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PERCEÇÃO DO IMPACTO DO NEURONUP NA REABILITAÇÃO COGNITIVA DE PESSOAS COM LESÃO CEREBRAL ADQUIRIDA E DOENÇA DE HUNTINGTON

PERCEPTION OF THE IMPACT OF NEURONUP IN THE COGNITIVE REHABILITATION OF PEOPLE WITH ACQUIRED BRAIN INJURY AND HUNTINGTON´S DISEASE

PERCEPCIÓN DEL IMPACTO DE NEURONUP EN LA REHABILITACIÓN COGNITIVA DE PERSONAS CON DAÑO CEREBRAL ADQUIRIDO Y ENFERMEDAD DE HUNTINGTON

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RESUMO

Introdução: A reabilitação cognitiva tem vindo a ganhar relevância no tratamento para melhorar e manter o funcionamento cognitivo em pessoas afetadas por doenças neurológicas. As TICs têm transformado os tratamentos cognitivos, sendo eficazmente integradas nas abordagens terapêuticas. Nesse contexto, o NeuronUP apresenta-se como um software desenvolvido para reabilitação cognitiva.
Objetivo: Examinar a eficácia da plataforma NeuronUP em pessoas com doença de Huntington e lesão cerebral adquirida;Explorar e analisar a experiência e a satisfação dos utilizadores com a aplicação.
Métodos: Estudo de métodos mistos. Participaram 12 indivíduos: 6 com doença de Huntington e 6 com lesão cerebral adquirida. Os escores utilizados foram obtidos por meio da adaptação espanhola do Mini-Mental (Lobo et al., 1979), e a experiência com o aplicativo foi avaliada por meio de entrevistas.
Resultados: Os resultados mostram uma melhoria cognitiva significativa em pacientes com lesão cerebral adquirida e estabilidade em pacientes com doença de Huntington. Os participantes também avaliaram positivamente o processo de reabilitação, destacando benefícios na memória, atenção e autonomia.
Conclusão: A eficácia de ferramentas digitais como o NeuronUp na reabilitação cognitiva como complemento às terapias convencionais é confirmada.

Palavras-chave: lesões encefálicas; doença de Huntington; declínio cognitivo; reabilitação cognitiva; terapia assistida por computador

ABSTRACT

Introduction: Cognitive rehabilitation has gained relevance in the treatment, improvement, and maintenance of cognitive functioning in individuals affected by neurological disorders. ICTs have transformed cognitive treatments by effectively integrating into therapeutic approaches. In this context, NeuronUP is presented as a computer software designed for cognitive rehabilitation.
Objective: To examine the effectiveness of the NeuronUP platform in individuals diagnosed with Huntington's Disease and Acquired Brain Injury, and to explore and analyze users' perceived experiences and their satisfaction with the application.
Methods: Mixed-methods study. A total of 12 subjects participated: 6 with Huntington's Disease and 6 with Acquired Brain Injury. The cognitive scores used in the study were obtained through the Spanish adaptation of the Mini-Mental State Examination (Lobo et al., 1979), and the experience was gained through the interviews.
Results: The results show a significant cognitive improvement in patients with Acquired Brain Injury and stability in patients with Huntington's Disease, together with a positive evaluation of the rehabilitation by the users, who highlight benefits in memory, attention, and autonomy.
Conclusion: These findings support the effectiveness of digital tools such as NeuronUP in cognitive rehabilitation as a complement to conventional therapies.

Keywords: brain injuries; Huntington disease; cognitive impairment; cognitive rehabilitation; therapy, computer-assisted

