1996): comparing, classification, one-to-one correspondence, seriation, use of number words, structured counting, resultative counting and general understanding of numbers. According to Van Luit (2010), these skills are important for a good development of mathematical understanding. Protective factors, like selective attention and working memory, have a positive influence on the development of these math skills. Selective attention for example, appears to have an influence on the rapidity in information selection and processing, while doing arithmetic (Commodari & Di Blasi, 2014). Additionally, working memory shows a significant effect on counting (Holmes, Adams, & Hamilton, 2008). An important aspect of working memory however, is attentive functioning (Commodari & Di Blasi, 2014). Therefore, this study will focus on the mediating effect of working memory on the relation between attention and early math skills.

Early math skills. Most mathematical difficulties in the first grade can be explained by poorly developed early math skills (Van Luit, 2010). The most important concepts of these early math skills are counting and quantity knowledge (Aunio, Hautamäki, & van Luit, 2005). Literature shows that, when looking at the central structure in the development of the concept ‘whole numbers’ in the early childhood, children around the age of four are situated in the predimensional period. In this period, children are capable of answering ‘more’ or ‘less’ questions and capable of counting the amount of objects in a set (Griffin, 2003). In other words: comparing and counting. Comparing is a concept used to differentiate between two nonequivalent situations. With comparing, children show that they grasp the concept of 'more' and 'less'. Gelman and Baillargeon (1983) found that four-year-olds are able to compare these nonequivalent situations. The concept of counting refers to counting (un)organized objects by pointing. Gersten, Jordan and Flojo (2005) pointed out that maturity and efficiency of counting strategies appear to be predictors of good mathematical development. Children around the age of five to six are able to correctly count objects (Fuson, 1988). This age differs from the age in the study of Gelman and Gallistel (1978), where children were able to count at the age of three to four years. The difference between the results of Fuson (1988) and Gelman and Gallistel (1978) could be explained by their measurement of counting. Each study uses a different counting-task, resulting in a low criterion validity (Gelman & Gallistel, 1978). Both abilities, comparing and counting, appear to be better developed in children with high selective attention skills.

Attention and math skills. Research indicates that selective attention, as well as working memory, have an effect on math. Selective attention is the process that focuses awareness on some stimuli to the exclusion of others (Passer et al., 2009), which can be seen as a filtering mechanism that becomes more efficient through the years (Mahone & Schneider, 2012). Difficulties in mathematics and attention often co-occur (Raghubar et al., 2009) and selective attention appears to be closely related to mathematical achievement (Commodari & Di Blasi, 2014): children with the ability to concentrate and exclude other stimuli, have less difficulty performing various arithmetic operations (Mahone & Schneider, 2012; Fuchs et al., 2006). Campos, Almeide, Ferreira, Martinez, and Ramalho (2013) studied this effect of selective attention on academic achievement in Portuguese eight- to nine-year-olds. They found that selective attention affects the quality of how children handle relevant information, by inhibiting, directing or retrieving. This leads to difficulties in comprehending the instructions, offered in mathematical problem-solving. A study by Commodari and Di Blasi (2014), in which Italian children were tested, provided similar results. Their study found that the capacity to select a target among distracting stimuli (i.e. selective attention) predicts all components of calculation skills. Therefore, research confirms the notion of van Luit (2010) that deficits in attention can be seen as a risk factor for the development of math skills.

