Difference in Strategy Use between Children with and without Mathematical Difficulties in Kindergarten.

Masterthesis

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Preface

Last year I worked on my masterthesis for the master program Orthopedagogy at the University of Utrecht. During this research I gained a lot of theoretical knowledge about mapping, number sense and strategies in mathematics. Next to that, my research and statistical abilities improved. Because of this, I worked to finish this thesis with great enthusiasm.

Firstly, I would like to thank dr. Evelyn Kroesbergen for all the supervision she gave me. She supervised my bachelorthesis first. Afterwards she gave me the chance to start my masterthesis in Poland. She gave me supervision at a distance, via skype and e-mail. Also when I was back in the Netherlands, Evelyn answered my questions quickly and provided clear feedback on my writings. The last two years, she invested time and energy in my development.

Furthermore, I would like to thank dr. Sanne van der Ven and dr. Femke Kirschner. They shared their ideas about the design and research questions of my masterthesis and made it possible to work on this project. Sanne helped me by creating a good data file, which I could use for my analysis. Moreover, she gave feedback and suggestions for statistical analyses.

Nadieh Ottink
Utrecht, April 2016

Abstract

Objective: This study set out to explore the differences in learning trajectory and strategy use by children with low number sense and with an at least average number sense. **Method:** Data was collected in 11 primary schools in the Netherlands, 239 children participated (M = 5.5 years). Children were divided in two groups: low number sense and at least average number sense. Number sense was measured with the shortened version of the Utrechtse Getalbegrip Toets-Revised, which measures different aspects of number sense. An educational computer game was used to test and train number sense. The game had two versions. In the first version a number was given, and children had to choose the matching number of apples (number-to-quantity). In the second version a number of apples was given and children had to choose the matching number (quantity-to-number). **Results:** Chi-square tests were used to analyze the data. No significant differences were found in learning trajectory between the two groups. Significant differences were found in the quantity-to-number version. Typically developing children used more optimal and less suboptimal strategies than the low average number sense group. No significant differences were found in the number-to-quantity version. **Conclusion:** This study indicates that children with an at least average number sense use more optimal and less suboptimal strategies, depending on the task characteristics. Further results and implications are discussed.

Keywords: number sense, mapping performance, strategy, mathematics, education, kindergarten.

Difference in Strategy Use between Children with and without Mathematical Difficulties in Kindergarten.

Children with a mathematical delay at the start of primary school usually stay behind in mathematics during their school career, which can have far-reaching consequences. For example, mathematical skills influence the future job perspectives and the amount of income. However, the development of early mathematical skills is not yet clearly understood. Therefore, it is critical to gain more insight into the mechanisms that facilitate children's early mathematical learning (Geary, 2013). Large individual differences in mathematical competencies exist between children. Studying individual differences in children's understanding of mathematical concepts and problem solving skills can give more insight in the cognitive development in early mathematics (Canobi, 2004). Furthermore, this information is important for the development of interventions for children with a delay in mathematical development (Geary, 2013).

A powerful predictor of later mathematical achievement is number sense (Jordan, Glutting, & Ramineni, 2010). According to Berch (2005) number sense is defined as *"An awareness, intuition, recognition, knowledge, skill, ability, desire, feel, expectation, process, conceptual structure, or mental number line. Possessing number sense ostensibly permits one to achieve everything from understanding the meaning of numbers to developing strategies for solving complex math problems; from making simple magnitude comparisons to inventing procedures for conducting numerical operations; and from recognizing gross numerical errors to using quantitative methods for communicating, processing, and interpreting information. With respect to its origins, some consider number sense to be part of our genetic endowment, whereas others regard it as an acquired skill set that develops with experience."* (pp. 333-334). An important aspect of number sense is mapping (De Smedt, Verschaffel, & Ghesquière, 2009; Kolkman, Kroesbergen, & Leseman, 2013). Mapping is the association between number words, Arabic numerals and the quantities they represent (Geary, 2013).

