Mathematical skills are essential for personal well-being, professional success, and overall societal progress. However, many people face challenges in acquiring these skills, including those with developmental dyscalculia—a learning disorder marked by difficulties in basic computation and mathematical reasoning. Research suggests that mathematical abilities rely on both specific processes, like understanding quantities, and broader cognitive functions, such as memory and attention. While it has been shown that memory, particularly working memory and the recall of arithmetic facts, plays a crucial role in math, more detailed processes occurring in long-term memory remain insufficiently studied in the context of mathematical abilities.

This project seeks to deepen our understanding of the memory mechanisms behind mathematical skills and math learning difficulties. Using **Fuzzy-Trace Theory**, which distinguishes between two types of memory —**verbatim (precise details, e.g. exact number)** and **gist (general intuition about a number's magnitude)**—researchers aim to investigate how these memory processes relate to math performance. The study will explore both the challenges and compensatory strategies individuals use, with a particular focus on those with developmental dyscalculia.

The research will unfold in three phases. The first phase will involve typically developing young adults, while the second will study individuals with dyscalculia alongside a control group. The research will examine various kinds of numerical memory, including long-term memory for numerosity in symbolic and non-symbolic forms, working memory in the context of numerical representations, and the ability to retrieve arithmetic facts from memory. Novel or significantly adapted tasks based on Fuzzy-Trace Theory will be used to examine numerical memory. Mathematical skills, such as numerical magnitude processing, arithmetic fluency, mathematical reasoning, and spatial processing, will be assessed using established methods from the field of mathematical cognition. In the third phase, machine learning methods will be applied to the collected data to determine if it is possible to detect dyscalculia based on specific patterns in numerical memory performance.

This project has the potential to significantly advance knowledge about the cognitive mechanisms underlying individual differences in mathematical skills, particularly in individuals with math learning difficulties. It may also provide a foundation for future interventions to support individuals with developmental dyscalculia. Additionally, by introducing Fuzzy Trace-Theory into research on mathematical cognition, the project will contribute to the integration of important research concepts in cognitive psychology.