RESUMEN

Introducción: La rehabilitación cognitiva ha ganado relevancia en el tratamiento de la mejora y el mantenimiento del funcionamiento cognitivo de las personas afectadas por trastornos neurológicos. Las TIC han transformado los tratamientos cognitivos incorporándose de manera efectiva en los enfoques terapéuticos. En este contexto, NeuronUP se presenta como un software informático diseñado para la rehabilitación cognitiva.
Objetivo: Examinar la eficacia de la plataforma NeuronUP en personas afectadas por enfermedad de Huntington y daño cerebral adquirido; explorar y analizar la experiencia percibida por los usuarios, así como su satisfacción con la aplicación.
Métodos: Estudio de métodos mixtos. Participaron 12 sujetos, 6 con enfermedad de Huntington y 6 con daño cerebral adquirido. Las puntuaciones que se utilizan se han obtenido a través del Mini-Examen Cognoscitivo (Lobo et al., 1979) y de la experiencia con la aplicación a través de la entrevista.
Resultados: Los resultados evidencian una mejora cognitiva significativa en los pacientes con daño cerebral adquirido y estabilidad en los pacientes con enfermedad de Huntington, junto a una valoración positiva de la rehabilitación por parte de los usuarios, quienes destacan beneficios en memoria, atención y autonomía.
Conclusión: Se corrobora la efectividad de las herramientas digitales como NeuronUp en rehabilitación cognitiva como complemento a las terapias convencionales.

Palabras clave: lesión cerebral; enfermedad de Huntington; disminución cognitiva; rehabilitación cognitiva; terapia asistida por computadora

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INTRODUCTION

The impact of cognitive deficits in neurological diseases (Lopes et al., 2017), such as Huntington's disease and acquired brain injury, highlights the need to analyze and understand the role of cognitive rehabilitation interventions in improving the quality of life and autonomy of affected individuals. People with Huntington's disease (HD) develop uncontrollable (choreic) movements in their fingers, feet, face, or trunk, similar to dancing (chorea), along with behavioral, emotional, and cognitive alterations (Mejía et al., 2024; Petrozziello et al., 2023). Its progression is slow but progressive, implying an approximate life expectancy of 15 to 20 years after symptom onset (Sánchez-Rojas et al., 2021). HD presents with motor, cognitive, psychiatric, and functional symptoms that vary between individuals and tend to worsen over time, significantly affecting autonomy and the ability to perform activities of daily living (Sánchez-Rojas et al., 2021; Parsons & Raymond, 2023). Cognitive impairments occur at all disease stages and worsen as the disease progresses; they can manifest even before motor onset, compromising cognitive functions such as memory, attention, and executive function (Cusme & Pucuna, 2024; Vidal, 2017). Although HD is best known for its motor symptoms, in some cases, cognitive deficits can be equally or even more disabling, generating significant difficulties for affected individuals.

Currently, no cure exists for the disease; however, various pharmacological treatments help manage symptoms. Similarly, non-pharmacological interventions such as occupational therapy, physical therapy, and speech therapy have improved functional abilities and slowed clinical progression (Mejía et al., 2024; Fritz et al., 2017; Quinn & Busse, 2017).

On the other hand, acquired brain injury (ABI) encompasses multiple causes, including traumatic brain injuries, strokes, tumors, infections, and hypoxia, among others (Arango & Olabarrieta, 2019; Muñoz et al., 2017; Paz, 2024). The consequences vary according to several factors: the location and severity of the injury, the timing of medical intervention, and individual patient characteristics, resulting in neurological, cognitive, behavioral, and functional impairments (Muñoz et al., 2017). Early rehabilitation is critical because the brain exhibits greater neuroplasticity—the brain's capacity for neural reorganization and adaptation following injury—during the initial phases following injury (Calderón-Chagualá et al., 2019; Fernández-Sánchez et al., 2022).

Given the cognitive deficits in both HD and ABI, cognitive rehabilitation constitutes an essential therapeutic component. These interventions leverage neuroplasticity to improve and maintain cognitive function. Although this adaptive capacity becomes more limited in neurodegenerative diseases such as HD than in ABI, rehabilitation interventions can minimize clinical deterioration and promote functional recovery (Guadamuz et al., 2022; Cuaspud et al., 2024).

As these pathologies progressively compromise functional independence—initially affecting complex activities and subsequently basic activities of daily living (ADLs)—interest in cognitive rehabilitation as a strategy to preserve autonomy and maintain quality of life has intensified (Calderón-Chagualá et al., 2019; Vidal, 2017). Furthermore, these interventions not only enhance cognitive and social function but also induce neural network reorganization.