During the early years, children develop mapping skills. Children have to understand that numbers matches numbers of objects, like fingers or apples. They also have to understand that '5' is bigger than '3' (Kolkman et al., 2013). In early mathematical development, the knowledge of counting plays a crucial role. The counting knowledge shapes the knowledge of quantity (Kolkman et al., 2013). It forms the base to continue to the next developmental stage, to make a connection between the knowledge of counting and the knowledge of quantity (Griffin, 2004). The abilities to make this connection are called *mapping skills* (Kolkman et al., 2013). At the age of four, children mostly have a basic knowledge of counting and a basic knowledge of quantity (Griffin, 2004; Kolkman et al., 2013). Moreover, a mapping factor can be distinguished (Kolkman et al., 2013). However, in this stage these skills are not well integrated yet. In the first years of primary school, it will get easier for children to make a connection between the knowledge of counting, the knowledge of quantity and mapping (Kolkman et al., 2013). However, there are large individual differences in the developmental trajectory of early mathematical development (Griffin, 2004).

Mapping skills are related to achievement on a mathematics test (Mundy & Gilmore, 2009). Mundy and Gilmore (2009) suggest that a better mapping performance can lead to a higher achievement on a mathematics test and children with mathematical difficulties have poorer mapping skills. However, the underlying mechanism is not yet clearly understood. Rousselle and Noël (2007) suggest that children with mathematical difficulties are not able to access the knowledge of quantity, rather than that they have problems with the knowledge of quantity itself, which consequently blocks the development of mapping skills. A study of Lipton and Spelke (2005) found that children with a high counting knowledge have better mapping skills than children with poor counting knowledge. According to De Smedt & Gilmore (2011) it could be possible that poor knowledge of counting leads to poor mapping skills.

Another important mechanism that influences the development of mathematical skills is the problem solving procedure that children use (Geary, 2013). School performance is often measured by standardized tests. However, these tests do not give information about the problem solving strategies that are used by children (Geary & Brown, 1991). Gelman and Gallistel (1978) proposed five counting principles, which children develop at a preschool age. The knowledge about these principles is implicit. The first principle is the one-to-one principle. This principle implies that every item needs to be counted only once. Secondly, the stable order principle, this implies that the counting always needs an ordered sequence in different tests. Thirdly, the cardinal principle. This means that the last count in the sequence gives the total number of items. Fourthly, the abstraction principles. This states that all kind of items can be counted, like fingers or apples. Lastly, the order-irrelevance principle. This implies that the order of the counting of the items is not important, as long as the other principles are followed (Gelman & Gallistel, 1978). Starting from these principles, the child can use shortened strategies to solve mathematical problems. There are three basic procedures for solving addition problems: the min procedure, the max procedure and the sum procedure. The min procedure means that the child starts with the larger valued addend and afterwards counts the same amount of times as the value of the smaller addend. For example to solve

3+2, the child counts: 3, 4, 5. In the max procedure, the child starts with the smaller addend and counts the same amount of times as the value of the larger addend. So to solve 3+2, the child counts: 2, 3, 4, 5. The sum procedure starts from 1 and counts both addends, so to solve 3 + 2, the child counts: 1, 2, 3, 4, 5 (Geary, Hoard, Byrd-Craven, & Desoto, 2004). It seems that many children understand addition before subtraction. Children understand that two parts that can be added in different orders to form a whole, which is called additive commutativity. However, they do not understand what the consequences are of taking one part away. More advanced problem-solving skills are needed to understand more difficult relations involving subtraction (Canobi, 2004; Canobi, 2005).

Children with mathematical difficulties use the strategies differently than typically developing children. The strategies used by children with mathematical difficulties to solve addition problems are about two grade levels behind when you compare it to normally achieving children (Geary, Hoard, Byrd-Craven, & Desoto, 2004). It seems that children with mathematical difficulties make more errors in counting than typically achieving children, such as counting either the first or the last item double. Moreover, children with mathematical difficulties use the min procedure less and the sum procedure more frequently than typically achieving children. This seems to be caused by an immature understanding of counting (Geary et al., 2004; Geary, Hamson, & Hoard, 2000). Also, children with mathematical difficulties have problems with the retrieval of basic arithmetical facts from the long term memory (Geary, Hoard, Byrd-Craven, & Desoto, 2004). The study of Geary, Bow-Thomas and Yao (1992) suggests that first grade children with mathematical difficulties and poor computational skills could have a developmental delay in the understanding of features of counting and have relatively poor skills at detecting certain forms of counting errors.