Working memory and math skills. Not only selective attention, but also working memory plays an important role in mathematical achievement (Holmes et al., 2008). Baddeley (2010) developed the 'working-memory-model', which consists of four components. Working memory consists of the central executive, the episodic buffer, the phonological loop and the visuospatial sketchpad. High functioning working memory allows an individual to associate mathematical problems with the correct answers, retrieving information from the long-term memory (Fuchs et al., 2005). Several studies indicated that each aspect of working memory has a different influence on mathematical skills. Especially the phonological loop and visuospatial sketchpad appear to have a great impact on math skills (De Hevia & Spelke, 2010). The phonological loop for example, deciphers and holds information for verbal codes, which could help a child to count, not only in exact mathematics, but also in algorithms (Holmes & Adams, 2006). Children with problems in the phonological loop have difficulty obtaining number facts and forming complete networks of facts in the long-term memory. They also count slower than the average child and experience more difficulty in retrieving number facts (Holmes & Adams, 2006). The other important component of the working memory model, the visuospatial sketchpad, functions as a ‘mental blackboard’, where the specific mathematical problem is encoded, retained and manipulated during the calculation. Furthermore, it has been shown that the visuospatial sketchpad is used to form a mental number line, with visuospatial codes for each number (Holmes & Adams, 2006). With the visuospatial sketchpad, children are capable of linking number and space. A good developed visuospatial memory enables children to recognize and remember numbers and connect them to representations (De Hevia & Spelke, 2010). The other components of working memory also appear to have an effect on math skills, but these will not be discussed in this study.

Geary (2006) studied the effect of working memory on mathematical skills. He found that through experience and improvement in working memory, children are more capable of keeping track of the counting process, which for example, helps them to abandon the use of their fingers for verbal counting (Geary, 2006). Concluding, several aspects of working memory influence the development of math skills.

Current study. Literature shows that both attention and working memory influence early mathematical abilities, specifically comparing and counting. Commodari and Di Blasi (2014) however indicated that attention appears to be a very important component of attentive functioning, a crucial skill for working memory. To investigate the extent to which attention has impact on early mathematical skills and the extent to which working memory eliminates this effect, mediation will be conducted. Therefore, this study wants to focus on the mediating effect of working memory on the relationship between selective attention and early math skills in children between two to three year old. It is expected that there is a mediating effect of working memory, which reduces the effect of selective attention on math.

Method

Participants

Two different methods were used to find participants: The first method was sending letters with a call for participation to a range of addresses, which were received from the municipality of Utrecht. Another call for participation was posted on different online forums for parenting issues. The sample used in this study consisted of 50 toddlers (22 boys, 28 girls), with a mean age of 2.94 years. Educational level and income indicate the socioeconomic status: 36% of the parents who filled in the questionnaire, are well educated, as well as 29% of their partners. While 58% of the children lived in households with an annual income of more than €50.000, only 12% had an annual income under €35.000.

Measures

Selective attention.

The Visual Search Task. The Visual Search Task (VST) is developed especially for toddlers. The test is used to measure the visual-spatial selective attention of toddlers. The VST in this study is a computer-based task, where toddlers are shown a matrix, which consists of elephants, bears and horses in the same color and size. The task is to point out only the elephants as fast as they can. Firstly, three matrices (1x2, 2x2, 3x3) are shown for practice, after which the actual test begins. This consists of two matrices of 6x8 and one matrix of 9x8. Each column always contains one elephant and each matrix is shown for a time period of 40 seconds. The total score consists of the sum of the correctly appointed elephants of the three matrices together, with a maximum of 24.

Early math skills.

Counting task. The counting task measures the one-on-one correspondence, a subskill of preliminary math. Within this study, a row of five different blocks will be put on the table. The toddler is asked to count the blocks. If the toddler is capable of counting the five blocks correctly, another five blocks are added. When the toddler makes a mistake, one block will be removed. The toddler is supposed to point at the blocks while counting. The total score is the highest number of correctly counted blocks, with a maximum of twenty blocks.

Comparing. The comparing task measures the comparing of non-symbolic quantities. The toddler is shown a picture with two different quantities of coins on a computer screen, and is asked to point out the quantity with ‘more coins.’ To motivate the toddler, a message, saying he/she has found a treasure chest, is shown each time they have chosen the correct quantity. The total score is the total of correctly answered items, with a maximum of 26.

Working Memory.

