Supporting the cognitive development of individuals with intellectual disabilities through a video game for emotional regulation

Apoyo al desarrollo cognitivo de personas con discapacidad intelectual mediante un videojuego para la regulación emocional

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Abstract. Emotional regulation is a fundamental skill for the cognitive, social, behavioral, and academic development of individuals with intellectual disabilities. However, these individuals often face significant challenges in this area. Therapeutic interventions have been designed to improve emotional regulation. Nevertheless, most interventions and studies have been directed at other populations, such as individuals with autism spectrum disorder or ADHD. Some of them have been proven to be effective in supporting individuals with intellectual disabilities, yet a promising alternative is the use of serious games, and no specific research has been found on the use of video games for the development of emotional regulation in individuals with intellectual disabilities. This article presents the first part of the design of a video game aimed at supporting the emotional regulation of individuals with intellectual disabilities, with the goal of providing an innovative and effective tool in this field.
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Keywords: serious video games, emotional regulation, intellectual disabilities

Abstract. La regulación emocional es una habilidad fundamental para el desarrollo cognitivo, social, conductual y académico de las personas con discapacidad intelectual. Sin embargo, estas personas a menudo enfrentan desafíos significativos en esta área. Se han diseñado intervenciones terapéuticas para mejorar la regulación emocional. No obstante, la mayoría de las intervenciones y estudios se han dirigido a otras poblaciones, como individuos con trastorno del espectro autista o TDAH. Algunas de ellas han demostrado ser efectivas para apoyar a personas con discapacidad intelectual, pero una alternativa prometedora es el uso de videojuegos serios, y no se ha encontrado investigación específica sobre el uso de videojuegos para el desarrollo de la regulación emocional en personas con discapacidad intelectual. Este artículo presenta la primera parte del diseño de un videojuego dirigido a apoyar la regulación emocional de personas con discapacidad intelectual, con el objetivo de proporcionar una herramienta innovadora y efectiva en este campo.

Keywords: videojuegos serios, regulación emocional, discapacidad intelectual.

1   Introduction

According to the American Psychiatric Association, intellectual disability is a disorder that begins during the developmental period of an individual. It includes limitations in intellectual functioning and adaptive behavior. Intellectual disability is classified into four levels: mild, moderate, severe, and profound, each presenting different characteristics in the conceptual, social, and practical domains [1]. Among the main characteristics of people with intellectual disabilities are delayed speech and self-care skills acquisition, limited vocabulary, short attention spans, limited initiative, delayed cognitive acquisitions, academic learning deficiencies, and social and emotional maladjustment [1] [2] [3]. Specifically, among the emotional characteristics of this population, they present difficulties in emotion recognition, lack of self-motivation, understanding the causes and consequences of emotions and self-control, inhibition, and emotion regulation [3] [4]. Emotion regulation is the ability to manage our own emotions appropriately. This is achieved by being aware of the relationship among emotion, cognition, and behavior, having appropriate coping strategies, and the ability to generate positive emotions autonomously [5]. It is important for individuals with intellectual disabilities to learn how to regulate their emotions properly. This represents a significant milestone in their cognitive development and an important achievement associated with social, behavioral, and academic competencies [6] [7]. In order to have adequate emotion regulation, individuals must first develop emotional awareness; which is the ability to be aware of their own emotions and the emotions of others. This includes the ability to identify their own emotions through the use of appropriate emotional vocabulary and the ability to perceive emotions in specific contexts [8]. Later, individuals develop emotional regulation in two phases: co-regulation and self-regulation [9] [7]. Co-regulation occurs when parents or caregivers support their children's emotional development through motivational or emotional scaffolding, as well as using some strategies for regulating emotions. Self-regulation is when the individual learns to control his/her behavior, emotions, and thoughts to achieve a goal on their own. There are some therapeutic interventions for emotional regulation applied to individuals with intellectual disabilities, such as mindfulness and dance/movement therapy. Both interventions have shown positive effects on stress management and the improvement of various emotional aspects in this population [12] [13].