The relationship between the basic numerical understanding and problem solving procedures is not yet clearly understood (Canobi, 2004). The difference between strategies used by children and their level of number sense is missing in the literature. For example, it could be possible that children with a low number sense use a different counting strategy (i.e. 1+1+1) than children with a typical number sense (i.e. 1+2). Moreover, the effect of number sense on the development of mapping skills has not been studies thoroughly. This information would be an addition to existing knowledge and is important to gain more insight into the development of mathematical skills in both children with mathematical difficulties and typically achieving children.

The goal of this study is to research if children with mathematical difficulties use different strategies than children with a typical mathematical achievement. A game-based intervention for Kindergartners will be used: the ‘elephant game’ (see Figure 1 for an example), which focuses on mapping skills. In this game, an elephant gives a number and children have to pick the right number of apples. The children can choose to pick one apple at a time, a group of two apples or a group of five apples. The learning trajectories and strategy use in this game will be examined. The differences in strategy use between children with mathematical difficulties and typically achieving children will be analyzed. The first research question is: Is there a difference in the learning process of mapping skills between children with low number sense and children with at least average number sense? The second research question is: Is there a difference in the proportion of optimal strategy used by children with low number sense and children with at least average number sense? Because children with mathematical difficulties use different strategies than typically developing children (Geary et al., 2004), it is expected that children with mathematical difficulties (i.e. low number sense) make less use of shortened strategies, like addition (Geary et al., 2004; Geary et al., 2000). Consequently, it is expected that children with low number sense use less optimal strategies and need more extra steps to find the right solution. For example, when the number 4 is given, it is expected that children with low number sense will use the strategy 1+1+1+1 (4 steps) more often. The optimal strategy would be 2+2 or 5-1 (2 steps). Furthermore, it is expected that children with a low number sense will have a slower learning process and will reach a lower result, because they will have more difficulties to make the connection between the knowledge of counting and the knowledge of quantity (Lipton & Spelke, 2005; Mundy & Gilmore, 2009; Rousselle & Noël, 2007; Smedt & Gilmore, 2011).

Method

Participants

The data was collected in eleven primary schools in the Netherlands. A total of 397 students from Dutch group 1, 2 and 3 were approached (i.e. aged between 4 and 7). Eight outliers were removed. The final sample consisted of 239 participants (see Table 1). The group was divided in low number sense and at least average number sense, based on the total score of the shortened version of the Utrechtse Getalbegrip Toets-Revised (UGT-R, see Materials).

Table 1
Descriptive Statistics

	Gender	Age in months	UGT score
Total sample	108 male, 121 female, 10 unknown	*M* = 66.12, *SD* = 7.19, range = 53-82	*M* = 7.78, *SD* = 4.60, range = 0-19
Low number sense	47 male, 54 female	*M* = 65.85, *SD* = 65.85, range = 53-81	*M* = 3.73, *SD* = 4.60, range = 0-19

At least average number sense	61 male, 67 female	*M* = 66.33, *SD* = 7.20, range = 53-82	*M* = 11.02, *SD* = 3.43, range = 7-19

Materials

Educational game.

An educational computer game that stimulates children to make the connection between their knowledge of counting and their knowledge of quantity was used to test and train their mapping skills (Tel je Zoo; Kirschner & Kroesbergen, 2016). The game included challenging and entertaining elements, like moving pictures and sounds and the need to avoid a 'bad guy'. Furthermore, a number of effective instruction methods were integrated in the game, like immediate feedback, adaptive instruction and interactivity. The children played each week three subgames.

Only one subgame was analyzed for this study. The 'elephant game' (see Figure 1 for an example). There were two different versions of the game. In the first version the elephant gives numbers and the children needed to pick the right number of apples (number-to-quantity version). In the second version apples were given and the children needed to pick the right numbers (quantity-to-number version).