Word recall. The word recall test is used to measure the short term memory (Alloway, Gathercole, Kirkwood & Elliott, 2008). This computer task originates from the Automated Working Memory Assessment (AWMA; Alloway, 2007). The toddler is asked to repeat sets of words spoken by a computer-generated voice. The first set consists of one word, and each following set is being increased by one word. The task starts with practice-sets, with words such as '*chair*, '*head-please'* and '*snake-go-word'*, after which the actual test begins. The task ends when the toddler makes three mistakes in one set. The total score is the number of correctly answered items, with a maximum of 42. The test-retest reliability of this test is .76 (Alloway, Gathercole, & Pickering, 2006).

Six-boxes task. The six-boxes task (SBT) measures the visual-spatial working memory. In this task, the toddler hides six plastic animals in six boxes and after waiting a predetermined period of time, they are allowed to open one box and remove the animal. After closing the box and waiting for the same time period, the toddler has to open a new box. The goal of the task is for the child to remember which box is already empty, while finding all the hidden animals. After more than three sequential mistakes, the number of boxes and waiting-time decrease. The total score is the score linked to the amount of boxes and waiting-time. A flow diagram for the trials will be added in Appendix A.

Data analysis

All statistical analyses will be done using SPSS 20. Firstly, Pearson correlations will be conducted for all variables. The values $\alpha < .05$ were considered statistically significant at two-tailed level. Both significance of the results and the relevance of the results will be analyzed using Cohen's criteria for relevance (1988), which defines an effect size of .10 as small, .30 as medium and .50 or more as large. Secondly, mediation will be tested four times, with different variables. Each mediation can be seen in Figure 1. Mediation will be analyzed as suggested by Kenny, Kashy and Bolger (1998). To start with, regression analysis on the relationship between the independent and dependent variable will be conducted. Subsequently, regression analysis between the mediator and independent variable follows. Finally, a regression analysis with the independent variable and mediator as predictors and the dependent variable as outcome will be conducted. Following the method of Kenny and colleagues (1998), mediation can be determined. The regression analysis results in r^2, the percentage of variation in the dependent variable explained by the predictor. An effect size of .1 to .25 is defined as weak .25 to .5 as moderate, .5 to .75 as strong and .75 to .9 as very strong.