In this context, Information and Communication Technologies (ICTs) have assumed a significant role by integrating into therapeutic processes, enabling the design of more personalized and accessible interventions (Alashram, 2026; Daiver et al., 2021). Among these tools, NeuronUP is a specialized software platform for cognitive rehabilitation and stimulation, designed to slow cognitive decline and preserve cognitive functions through activities based on neuroplasticity (NeuronUP, 2024; Sastre, 2020). The platform offers numerous, adaptable resources to different clinical profiles, facilitating interventions tailored to individual needs and promoting improvements in cognitive abilities and quality of life (Calderón-Chagualá et al., 2019; NeuronUP, 2021; Sastre, 2020).

While the benefits of NeuronUP have been described in multiple pathologies, studies examining individuals with HD and ABI that combine objective assessment of cognitive changes with user perceptions in real-world intervention settings remain limited. This study aims to contribute to this line of research by jointly analyzing cognitive efficacy and users' perceived experiences.

This study was developed in a local occupational therapy service center in a Spanish city that collaborates with various local associations. Two questions guided this study: 1) Are there differences in cognitive impairment scores on the Mini Mental State Examination (Spanish adaptation) before and after intervention with NeuronUP? 2) What are users' perceptions of the cognitive changes they experienced after using the platform? The objectives of the study were: (1) To examine the effectiveness of the NeuronUP platform in people affected by Huntington's disease or acquired brain injury. (2) To explore and analyze users' perceived experiences and their satisfaction with the application.

1. METHODS

1.1 Study Design

A convergent mixed-methods research design QUAN + QUAL = (Creswell & Plano Clark, 2017) was used. This dual-component design is characterized by the relative independence of the data sets until after each had been analyzed separately, their presentation as independent data sets in the results section, and the integration of findings in the discussion, such that neither the data nor the analyses depended on each other (Guest & Fleming, 2015). This approach, quantitative and qualitative, began with the collection and analysis of data from the user questionnaire—specifically, the Spanish adaptation of the Mini-Mental State Examination (MMSE)—which was administered before and after neurocognitive rehabilitation with NeuronUP. Subsequently,

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information from interviews was collected and analyzed. Both quantitative and qualitative aspects were weighted equally, with the two types of data remaining distinct yet integrated.

1.2 Participants

A convenience sample of 12 participants (6 men and 6 women) was recruited from local brain injury or Huntington's disease associations. The sample comprised 6 individuals with HD and 6 with ABI. **Inclusion criteria** were: a diagnosis of HD or ABI, availability of baseline MEC assessment data, and written consent for research use of their data. **Exclusion criteria** included: lack of a confirmed HD or ABI diagnosis, incomplete baseline MEC assessment data, or failure to provide authorization for use of the data. Participant age ranged from 41 to 75 years at the time of baseline assessment (Table 1).

Table 1 - Characteristics of participants

Subject ID	Gender	Age	Diagnosis
S.1	Woman	62	HD onset in 2017
S.2	Woman	59	HD onset in 2019
S.3	Woman	59	HD onset in 2022
S.4	Woman	61	HD onset in 2014
S.5	Man	67	HD onset in 2018
S.6	Man	71	HD onset in 2020
S.7	Woman	75	Stroke in 2015
S.8	Man	68	Stroke in 2022
S.9	Man	41	Hyponatremia in 2018
S.10	Woman	54	Stroke in 2007
S.11	Man	63	TBI in 1995
S.12	Man	70	Aneurysm in 2000

1.3 Instruments

Mini-Examen Cognoscitivo (MEC-35)

In 1978, Folstein's Mini-Mental State Examination (MMSE) was adapted and translated into Spanish by Dr. Lobo and his team (Lobo et al., 1979), resulting in the *Mini-Examen Cognoscitivo (MEC)*. This version has subsequently been validated in numerous studies, demonstrating reliability and validity both in Spain and in Spanish-speaking countries, with a specificity of 82% and a sensitivity of 84.6%. This test is used to identify possible signs of cognitive impairment, particularly in adult populations. It comprises 35 questions divided into five domains: orientation, fixation, memory, attention and calculation, and language and construction. Its brief administration time—approximately 10 minutes—makes it a practical tool for rapid cognitive screening (Lorente et al., 2009). The MEC-35 was administered to patients with HD upon arrival at the occupational therapy center in 2023 and 2024. For patients with ABI, the instrument was administered in 2022, with this assessment serving as the pre-test for this study.

