

# Mathematical development in different performance groups

*Longitudinal study on the development of symbolic numerical magnitude processing, arithmetic skills, and interest in mathematics from first to third grade*

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## Abstract

There is a growing body of research on the development of mathematical skills, such as the prediction of early mathematical competencies on later achievement (MacDonald & Carmichael, 2018; ten Braak et al., 2022) and individual differences in early mathematical skills (Aunola et al., 2004; Geary et al., 2009; Wong et al., 2014). Few studies have investigated multiple mathematical skills simultaneously and longitudinally. Furthermore, most of the research has been conducted on kindergarten children (Kolkman et al., 2013; Nanu et al., 2017; Scalise and Ramani, 2021), later elementary or secondary school children. Currently, there has not been any longitudinal studies investigating the development of multiple mathematical skills and interest in mathematics, with mathematical performance in different performance groups. Therefore, the aim of this study is to examine how the children in different performance groups develop in different mathematical skills and in their interest in mathematics from first to third grade, by answering the following research questions (RQ):

*RQ 1: How do children in different performance groups develop in symbolic numerical magnitude processing, and addition and subtraction fluency?*

*RQ 2: How is interest in mathematics associated with mathematics performance and how do the different performance groups develop in their mathematics interest?*

*RQ 3: Is there a significant difference between the performance groups on the curriculum-based mathematics test at the end of the third grade?*

The data used in this study is part of a broader research project *Tracking individual differences in numeracy development. Interplay between skills, motivation, and well-being (iSeeNumbers)*. There were 172 children ( $M_{\text{age}} = 6$  years, 9 months) participating in our study. Children's symbolic numerical magnitude processing (SNMP), addition and subtraction skills and interest in math were measured four times in the first, second and third grade. The children were grouped into three performance groups based on their first grade performance on SNMP. The low-performing group consisted of all children whose SNMP performance in the first grade was below the 25th percentile.



Children who performed between the 25th and 75th percentile on SNMP in Grade 1 were allocated to the average-performing group. All children whose SNMP performance in Grade 1 was above the 75th percentile was in the high-performing group.

There were three main results emerging from this study. First, the repeated-measures ANOVA analyses showed that both time and group had a positive effect on SNMP, addition, and subtraction. Second, only the low-performing group and the high-performing group showed significant consistent differences on all measures of mathematical skills. While the low-performing and average-performing group showed similar scores and development, with exception of SNMP. Third, for interest in mathematics there was only an effect of time, and interest decreased over time. These findings support previous findings suggesting that early mathematical skills could serve as good predictors for later mathematics performance at first, second and third grade (Siegler, 2009). These findings are also in line with research suggesting that individual differences in mathematics performance grow larger across time (Aunola et al., 2004, Jordan et al., 2002), as the gap between the low-performing and high-performing group increased over time, and that the gap maintained over time (Scammacca et al., 2020). Implications for the educational field is that early mathematical skills such as symbolic numerical magnitude processing and arithmetic skills should be emphasized in instruction and monitored to support children performing low in these skills.