An alternative to enhance emotional regulation interventions is interactive technology, such as serious video games. Serious video games are designed with the aim of educating, training, or modifying some behavior in the player while having fun [14]. In the literature, various studies have shown that the use of serious games can support the development of different skills (e.g. literacy [15]) in individuals with intellectual disabilities; however, no work has been found focused on supporting emotional regulation in this population [16]. Therefore, this study aims to design a serious video game that supports emotional regulation in individuals with intellectual disabilities.

2   Related work

In the literature, several works support the development of different abilities in people with intellectual disabilities; some of them are presented below:

2.1   Technology for individuals with intellectual disabilities

STOMP is a system based on an interactive floor that allows users to interact with digital environments using sensors integrated into a carpet on the floor [17]. This system demonstrated that individuals with intellectual disabilities can participate in various problem-solving activities and overcome challenges using this technology. On the other hand, VirtualMath is a serious virtual reality game designed to support the teaching of logical-mathematical concepts to students with intellectual disabilities [18]. VirtualMath was evaluated with students with intellectual disabilities, and the results indicated that it contributes to the development of mathematical reasoning in this population. These works have demonstrated that there is evidence that

interactive technology can support the development of different skills in individuals with intellectual disabilities.

2.2 Technology to support emotional regulation of individuals with intellectual disabilities

Several studies have been developed with the aim of supporting the development of emotion regulation skills, such as emotional awareness and emotion regulation, in diverse populations. Most of these works focus on supporting individuals with Autism Spectrum Disorder (ASD), and a few of those support people with Attention Deficit Hyperactivity Disorder (ADHD) and individuals with intellectual disabilities. Among the works aimed at supporting emotional awareness in individuals with intellectual disabilities is Emotion4Down, a serious video game designed to support the teaching of emotion recognition in people with Down syndrome and/or intellectual disabilities [19]. This video game does not present an evaluation of its usefulness or effectiveness in teaching emotions. However, it was evaluated in terms of its design, involving seven people with intellectual disabilities. The results indicated some changes in the design characteristics and data collection instruments.

On the other hand, the work of Zheng and Motti [20]presents a wearable application to support the emotion regulation of individuals with developmental disabilities. In this sense, the literature indicates that ASD, ADHD, and intellectual disabilities are grouped under developmental disabilities [21]. The aim of this work is to explore how the use of smartwatches can support the process of emotional self-regulation in individuals with developmental disabilities within the classroom. The system was evaluated with five students with developmental disabilities. The results showed that the system should add more functionalities to allow students to be more independent.

These works aimed at supporting emotional awareness and emotion regulation demonstrated that only a few studies focus on using interactive technology to support these skills in individuals with intellectual disabilities.

3 Methods

3.1 Data collection

We conducted a contextual study in two centers that provide education and therapies to individuals with intellectual disabilities and one center where psychologists, teaching assistants for special needs and babysitters collaborated. We carried out seven sessions of non-participatory observation during scholarly and therapeutic activities involving individuals with intellectual disabilities (Figure 1). Additionally, we conducted twelve structured interviews with special education teachers, psychologists, babysitters, shadow teachers, and teaching assistants for special needs. The goal of the observation sessions and interviews was to understand the characteristics of individuals with intellectual disabilities and the educational and therapeutic activities that are carried out to support their emotion regulation. Finally, we conducted five technology testing sessions with five students with intellectual disabilities to explore the use of different technologies and identify which characteristics of existing technology are appropriate for this population.

Fig. 1: Non-participatory observation session.

3.2 Data analysis

The interviews, observation sessions, and technology testing sessions were transcribed and analyzed using grounded theory techniques. Subsequently, we created an affinity diagram to organize the themes resulting from the qualitative analysis. Based on the results obtained during the analysis, we used the persona technique to describe the different user types we found in the contextual study.

3.3 Design session

To discuss the results obtained from the data analysis collected during the contextual study and obtain design proposals for video games to support the emotional regulation of individuals with intellectual disabilities, we conducted a design session with two human-computer interaction (HCI) experts. The methodology followed in this session consisted of three stages:

-Stage 1) Introduction: A brief introduction was provided about the problem being addressed and the preliminary results obtained during the data analysis process.
-Stage 2) Discussion of the proposed scenarios: In this stage, we presented the proposed scenarios that emerged from the previous stage's results to discuss their pros and cons.
-Stage 3) Discussion of the preliminary characteristics of the video game: Finally, we discuss with the experts the emotions and coping strategies that could be implemented in the video game.