In this game, an elephant and apples (or numbers) were shown. The apples were clustered in different amounts (one apples, group of two apples and group of five apples). It involved a barrel and a trash can where the apples could be put in. Before starting the game an example was shown to the children to make clear how the game works. In the example, a number (or number of apples) was shown. The cursor moved to the apples and clicked on the right number of apples. After this, the apples moved to the barrel and the cursor clicked on the barrel. The elephant ate the apples. There were four different complexity levels. In complexity level 0, five different numbers were asked (numbers 1-5). In the complexity level 1, 2 and 3, ten or eleven different numbers were asked (respectively numbers 1-10, 5-15 and 10-20). There were different ways to solve the question with the different numbers of apples shown. The children should put the right number of apples in the barrel, click on the barrel and the elephant will eat the apples. Immediate feedback was given about the correctness of the answer. There was a purple insect visible during the game and it was possible to click on it. It would fly into the barrel and afterwards it would fly out again. When the participants answered more than 80% correctly, they were able to go to the next level. When the participants answered less than 60% correctly, they were going back to the previous level.

Figure 1: Click on the right number of apples that is asked.

The following data of the game will be used to answer the research questions:

- Version of the game (quantity-to-number, number-to-quantity).

- Proportions of strategy use: The frequency of three strategies were used: Optimal strategy, suboptimal strategy and wrong answer. The frequencies of strategy use per session were used in the analysis. The optimal strategy is to solve the question correctly in the minimal number of steps (2 = click on 2 apples). The suboptimal strategy is to solve the question correctly, but in more than the minimal number of steps (2 = click on 1 apple and click on 1 apple again). Wrong answer is when the question is answered incorrect.

- Complexity level played: Complexity 0, 1, 2 or 3.

Shortened version of the Utrechtse Getalbegrip Toets-Revised

The shortened version of the Utrechtse Getalbegrip Toets-Revised (UGT-R; van der Luit & van de Rijt, 2009) was used to test number sense. This test is used in children between 4,0 – 7,6 years old and measures the early number sense skills. The test measures nine different aspects with 45 items in total. Four aspects were measured in the shortened version: Using numerical words, linking quantities, counting resultative and applying general knowledge of numbers. Each subscale has five items, zero points for each incorrect item, one point for each correct item. A total of 20 points was the maximum amount of points possible.

The reliability of the test is good (α = .93). Also according to the Commission Test Affairs Netherlands (Commissie Testaangelegenheden Nederland [COTAN]) the reliability is sufficient (Evers et al., 2010). According to COTAN the validity is insufficient, because the validity of this instrument has not been examined thoroughly yet (Evers et al., 2010).

Procedure and analysis

Appropriate ethical standards were followed carefully. The ethical procedure was approved by the Ethics Committee of the Faculty of Social Sciences of Utrecht University. Participants were tested in regular classrooms. The participants played the game one time a week, individually. The two versions are played every other week.

Before testing the hypotheses, outliers were removed. The last four sessions were used in the analysis (session five until eight), because the first sessions of the game were used to select the right complexity level for the participants. This would not give valid results. Chi-square (χ^2) tests of contingencies were conducted to examine if there is a difference between children with a low number sense and children with an at least average number sense in strategy use during the last four sessions. Chi-square tests of contingencies were also conducted to examine if there is a difference between the two groups in the complexity level played during the last four sessions.

Results

The assumptions of normality and homoscedasticity were assessed, and found to be supported. Specifically, a visual inspection of the normal Q-Q and detrended Q-Q plots for each variable confirmed that they were normally distributed. Eight outliers were removed based on the average number of extra steps (two standard deviations below or above the mean). The amount of extra steps has an influence on strategy use, which would make the analyses less reliable. The sample was first divided into two groups based on the UGT score, children with a low level of number sense and children with an at least average level of number sense.

Percentages of children in every complexity level can be found in Figure 2, 3 and 4.

