# Virtual Reality and Neurocognitive Intervention: Rehabilitation approaches towards assisting autistic children with cognitive deficit

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## ABSTRACT

Autism Spectrum Disorder (ASD) is a developmental condition in which the sufferer experiences difficulties in communication with other people, struggles with social interaction and is confused by the world around. Although there is no remedy for this condition, Various medical and technological organizations are working on the development of unconventional solutions such as therapy and assistance for aiding individuals with ASD to manage their condition. Information and communications technology (ICT) is used as a form of therapy in the clinical treatment of psychological disorders. Virtual Reality (VR) is a reasonably new addition to ICT based therapy which can be used to encourage, guide and support individuals with cognitive disorders to develop their skills necessary for independence. Previous researches and experiments have shown that it is possible to enhance the level of concentration, coordination, socialization, communication, self-awareness, and memory in individuals supported with VR. It is not only an ideal way of ameliorating these skills before encouraging individuals to try these out in the real world but also creates a safer environment. This paper focuses on exploring the VR based rehabilitation systems that look into the efficacy of the combination of VR and interactive rehabilitation techniques to complement the current conventional rehabilitation treatments for individuals with ASD. This will be presented through two examples: enhance awareness and coordination by teaching autistic children how to cross a road, and enhance focus and attention using a virtual classroom.

## Keywords

Virtual reality, autism spectrum disorder, cognitive rehabilitation

## 1. INTRODUCTION

The incidence of ASD has increased steadily over the last twenty years. According to the National Autism Association statistics, it is the fastest growing developmental disorder, yet most underfunded [5]. Some studies have been published which show that in recent years there has been an increase in ASD cases by 78% since 2002 [5][1]. However, it must be noted that there is a lack of consensus regarding the prevalence of ASD. Recent studies published in March 2014 by the Center for Disease Control and Prevention (CDC) show that about 1 in 68 children has been identified with ASD in the USA. Studies in Asia, Europe, and North America have identified individuals with ASD with an average prevalence of between 1% and 2% [5]. ASD itself does not affect life expectancy; however research has shown that the mortality risk among individuals with ASD is twice as high as the general population, in large part due to drowning and other accidents. These numbers clearly exemplify that this is indeed an area of concern. Currently there is no cure for ASD, though with early intervention and treatment, the diverse symptoms related to ASD can be improved significantly to enable the person with ASD to lead a useful and productive life.

Since the 1960s the brain has been considered an irrecoverable organ, unable to substitute lost nerve cells [6]. As a result the loss of cognitive functioning were considered to be irreversible and untreatable. When the concept of neuroplasticity gained popularity in the 1980s, this view of the hardwired brain started to change and the potential for cognitive rehabilitation was acknowledged. Neuroplasticity entails the ability of the brain to alter existing connections between cells, to form new connections, to create new cells, and to resist cell death. It allows the neural networks in the brain to reorganize their architecture and functioning through exposure to new sensory experiences [14]. The idea was first proposed in 1892 by Santiago Ramon y Cajal, and subsequently neglected for the next 50 years [13]. Along with the support for the concept of neuroplasticity and how it may enable cognitive rehabilitation, VR was investigated as an enabling technology for cognitive interventions [13].

## 2. VR AND COGNITIVE REHABILITATION

The perceived impact of cognitive impairment on day-to-day functioning has led to the development of cognitive rehabilitation approaches intended to remedy these impairments, thus improving the functioning of people with psychiatric disabilities. In this context, professionals from different fields have been studying and developing cognitive rehabilitation strategies, generating controversy, and a variety of views regarding the effectiveness of each one. In general, these approaches may be classified as restorative or compensatory, as well as computerised and non-computerised.

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Some areas of particular interest in which applications of VR are being researched and developed are in clinical psychology, and the cognitive and neurosciences. VR can be used as an assessment or intervention instrument for the clinical treatment of psychological disorders. Studies have been conducted which focused on cognitive behavioral therapy for the rehabilitation of anxiety disorders such as fear of heights (acrophobia) [11], fear of flying (aviophobia) [11], fear of open spaces (agoraphobia) [7] and social phobia [7]. Other applications involve the rehabilitation of anxiety disorders such as Post Traumatic Stress Disorders for war veterans (Vietnam, Iraq, and Afghanistan) [9]. VR applications have also been developed to clinically rehabilitate a degradation of cognitive functioning resulting from a range of diseases including Alzheimers [8], schizophrenia [4] or conditions such as autism [3] and intellectual disabilities [12]. A functional overlap exists in many of these applications in that they can aim to achieve similar goals such as training with activities of daily life which support more independent living, enhancing cognitive performance and improving social skills.

## 2.1 Case Study I:Awareness and Coordination

One example of a VR for enhancing the awareness and coordination of ASD individuals is a study conducted by a team of researchers at the University of Haifa, Israel [2]. This system features several scenarios which are all designed to teach autistic children how to cross a road. The simulation shows a street with traffic lights and cars which the child interacts with. The child learns to cross a road safely and without placing them in danger or causing undue stress. Plus these skills are then practiced in a real-world but controlled area.

## 2.2 Case Study II:Focus and Attention

Virtual reality is also used to help autistic children with social attention problems. An autistic child often finds it difficult to read facial expressions, pick up visual cues or pay attention to another person while they speak. An example of a VR for enhancing the focus and attention of ASD individuals is a system developed in the US which aims to improve social attention in autistic children [10]. The child wears a head-mounted display (HMD) which shows images from a virtual classroom. This classroom contains a set of 3D virtual people or avatars who deliver an individual presentation. But each of these avatars starts to fade if the child looks away or loses interest.Figure 1 illustrates a scene from the commercial prototype of the virtual classroom.

**Figure 1: A Scene from the virtual classroom [10]**

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