VIRTUAL REALITY

as a tool to investigate children's motor behavior and risk management

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Virtual Risk Management – ViRMa

Children naturally seek excitement and adventure during play and allowing them to take risks provides valuable experiences that can help them learn to manage risky situations. Engaging in risky play substantially benefits children's health and physical, psychological, and social-emotional development. It increases activity levels, reduces sedentary time, and contributes to lifelong physical activity (Sandseter, 2009; Brussoni et al., 2012). However, there are indications that children are increasingly restricted from playing risky and, therefore, deprived of learning about risk through play (Gray, 2020).

The Virtual Risk Management (ViRMa) project aims to develop and validate ethical, technological methods to investigate children's motor behavior and risk experiences in risky play and leisure time physical activities related to their risk management skills. There exists a gap in the literature regarding risky play and its benefits to health, motor development, and learning. The project hopes to gain a deeper understanding of how children's experiences with risk affect their ability to manage risks by combining risky situations in virtual reality (VR) and through background questionnaires from guardians regarding the children's injury history, living conditions, access, and use of nature, and experiences with leisure physical activities.

Innovative measurements

In this study, 417 Norwegian children from rural and urban schools between the ages of 7 and 10 participated, further elaborated in Sandseter et al., (2023). The study examined three scenarios developed based on the most common causes of death and severe injuries among children: transport accidents (Nesje et al., 2019), drowning, and falls from heights (Sethi et al., 2017). The use of innovative technology such as VR and motion sensors has made it ethically possible to investigate the risk factors in society, which was previously not feasible. VR is a computer technology that uses head-mounted displays (goggles) to create an immersive visual and auditory experience, simulating the feeling of physically existing in different environments (Feng et al., 2018). VR is increasingly utilized in health-related research for rehabilitation and physical/psychological disabilities (Snider et al., 2010; Bortone et al., 2018) and offers opportunities for learning and developing complex skills.

For this study, the HTC Vive Pro Eye VR headset was used along with 4 Steam VR 2.0 Base Stations, defining a VR space of 5 × 6 meters and 5 trackers. Two of the trackers were located on the children's feet enabling them to see transparent feet during their VR experience which were crucial during balancing tasks. The VR features eye-tracking technology, enabling researchers to analyze how the children perceive and respond to potential risks, as well as determine their path planning behavior, perception-action coupling. To capture the children's motor behavior, the study utilized the Xsens Awinda system, which consist of 17 wireless sensors strategically placed around the children's bodies to provide

accurate time-synchronized data of whole-body movements (Fig. 1). The system has previously been successfully used in sports, physical activity, rehabilitation (Al-Amri et al., 2018; Cudejko et al., 2022).

Scenario 1 – Traffic

In the first scenarios, street crossing challenges in two urban traffic environments meet the children (Fig. 2). The level of risk varies based on the type of vehicle and the complexity of the traffic picture – whether there are several types of vehicles, their direction as well as their speed. It begins with bicycles passing from one side, then from the other side, and the last task include bicycles coming from both directions. Subsequent, traffic tasks involve both cars and bicycles coming from various directions. If the child is hit by a vehicle, the VR screen would turn black, and the child would get a message from a pre-recorded voice that he/she was hit and have another attempt. Findings revealed that children who cross roads safely are more likely to look both ways and spend more time assessing their surroundings. In contrast, dangerous crossing is linked to shorter assessment times and less visual checks (Sando et al., 2024).

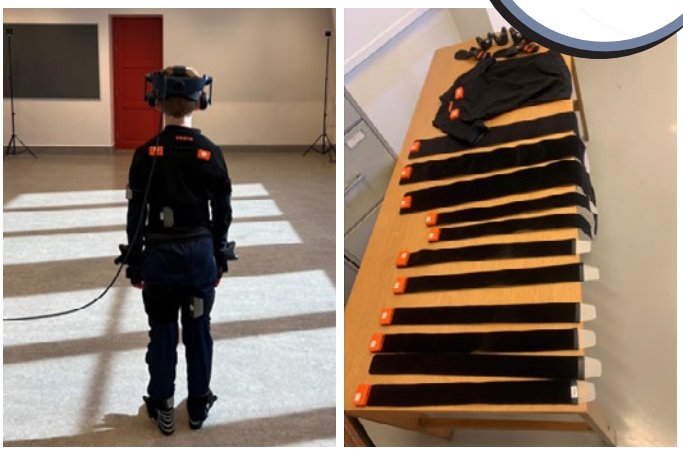

Figure 1: Xsens motion capture system with seventeen sensors (the orange bricks) strategically placed around.