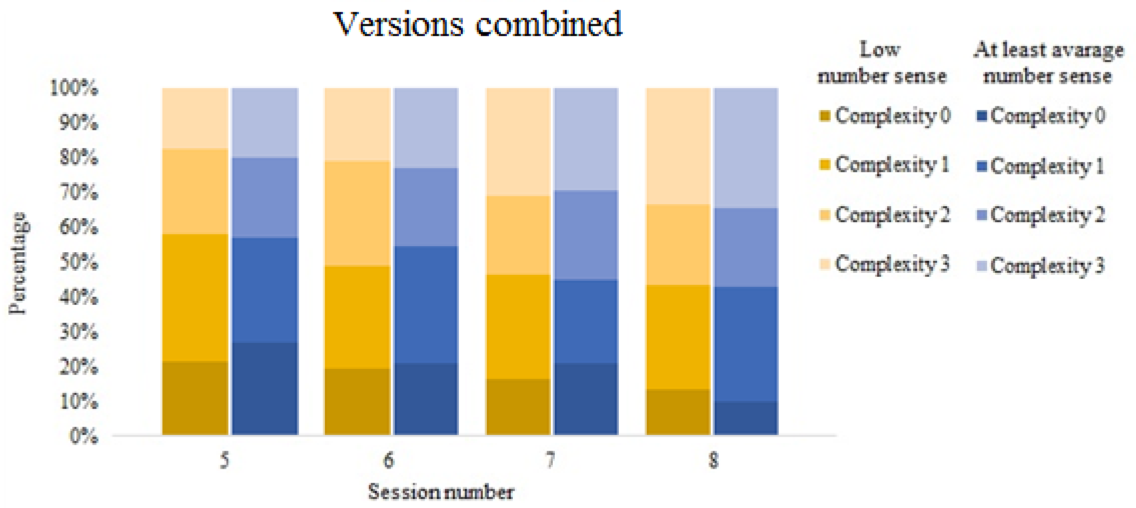

Figure 2: Complexity level per session in children with low number sense and at least average number sense, versions combined.

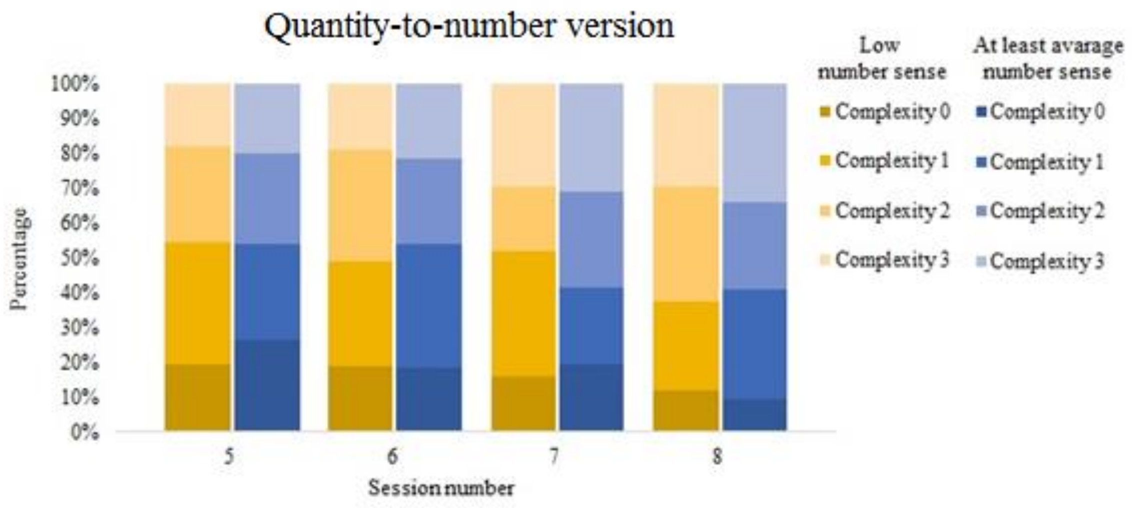

Figure 3: Complexity level per session in children with low number sense and at least average number sense, version quantity-to-number.