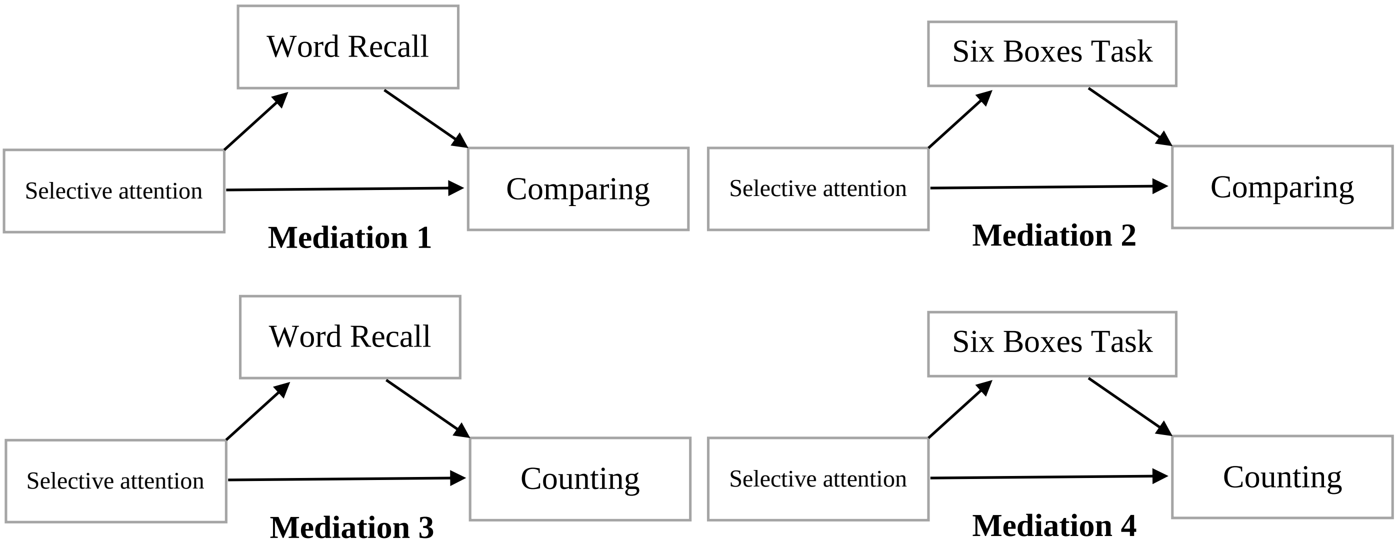


Figure 1. Diagram of the conducted mediations.

Results

Table 1 shows the means, standard deviations and sample size of the different variables. Pearson's correlation coefficient was computed to assess the relationships between all variables, shown in Table 2.

Table 1

Descriptive Statistics of the Study Variables

Variable	*M*	*SD*	*N*
Comparing	14.18	3.36	40
Counting	2.64	3.46	28
Word Recall	8.79	2.49	34
Six Boxes Task	5.11	1.07	47
VST	13.96	3.35	47

Table 2

Correlations between all variables.

Variables	1	2	3	4	5
1. Comparing	–				
2. Counting	.43*	–			
3. Word Recall	-.06	-.13	–		
4. Six Boxes Task	.32	.37	-.29	–	
5. VST	-.22	.12	.19	-.11	-

*$p < .05$ at two-tailed level.

The results indicate that only the comparing task and the counting task are significantly correlated, $r(24) = .43$, $p < .05$. This suggests an average to high practical significance, according to Cohen's criteria (1988). No other statistically significant relationships were found. When looking at effect sizes however, it appears that the Six Boxes Task has a small effect on comparing and counting.

In the first step of mediation, the relation between the independent variable and the dependent variable was examined, for each mediation separately, as shown in Figure 1. For each mediation, all missings in the used variables were excluded. For mediation 1, the regression between VST and comparing was non-significant, $F(1, 27) = 1.76$, $\beta = -.23$, $p = .20$. The effect of the VST on comparing can be predicted, but the prediction strength is very weak ($r^2 = .06$). For mediation 2, the regression between VST and comparing too was non-significant, with a different group of children, $F(1, 36) = .52$, $\beta = -.12$, $p = .48$. The prediction was very weak ($r^2 = .01$). For mediation 3, the regression between VST and counting was also non-significant, $F(1, 22) = .45$, $\beta = .14$, $p = .51$. The effect of the VST on counting can be predicted, but the prediction strength is very weak ($r^2 = .02$). For mediation 4, the regression was again non-significant, $F(1, 25) = .37$, $\beta = .12$, $p = .55$, with a very weak prediction strength ($r^2 = .02$). In summary, all relationships between independent and dependent variables were non-significant and showed no relevant effect sizes. Therefore, further steps of mediation cannot be performed, indicating no mediating effect of working memory on the relation between selective attention and comparing/counting.

To investigate possible other effects, several separate regressions are conducted. The regression of VST on Word Recall was non-significant, $F(1, 27) = .35$, $\beta = .08$, $p = .56$, $r^2 = .01$. The regression of Word Recall on counting was non-significant, $F(1, 22) = .37$, $\beta = -.18$, $p = .55$, $r^2 = .02$. The regression of Word Recall on comparing was also non-significant, $F(1, 27) = .10$, $\beta = -.08$, $p = .76$, $r^2 = .00$. The regression of VST on SBT unfortunately was also non-significant, $F(1, 25) = .00$, $\beta = .00$, $p = .95$, $r^2 = .00$. However, the regression of the Six Boxes Task on comparing and counting showed results. Regression of SBT on counting had a trend towards significance, $F(1, 25) = 3.88$, $\beta = 1.25$, $p = .06$, with a weak prediction strength ($r^2 = .13$). Regression analysis of SBT on comparing was significant, $F(1, 25) = 4.79$, $\beta = 1.03$, $p = .04$, $r^2 = .12$.