Scenario 2 – River crossing

The second scenario is a river crossing task, where the participants should try to cross a river without falling into the water. The scenario consists of seven tasks involving river crossing on planks and stones. The first river task is designed

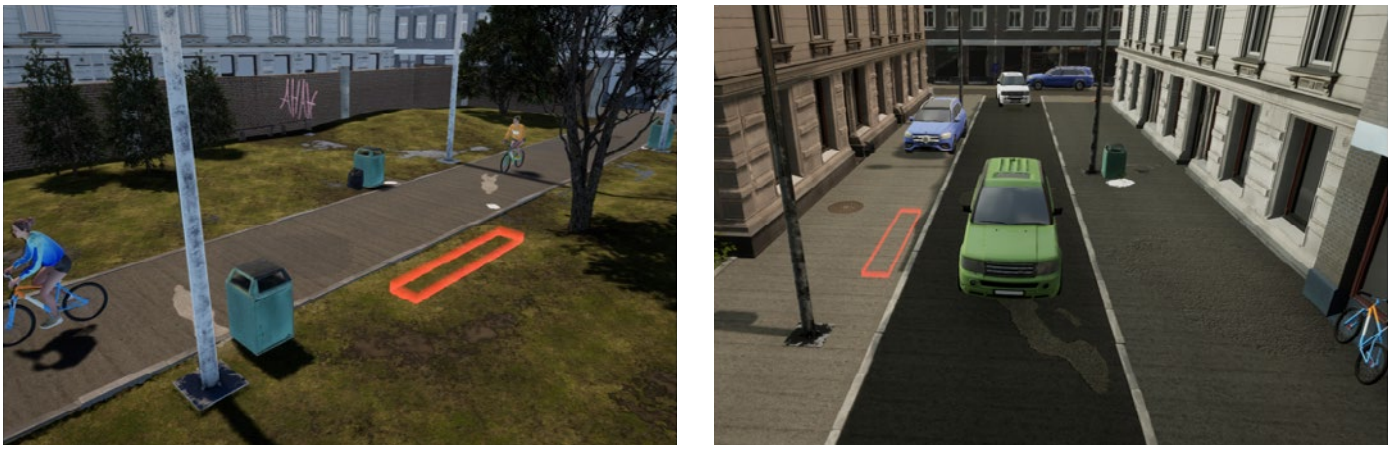

Figure 2: Children start on the opposite side of the red square and gets transferred to the next task when they successfully step into the red area without being hit passing the road.

Figure 3: The first river crossing task is crossing the river by balancing on planks of various sizes, and the last task involves several stones for the child to jump on to cross.

Figure 4: The playground scenario, where the red x marks the beginning for the child. The child starts in zone 1 that equals 0 meters, zone 2 = 0.8 meters above the ground, zone 3 = 1.45 meters above the ground and zone 4 = 2.35 meters above the ground.

to assess the children's willingness to take risks (Fig 3 – left). Further into the scenario, all participants get to try wide and narrow planks before they cross the river by jumping on stones. Their path is up to them as long as they avoid falling into the river, allowing the researchers to examine the children's risk willingness, risk management, motor behavior, and affordances. Preliminary findings indicate that children's height, personality, and gender influence their decisions when navigating, although, children are generally aware of their physical capabilities and limitations.

Scenario 3 – Playground

The playground consists of a balance beam located in a city environment (Fig. 4). The uniqueness of the no-goal-directed target distinguished the last scenario from the first two. Here, children could explore freely for three minutes based on their prerequisites for movement without instructions on how to perform the task or what the purpose is other than play and explorations. The playground features various high zones from 0 cm to 235 cm from the virtual ground on the balancing beam and has a width of the balancing beam of 40 cm. The pillars exist to invite children to jump on if they want to explore and take risks.

We identified four primary patterns of relationship between variability in upper and lower body movements. The first group of children exhibited lower variability in both upper and lower body movements, suggesting a cautious approach to exploring the playground. The second group showed higher variability in both lower and upper body movements, indicating more dynamic locomotor patterns. The third group managed the virtual playground using a shuffling or heel-to-toe pattern with their lower extremities while actively engaging their arms and shoulders to maintain balance. The fourth group restricted movements in their upper body while enabling greater movement in their lower extremities (Storli et al., 2024).

Early childhood education (ECEC) institutions and primary schools in Norway are required by law to provide children with opportunities to understand and manage risk. For the ECEC, children should have the opportunity to experience, assess, and master risky play through physical and motor challenges (Kunnskapsdepartementet, 2017). Additionally, by the end of 2nd grade, according to the curriculum, children should be able to practice safe movement in traffic and around water (Kunnskapsdepartementet, 2020). The continued development of VR and other technologies for simulation real-life experiences is crucial for enhancing the ecological validity of research. Findings from this study emphasizes the value of using innovative measurements and whole-body motion capture to investigate individual differences in children's movement variability of motor behavior (Storli et al., 2024). This knowledge holds significant value for decisions-makers, especially public health authorities, regulators in the field of early childhood educations. It will also contribute to more knowledge about how to avoid sever injuries among children.

En komplet litteraturliste findes på side 37.