Exploring the Influence of Super-Functional Virtual Hands on Embodiment and Perception in Virtual Reality with Children

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Figure 1: Go-Go Training Task: (a) Participants grab fruit to feed an animal at a set location, followed by (b) Sub-Hand, (c) Normal-Hand, and (d) Super-Hand functions.

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1 INTRODUCTION

As Virtual reality (VR) technology advances, more researchers are delving into human perceptions via virtual bodies. Many studies have adeptly manipulated the superficial appearance or form of virtual bodies [3, 5]. However, there has been limited research directly addressing the alteration of their functionality [4]. A critical question remains largely unexplored: Can enhancing virtual hand functionality lead to significant changes in how people perceive their real hands? Body size and shape change rapidly during childhood, and this requires equally fast adjustments in body representations during this period. Further, children under 10 years old rely heavily on visual cues to cultivate ownership over novel bodies [1]. We, therefore, hypothesise that children of this age will show enhanced plasticity in body representation, resulting in enhanced ownership over functionally novel bodies.

Virtual reality, and the embodiment of virtual bodies specifically, is a promising experimental tool to investigate how virtual hand function might shape children's subjective embodiment and motor performance, as well as how these domains relate. Consequently, our project aims to dissect this relationship between virtual limb functionality and embodiment in both children and adults. Our primary objective revolves around discerning whether virtual bodies with enhanced functionality (super-functional) are more seamlessly controlled and ownership felt more strongly compared to those with limited (sub-functional) and normal abilities. Central to our approach is the manipulation of the virtual arm's movement gain in relation to the real arm's extension, the previously named "Go-Go technique" [7]. The intention is to create a spectrum ranging from super to sub-functional virtual upper limbs. Platforms like Unity are instrumental in this prototype development journey. Currently, we have concluded data collection in 171 children aged 5 to 10 years old. This poster's objective is to elucidate our methodology, and in doing so, present to psychologists a unique tool - a set of hands which vary in functionality.

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2 RELATED WORK

To test whether super-functional virtual bodies will be easier to own and control than sub-functional bodies, we need to select and refine a usable, effective function with different levels (two levels each of super-human and sub-human functions). We achieved this through an interaction design process, designing different suitable tasks and developing prototypes in Unity to test different functions and varying their parameters. We established a series of prototypes to explore and refine these hand functions in Unity, emphasizing their applicability and user interactivity by using different training tasks. Specifically, three VR Techniques were considered.

The **Go-Go interaction technique [7]** essentially provides the user with an extendable arm to reach and manipulate distant objects. As for the "Remote Target Selection" task in this study, participants were asked to remotely grab a decoration(n=10) from a Christmas tree and place it into a red box. A 3D interaction method named **PRISM** [2] offers precise and rapid interaction through scaled manipulation. The objective of PRISM is to elevate user precision and control in virtual settings, mirroring their familiarity with the real world. The tasks include PRISM Rotation (Rotate a red brick until it perfectly aligns with a slightly larger green counterpart) and Transition (Navigate the red brick to ensure its complete placement inside the green brick). **HOOK** [6] is a heuristic methods for selecting the closest high-scored 3D object in dense