Concluding, mediation could not be performed since no significant results were found in the independent-dependent regression analysis. However, the results of the regression of SBT on comparing were significant.

Discussion

The current study was conducted to test whether there is a mediating effect of working memory on attention and early math skills. The results indicate hardly any significant relations between selective attention and comparing/counting, so that further steps of mediation could not be conducted. However, regression analysis on separate variables draws attention to the relation between visuospatial working memory and early math skills. Results indicated that children who were more competent in the Six Boxes Task, also scored higher on the comparing task. This confirms the findings of Holmes and Adams (2006), where a stronger predictive role for the visuospatial sketchpad on mathematic performance was found. The results also indicated a significant correlation between counting and comparing. Children who are better in comparing quantities also appear to be better at counting objects. Holmes and Adams (2006) found the same results, with higher *number and algebra* skills in children with more developed mental arithmetic.

The fact that no other significant relationships were found, could be explained by not fully developed working memory skills. Geary (2006) showed that preschool children are able to hold three to four items of information in their working memory, while fourth graders can hold six items. Retraining information is an essential feature to develop early math skills (Geary, 2006). Thus, a not fully developed working memory might result in a less pronounced effect on early math skills.

Several restrictions of this study should however be mentioned. Firstly, the dataset consisted of only 50 children, with 16 children missing more than two variables. A possible explanation for the large amount of missing variables could be the duration of testing, since all tests were conducted in 90 minutes. This can be experienced as long, resulting in a loss of concentration. To motivate the toddlers, they could collect stickers after each successfully finished task. Thus, the duration of testing was long, but the toddlers were kept motivated. Secondly, the sample was very homogeneous: all families lived in Utrecht and region, and most of the families had a high annual income and were highly educated. These restrictions lead to the conclusion that generalization should be done with caution.

The research question of this study is relevant for the educational world. Research on mathematical development in the early years gives insight in how learning problems can be prevented. The majority of mathematical problems can be traced back to problems in working memory and attention skills (Van Luit, 2010). Unfortunately, this study only found an effect of the visuospatial sketchpad on early math skills. This effect, however, can be very important in teaching. When teachers are aware of the important influence of the visuospatial sketchpad on math skills, they might focus their interventions and practices less on math training and more on training the visuospatial sketchpad. Future research could focus more on the longitudinal effect of the visuospatial sketchpad on math skills, to discover whether there is a longitudinal effect. Additionally, in order to allow generalization, future studies should have larger samples and a less homogenous group of parents.

References

Alloway, T. P. (2007). *Automated Working Memory Assessment*. Londen: Pearson Assessment.

Alloway, T. P., Gathercole, S. E., Kirkwood, H., & Elliott, J. (2008). Evaluating the validity of the automated working memory assessment. *Educational Psychology, 28*, 725-734. doi:10.1080/01443410802243828

Alloway, T. P., Gathercole, S. E., & Pickering, S. J. (2006). Verbal and visuospatial short term and working memory in children: Are they separable? *Child Development*, *77*, 1698-1716. doi:10.1111/j.1467-8624.2006.00968.x

Aunio, P., Hautamäki, J., & Van Luit, J. E. H. (2005). Mathematical thinking intervention programs for preschool children with normal and low early math. *European Journal of Special Needs Education, 20*, 131–146. doi:10.1080/08856250500055578

Baddeley, A. (2010). Working memory. *Current Biology, 20*, 116-140. doi:10.1016/ j.cub.2009.12.014

Barkley, B. A. (2001). The executive functions and self-regulation: An evolutionary neuropsychological perspective. *Neuropsychology Review*, *11*, 1-29. doi: 10.1023 /A:1009085417776

Bull, R., Espy, K. A., & Wiebe, S. A. (2008). Short-term memory, working memory, and executive functioning in preschoolers: Longitudinal predictors of mathematical achievement at age 7 years. *Developmental Neuropsychology*,*33*, 205-228. doi:10.1080/87565640801982312

Campos, I. S., Almeide, L. S., Ferreira, A. I., Martinez, L. F., & Ramalho, G. (2013). Cognitive processes and math performance: a study with children at third grade of basic education. *European Journal of Psychological Education*, *28*, 421-436. doi:10.1007/s10212-012-0121-x

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Hillsdale, New Jersey: Erlbaum.