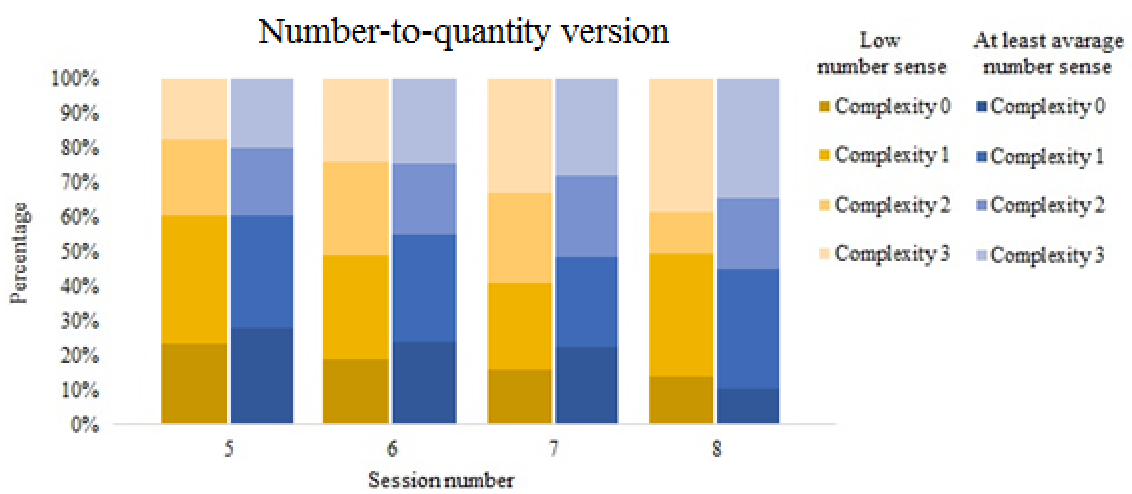

Figure 4: Complexity level per session in children with low number sense and at least average number sense, version number-to-quantity.

A series of Pearson's chi-square test of contingencies (with $\alpha = .05$) was used to evaluate whether the two groups differed on the learning process of mapping skills. The chi-square test was not statistically significant in all sessions, in both versions. Results are reported in Table 2.

Table 2
Chi-Square Tests UGT and complexity level.

	N	df	Pearson Chi-Square [χ^2]	Asymp. Sig.(2-sided) [*p*]	Effect size [ϕ]

Total sample					
Session 5	409	3	2.73	.44	0.08
Session 6	384	3	2.88	.41	0.09
Session 7	349	3	2.96	.40	0.09
Session 8	323	3	0.90	.83	0.05
Quantity-to-number					
Session 5	208	3	1.95	.58	0.10
Session 6	195	3	1.80	.61	0.10
Session 7	180	3	4.65	.20	0.16
Session 8	163	3	2.18	.54	0.12
Number-to-quantity					
Session 5	201	3	1.00	.80	0.07
Session 6	189	3	1.66	.65	0.09
Session 7	169	3	1.46	.69	0.09
Session 8	160	3	2.20	.53	0.12

An overview of the percentages of strategy use are reported in Table 3 and Appendix 1.

Table 3
Percentage of strategy use of children with low and at least average number sense per session, divided by the versions.

Strategy use per session	Low level of number sense			At least average number sense		
	Versions combined	Version quantity-to-number	Version number-to-quantity	Versions combined	Version quantity-to-number	Version number-to-quantity
Session 5						
Optimal	58.6%	58.3%	59.0%	61.8%	63.7%	59.8%
Suboptimal	28.9%	27.8%	30.0%	26.0%	23.5%	28.6%
Wrong answer	12.5%	14.0%	11.0%	12.2%	12.7%	11.6%
Session 6						
Optimal	57.8%	58.9%	56.6%	61.8%	63.9%	59.5%
Suboptimal	30.9%	30.3%	31.5%	25.5%	23.7%	27.6%
Wrong answer	11.3%	10.8%	11.9%	12.6%	12.4%	12.9%
Session 7						
Optimal	59.6%	59.8%	59.4%	62.7%	65.5%	59.5%
Suboptimal	29.4%	28.1%	30.8%	24.7%	22.4%	27.3%

Wrong answer	11.0%	12.1%	9.8%	12.6%	12.1%	13.1%
Session 8						
Optimal	57.6%	56.1%	59.3%	61.3%	63.00%	59.3%
Suboptimal	29.3%	29.4%	29.2%	25.8%	24.20%	27.6%
Wrong answer	13.1%	14.5%	11.5%	12.9%	12.7%	13.1%

A series of Pearson's chi-square test of contingencies (with α = .05) was used to evaluate whether the two groups differed in strategy use during session 5 until 8. Over the total sample, the chi-square test was statistically significant in session 6 and 7 (see Table 4). Children with an at least average number sense used the optimal strategy more and the suboptimal strategy less often than children with a low number sense. The same trend is seen in session 5 and 8, although no significant differences were found. In the quantity-to-number version, the chi-square test was statistically significant in all four sessions. Children with an at least average number sense use the optimal strategy more and the suboptimal strategy less often than children with a low number sense. In the number-to-quantity version, no significant differences were found.

