



UMEÅ UNIVERSITET

# MOTOR PLANNING IN AUTISM AND IN TYPICAL DEVELOPMENT ACROSS EARLY SCHOOL AGE

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## Akademisk avhandling

som med vederbörligt tillstånd av Rektor vid Umeå universitet för avläggande av filosofie doktorsexamen framläggs till offentligt försvar i Aula Biologica, Biologihuset, fredagen den 6 december, kl. 09:00.

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### **Abstract**

In our daily lives, we often engage in various manual activities with specific goals in mind. To adapt effectively to an ever-changing environment, it is important for us to anticipate future events while carrying out our actions. Motor planning plays a crucial role in most of our daily activities, underscoring the significance of comprehending its development and its connection to cognitive and perceptual development. In this endeavor, it is critical to also consider atypical development, including the role of motor planning in the prevalent motor problems experienced by children with autism. The primary goal of this thesis was to enhance our comprehension of motor planning development in early school-age children, including both those with typical development and those with autism. The main focus was to investigate the performance of sequential manual movements and detailed characteristics of motor planning from a developmental perspective. To achieve this goal, 3D motion capture technology was utilized. In Study I, variations in motor planning abilities among typically developing 6- and 10-year-old children were examined compared to adults. The findings demonstrated significant enhancements in movement organization between the ages of 6 and 10. However, it is important to note that, even at 10 years old, the children had not yet attained the same level of motor planning ability as adults. Additionally, at the age of 6, the children's sequential movements were more exploratory and relied strongly on feedback processes. It was also evident that they encountered difficulties in making real-time adjustments. By the age of 10, the children demonstrated movement speed and smoothness similar to that of adults, but differences in motor planning outcomes still persisted when compared to adults. Study II investigated differences in motor planning and movement execution between 6-year-old children with autism and typically developing children. In addition, it explored the associations between movement parameters and cognitive functions within the group of children with autism. The findings indicated that, compared to typically developing children, children with autism displayed difficulties in planning sequential movements and exhibited decreased performance consistency. Difficulties in movement execution were further evident towards the end of the movement, which was probably related to suboptimal planning. Among the children with autism, movement time and smoothness were linked to working memory ability, while proactivity in object adjustment (a specific planning aspect of the study task) was associated with general cognitive functioning and non-verbal fluid abilities. Study III was a longitudinal study that examined the development of motor planning in children with autism in comparison to typically developing children during early school age (ages 7, 8, and 9 years). Findings revealed that the children with autism displayed atypical motor planning development in sequential movements. Specifically, increased reliance on initial visual information, particularly at the age of 9, facilitated motor planning improvements in the typically developing children but not the children with autism. These findings support that early school age seems to be an important period when the reorganization of sequential movements develops into more adult-like behavior. These improvements appear to be associated with an increased reliance on initial visual information and changes in visuomotor integration in typical development. However, the children with autism demonstrated less efficient motor planning and atypical motor planning development during this period. This is primarily attributed to their reliance on initial visual information, which supports the notion that difficulties in visuomotor integration have an impact on motor planning development in children with autism. Overall, these findings underscore the importance of considering developmental aspects in both research and practice related to motor problems in children with autism.

### **Keywords**

Motor planning, Action prediction, Development, School-age children, Autism spectrum disorder, Kinematics, Visuomotor integration, Working memory, Intelligence, Longitudinal

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