Commodari, E. & Di Blasi, M. (2014). The role of the different components of attention on calculation skill. *Learning and Individual Differences, 32*, 225-232. doi:10.1016 /j.lindif.2014.03.005

De Hevia, M. D., & Spelke, E. S. (2010). Number-space mapping in human infants. *Psychological Science*, *21*, 653-660. doi:10.1177/0956797610366091

De Stefano, D., & LeFevre, J. (2004). The role of working memory in mental arithmetic. *European Journal of Cognitive Psychology, 16*, 353–386. doi:10.1080

/09541440244000328

Engle, R. W., Tuholski, S. W., Laughlin, J. E., & Conway, A. R. (1999). Working memory, short-term memory, and general fluid intelligence: A latent-variable approach. *Journal of Experimental Psychology: General*, *128*, 309. doi:10.1037/0096-3445.128.3.309

Fuchs, L. S., Compton, D. L., Fuchs, D., Paulsen, K., Bryant, J. D., & Hamlett, C. L. (2005). The prevention, identification, and cognitive determinants of math difficulty. *Journal of Educational Psychology*, *97,* 493−513. doi:10.1037/0022-0663.97.3.493

Fuchs, L. S., Fuchs, D., Compton, D. L., Powell, S. R., Seethaler, P. M., Capizzi, A. M., ... & Fletcher, J. M. (2006). The cognitive correlates of third-grade skill in arithmetic, algorithmic computation, and arithmetic word problems. *Journal of Educational Psychology*, *98*, 29. doi:10.1037/0022-0663.98.1.29

Fuson, K. C. (1988). *Children's Counting and Concepts of Numbers*. New York/Berlin: Springer-Verlag.

Gathercole, S. E, & Alloway, T. P. (2006). Working memory deficits in neurodevelopmental disorders. *Journal of Child Psychology and Psychiatry, 47,* 4–15. doi:10.1111/j.1469 7610.2005.01446.x

Geary, D. C. (2006). Development of mathematical understanding. In D. Kuhn, R. S. Siegler, W. Damon, & R. M. Lerner (Eds.), *Handbook of child psychology: Volume 2: Cognition, perception, and language* (pp. 777–810). Hoboken: Wiley.

Gelman, R., & Baillargeon, R. (1983). A review of some Piagetian concepts. In P. H. Mussen (Ed.), *Handbook of child psychology* (pp. 167-230). New York: Wiley.

Gelman, R., & Gallistel, C. R. (1978). *The child's Understanding of Number*. Cambridge: Harvard University Press

Gersten, R., Jordan, N. C., & Flojo, J. R. (2005). Early identification and interventions for students with mathematics difficulties. *Journal of Learning Disabilities, 38,* 293-304. doi:10.1177/00222194050380040301

Griffin, S. (2003) The development of math competence in the preschool and early school Years. In J. M. Royer (Ed.) *Mathematical cognition* (pp. 1-32). Greenwich, CN, Information Age.

Hannula, M. M. (2005). Spontaneous focusing on numerosity in the development of early mathematical skills (Unpublished doctoral dissertation). Retrieved from University of Turku, Finland.

Holmes, J., & Adams, J. W. (2006). Working memory and children's mathematical skills:

Implications for mathematical development and mathematics curricula. *Educational Psychology, 26,* 339-366. doi:10.1080/01443410500341056

Holmes, J., Adams, J. W., & Hamilton, C. J. (2008). The relationship between visuospatial sketchpad capacity and children's mathematical skills. *European Journal of Cognitive Psychology, 20,* 272-289. doi:10.1080/09541440701612702

Kenny, D. A., Kasher, D. A., & Bolger, N. (1998). Data analysis in social psychology. In D. Gilbert, S. T. Fiske, & G. Lindsey (Eds.), *Handbook of social psychology* (pp. 233–265). New York: McGraw-Hill.