4 Results

4.1 Non-technology use case scenario

As a result of the data analysis process, we obtained some scenarios that show how therapeutic activities are carried out to support the emotional regulation of people with intellectual disabilities in the centers where they receive education. Below is one of these scenarios illustrating some of the challenges of these sessions:
Karla works in a center that educates people with intellectual disabilities. Every day, she works individually with each student to reinforce their areas of need. One of her students is Pedro, with whom she works on emotions. During the session, Karla uses cards with faces that express emotions. Karla takes a card, shows it to Pedro, makes facial expressions of emotion, and verbally describes it. After showing him all the emotions, Pedro then has to identify the emotions himself.

Next, Karla shows him videos of everyday situations for Pedro to identify the emotions in each situation. Finally, she teaches him coping strategies, such as breathing. Sometimes, Pedro loses focus on the activity and prefers to play, so Karla gives him a moment to distract

himself before resuming the activity. At the end of the session, Karla congratulates Pedro on his good work and lets him play with his favorite toys for a few minutes.

4.2   Preliminary Design Characteristics

Once the previous scenario was discussed with the HCI experts, the design session resulted in the following initial design characteristics for a video game to support the therapeutic interventions of emotion regulation of individuals with intellectual disabilities.

-DC1: Customization: People with intellectual disabilities have diverse characteristics and needs, so the activities they perform to develop different skills must be customized. To address this, the video game should include a module that allows the special education teacher or therapist to customize emotions, stages, rewards, and coping strategies used during the game activities.

-DC2: Stages: During emotional regulation therapies, therapists conduct activities focused on emotion recognition and encourage the learning of coping strategies as part of the emotion regulation process. Therefore, the video game should incorporate stages for emotional awareness (emotion recognition) and emotion regulation.

-DC3: Reinforcers: One strategy employed by therapists and special education teachers to maintain the motivation of individuals with intellectual disabilities during activities is the use of positive reinforcement. An essential feature to implement in the video game is to provide positive reinforcement immediately after the player completes an activity and at the end of all activities previously programmed by the therapist.

-DC4: Interaction model: As a result of the technology testing sessions, we observed that motion-based video games can maintain the motivation and attention of individuals with intellectual disabilities. Additionally, other technologies could enable users to provide feedback to the system, providing information about their activities. This would allow for a record of their progress during video game usage sessions,

-DC5: Instructions: The instructions of the video game should be verbal, brief, direct, and through examples.

-DC6: Emotions: According to specialists, anger and frustration are some of the most challenging emotions for individuals with intellectual disabilities to manage. However, other emotions, such as sadness and happiness, can also present difficulties.

4.3   The Video game

We developed a low-fidelity prototype based on the initial design characteristics proposed by HCI experts. The interaction model relies on movement (DC4), and the activities are divided into two stages: emotional awareness and emotional regulation (DC2). Therapists will be able to customize some features of the video game according to the player's needs and preferences (DC1), such as name, stage to work on, emotions, reinforcements, and coping strategies (Figure 2a).

Additionally, the video game will allow the practice of four emotions: happiness, sadness, anger, and frustration (DC6).

(a) Customization module.

(b) Stage I- Emotional awareness.

(c) Stage II- Emotion regulation (Phase: Co-tion (Phase: regulation).