Table 4
Chi-Square Tests number sense and strategy use

	N	df	Pearson Chi-Square [χ^2]	Asymp. Sig.(2-sided) [*p*]	Effect size [ϕ]
Total sample					
Session 5	3607	2	4.27	.12	0.03
Session 6	3363	2	11.84	< .01	0.06
Session 7	3050	2	8.93	.01	0.05
Session 8	2801	2	4.71	.10	0.04
Quantity-to-number					
Session 5	1862	2	6.01	.05	0.06
Session 6	1758	2	9.62	.008	0.07
Session 7	1596	2	7.13	.03	0.07
Session 8	1469	2	7.49	.02	0.07
Number-to-quantity					
Session 5	1745	2	0.47	.79	0.02
Session 6	1605	2	2.95	.23	0.04
Session 7	1454	2	4.97	.08	0.06

Session 8	1332	2	0.98	.61	0.03

Discussion

Prior work has documented that children with mathematical difficulties use strategies that are about two grade levels behind when compared to typically achieving children (Geary et al., 2004). It is also reported that children with mathematical difficulties make more errors and use the min procedure less and the sum procedure more frequently. Additionally, children with a low number sense have more difficulties to make the connection between the knowledge of counting and the knowledge of quantity (Lipton & Spelke, 2005; Mundy & Gilmore, 2009; Rousselle & Noël, 2007; Smedt & Gilmore, 2011). However, the relations between strategy use and level of number sense have not been studied thoroughly. This information is important to gain more insight into the development of early mathematical skills in both children with mathematical difficulties and typically achieving children.

This study set out to explore the effects of an intervention for Kindergartners, focused on mapping skills. The differences in the learning trajectory of mapping performance between children with a low number sense and an at least average number sense were explored. Additionally, this study attempted to examine the differences in strategy use between the two groups. The data was collected in eleven primary schools in the Netherlands and used children in Dutch group 1, 2 or 3. The data were analysed.

Firstly, there was no significant difference in complexity level played in children with a low level of number sense and an at least average level of number sense during the last four sessions, in both versions of the game. The expectation that children with low number sense would have a slower learning process is not supported. This is not in line with the expectations based on former research, which reports that children with low number sense have more difficulties to make the connection between the knowledge of counting and the knowledge of quantity (Lipton & Spelke, 2005; Mundy & Gilmore, 2009; Rousselle & Noël, 2007; Smedt & Gilmore, 2011). A possible explanation could be that the mapping game does not ask for the same abilities as the shortened version of the Utrechtse Getalbegrip Toets-Revised. This might be a reason to hypothesize that number sense is not related to mapping performance, which contradicts the finding that mapping is an important aspect of number sense (De Smedt, Verschaffel, & Ghesquière, 2009; Kolkman, Kroesbergen, & Leseman, 2013). Another explanation is that the difference between the groups of children already decreased in the first four sessions that the game was played.

However, a significant difference was found in strategy use between the two groups, although not in all sessions and only in the quantity-to-number version. A higher percentage of the at least average number sense group uses the optimal strategy in comparison to the low number sense group, who use the suboptimal strategy more often. In the number-to-quantity version, no significant differences are found. This suggests that children with a low number sense use the sum procedure more often, but only when the quantity is given and numbers have to be chosen. This expands the findings of Geary and colleagues (2004). It could be hypothesized that strategy use depends on the task characteristics. Moreover, it seems that this version of the game requires a higher level of number sense to solve the task in the most optimal way. However, it should be noted that the differences in the performance on the two versions is little.

As Rousselle and Noël (2007) suggest, children with mathematical difficulties have a core difficulty in relating numerical symbols to their underlying meaning, rather than that they have problems with the knowledge of counting. This consequently blocks the development of mapping skills. According to this, a possible explanation of the current results could be that children need to relate the numerical symbols to their underlying meaning more when quantity is given, than when quantity has to be chosen. This could explain the significant difference in strategy use in this version of the game. This information is valuable in mathematics education. It seems that children develop the ability to find a quantity when a number is given first, which can be used in teaching mathematics in primary school.