Mahone, E. M., & Schneider, H. E. (2012). Assessment of attention in preschoolers. *Neuropsychology Review, 22,* 361-383. doi: 10.1007/s11065-012-9217-y

Passer, M., Smith, R., Holt, N., Bremner, A., Sutherland, E., & Vliek, M. (2009). Social thinking and behaviour. *Psychology: The Science of Mind and Behaviour.* Berkshire: McGraw-Hill Publishers.

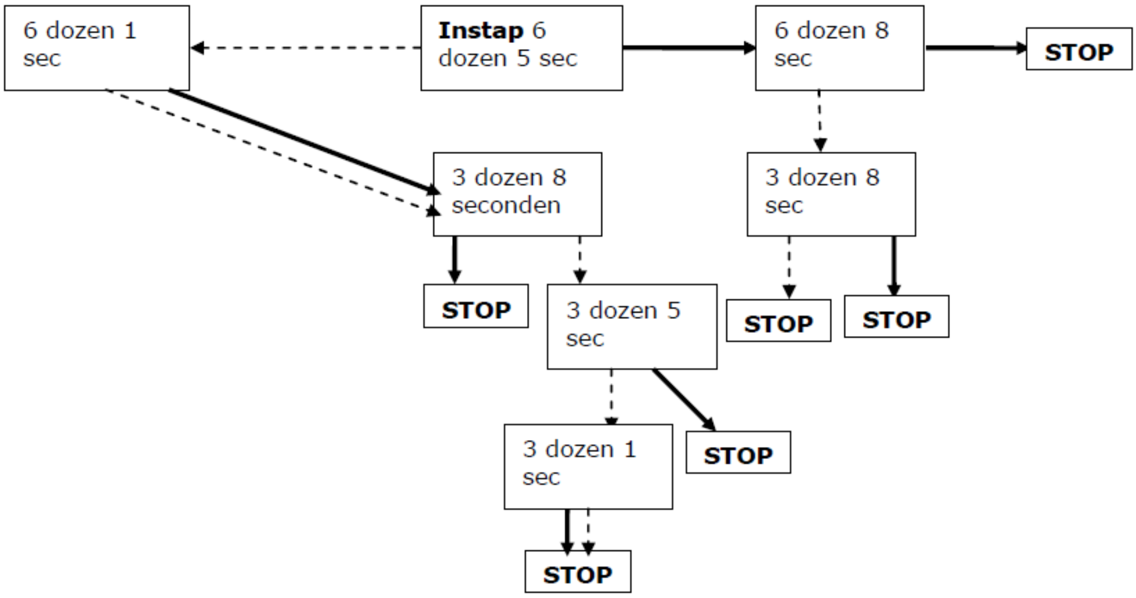
Raghubar, K. P., Cirino, P., Barnes, M. A., Ewing-Cobbs, L., Fletcher, J., & Fuchs, L. (2009). Errors in multi-digit arithmetic and behavioral inattention in children with math difficulties. *Journal of Learning Disabilities, 42*, 356–371. doi:10.1177 /0022219409335211

Reyna, V. F., & Brainerd, C. J. (2007). The importance of math in health and human judgment: Numeracy, risk communication and medical decision making. *Learning and Individual Differences, 17,* 147-159. doi:10.1016/j.lindif.2007.03.010

Van Luit, J. E. H. (2010). Dyscalculie, een stoornis die telt. *Orthopedagogiek: Onderzoek en Praktijk, 49,* 448-465.

Van de Rijt, B. A. M. (1996). *Voorbereidende Rekeningvaardigheid bij Kleuters. De Ontwikkeling van Rekenvaardigheidsschalen en een Onderzoek naar de Invloed van een Programma.* Doetinchem: Graviant.

Appendix A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