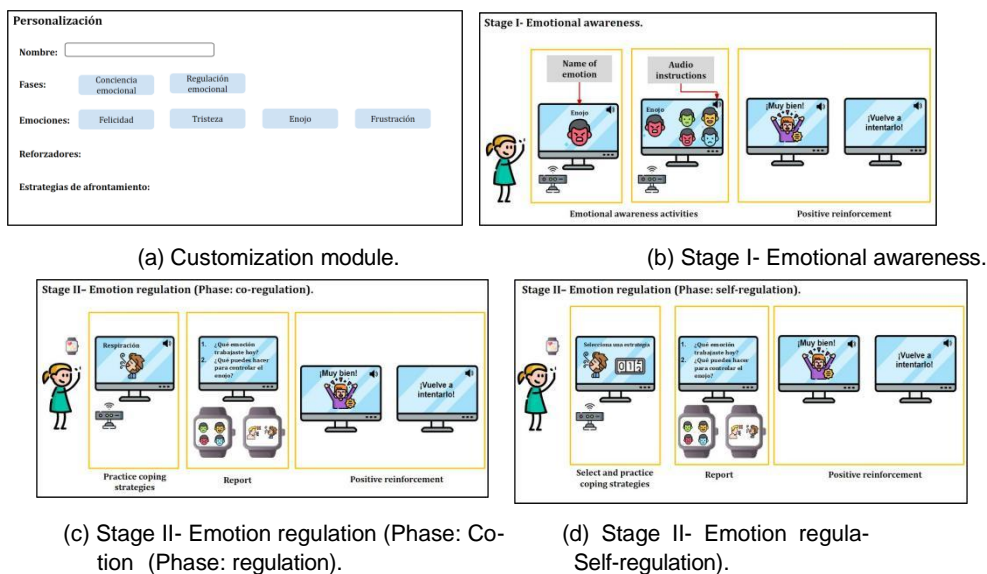
(d) Stage II- Emotion regula-Self-regulation).

Fig. 2: Low-fidelity prototype from the preliminary design characteristics.

The goal of the emotional awareness activities is to support the recognition of these four emotions in faces and everyday situations (Figure 2b). Subsequently, during the emotional regulation stage, the user will engage in emotional

co-regulation, practicing coping strategies previously defined by the therapist. The user will then complete a report detailing the emotion they worked on and how it can be managed. This report will be completed using a smartwatch connected to the video game to store gathered information, which the therapist can later review (Figure 2c). Finally, in the second part of this stage, during the emotional

self-regulation phase, the user will be able to select, based on their own criteria, the coping strategy they consider appropriate for the emotion they are working on. (Figure 2d)

Instructions throughout all activities will be brief and provided in audio format (DC5). After all activities the therapist schedules, the player will receive a final reward composed of the partial rewards earned during the game (DC3).

Referring to the non-technology use case scenario described in the section 4.1, the following shows how the proposed video game can support emotional regulation interventions for people with intellectual disabilities:

Karla works in a center that provides education for people with intellectual disabilities. Every day, she works individually with each student to reinforce their areas of need. One of her students is Pedro, with whom she works on emotions. During the session, Karla personalizes the video game with the name of the student, the phase, and the emotions to work on (happiness, sadness, anger, or frustration) (DC6), as well as the reinforcers to be presented (DC1). During the activities, the videogame's audio instructs Pedro to identify different emotions and select the images that express them (DC5). When Pedro selects the correct answer, the videogame congratulates him. If Pedro selects an incorrect image, he is asked to try again (DC3). When Karla observes that Pedro performs the activities correctly, she moves on to the emotional regulation phase (DC2). Karla customizes the game for Pedro to practice the coping strategies she selects (DC1). At the start of the game, Pedro has to mimic the game character's exercise while the game tracks his movements to determine if he performs them correctly (DC4). Then, using a smartwatch, Pedro answers some questions about the exercise (DC4). Once Karla observes that Pedro performs the exercises correctly, she personalizes the game again so that he can choose the coping strategy he wants to practice. Throughout the session, Pedro is motivated to complete all the activities. At the end of the session, Karla congratulates the student on his good work, and they return to their academic group activities

5   Conclusion and future work

This paper presented the results of the first design session to design a video game to support the emotional regulation of individuals with intellectual disabilities. We conducted a contextual study involving psychologists, special education teachers, babysitters, and individuals with intellectual disabilities. The results of the contextual study indicated that individuals with intellectual disabilities often struggle to regulate their emotions. Individuals with intellectual disabilities must learn to regulate their emotions properly because this represents a significant milestone in their cognitive development and the achievement of an independent life. Currently, we are conducting design sessions with special education teachers to discuss the preliminary design features resulting from the session with the HCI experts and to generate new proposals for the video game design to support emotional regulation in individuals with intellectual disabilities. Once the design sessions are completed, the high-fidelity prototype will be implemented, and formative evaluations will be carried out with the participation of people with intellectual disabilities to validate the design features and evaluate the video game's usability. Subsequently, we plan to conduct summative evaluations to investigate its impact in the emotional regulation of individuals with intellectual disabilities.

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