Another explanation for the current results is that mapping in the quantity-to-number version, participants have to map two times. Firstly, the quantity (picture of five apples) has to be transformed to a counting word (five), secondly, they have to decide with what numbers (5) this counting word can be made. In the number-to-quantity, participants just have to know the meaning of the number and can directly count the apples. The consequence of this difference could be that children with a low number sense use less optimal strategies than the at least average number sense group in the version of the game where they have to map two times, because this is more difficult for them.

A number of limitations of this study are important to be discussed. Firstly, an important point of concern is the reliability of the moments that the mapping game is played. In the first session, a few children started in complexity 1 instead of complexity 0, which could have affected their performance in the mapping game. Next to that, missing data were found in the sessions played. This could not be included in the analysis, which could have affected the results. Furthermore, there were sessions that were not finished. Those sessions were not included in the analysis as well. It could be that one of the groups played the game more often than the other group, consequently, different session numbers could have been compared in the analysis. These limitations could have affected the reliability of the study. Moreover, every item is analyzed separately, in future research it would be better to analyze the data on the child level.

Another important aspect that is not addressed in the current study is the relation between the performance in the mapping game and the age group of the children. It could be that for the children in Dutch group 3, it is easier to make the connection between the knowledge of counting, the knowledge of quantity and mapping in comparison to Kindergartners (Kolkman et al., 2013). Moreover, the sample size was small.

Despite these limitations, this study could be a motivation for future research. Most notable, this is the first study to our knowledge to investigate the differences in strategy use in children with low and at least average number sense, when a difference is made between the task characteristics. This gives a reason to study this topic more thoroughly. Future studies should focus on the reliability of the method. Children should play the game at the same day and time, during the same period. Moreover, the children should have the same number of sessions. This process should be closely controlled. Furthermore, the relation between number sense and mapping performance should be further investigated. Reliability should be improved, in this way valuable information about mathematical development and strategy use can be given. This may eventually lead to an improvement of the education of mathematics at the start of primary school.

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Appendix A: Figures strategy use per session.

Figure 5: Strategy use per session in children with low number sense and at least average number sense, versions combined.

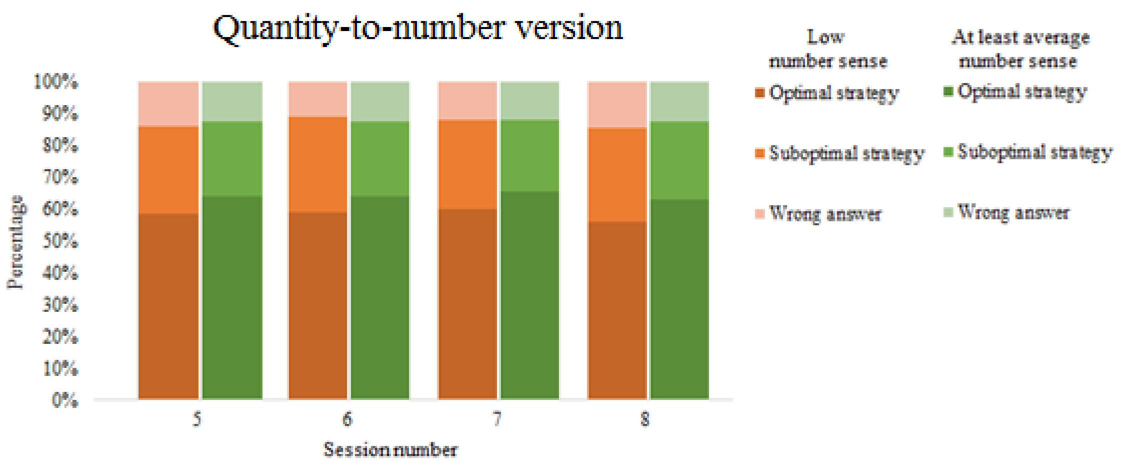

Figure 6: Strategy use per session in children with low number sense and at least average number sense, version quantity-to-number.

Figure 7: Strategy use per session in children with low number sense and at least average number sense, version numbers given.