Semi-structured interviews

Semi-structured interviews (Magaldi & Berler, 2020) were conducted with participants whose intervention included the NeuronUP software and who voluntarily agreed to participate. Interviews were designed to explore participants' perceptions, experiences, opinions, and subjective motivations regarding the cognitive changes they experienced. Six open-ended questions were developed based on the study objectives and previous literature, addressing core themes relevant to the study regarding disease-related changes and the rehabilitation experience. Rather than focusing solely on software satisfaction, the questions aimed to elicit deeper insights into cognitive progress. The questions were designed to be answered in an open and non-directive manner, with flexibility to vary their order, reformulation, and depth based on the interviewer's judgment and the conversational flow (Xu, 2024). This approach promotes content validity by enabling in-depth exploration of participants' experience. Before conducting the interviews, the study purpose and interview procedures were explained in detail, and anonymity was guaranteed. Following informed consent—which was also duly explained—interviews were scheduled at times and locations convenient to participants. All interviews were conducted in person, recorded, and transcribed. Each interview lasted approximately 15 minutes and took place at the association's facilities.

1.4 Procedure

Quantitative pre-test data for both groups were obtained from retrospective clinical records already available at the center, with informed consent from users and institutional approval. This approach is justified by the availability of systematic evaluations using the same instrument in routine clinical practice, which ensures comparability of measurements. Additionally, this method allowed for pre-post comparison across all participants and established a baseline prior to intervention without significantly extending the study duration. Post-test data were collected between February and July 2025, with the MEC-35 administered again

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following intervention with NeuronUP software. Qualitative data were collected through semi-structured interviews conducted during the first half of 2025.
Participants received cognitive stimulation through the NeuronUP platform in individual sessions of approximately 50 minutes, held weekly. An occupational therapist planned and supervised all activities, employing an individualized approach tailored to each participant's specific needs and characteristics. Treatment was continuously adapted based on participants' cognitive and functional profiles. The intervention targeted multiple cognitive domains, primarily attention, memory, language, calculation, and executive functions, with difficulty levels progressively adjusted according to observed performance. For participants with ABI, the intervention was delivered in person; for those with HD, it was provided online. Additionally, many participants engaged in complementary rehabilitation activities, including group cognitive therapy, reading clubs, and other sociocultural activities designed to promote cognitive stimulation, social interaction, and maintain occupational participation.
Each participant was assigned an alphanumeric code in compliance with ethical guidelines for human research, including the Declaration of Helsinki (WMA, 2024). All procedures adhered to both the European Union General Data Protection Regulation 2016/679 and the Spanish Organic Law 3/2018 on Personal Data Protection and Guarantee of Digital Rights. The study received ethical approval from the University of Burgos Bioethics Committee (IO 47/2025).

1.5 Analysis

Quantitative data were analyzed according to the instrument's guidelines. For individuals over 65 years of age, scores below 23/24 points out of 35 suggest possible cognitive impairment. For those under 65, the cutoff score is 27/28, though educational level affects interpretation (Lorente et al., 2009; Lobo et al., 2002; López & Martí, 2011). To compare pre- and post-NeuronUP cognitive impairment within each group (HD and ABI patients separately), the Wilcoxon signed-rank test was applied. The same test was used to assess whether significant differences existed between the two independent groups (HD vs. ABI) in terms of pre- and post-NeuronUP cognitive impairment. Data were analyzed using IBM SPSS Statistics 29.
Qualitative data underwent content analysis, employing both manifest analysis (examining what participants explicitly stated) and latent analysis (seeking to uncover underlying meaning) (Martínez, 2023). The latent approach was particularly valuable given the narrative reticence common in individuals affected by HD. Following familiarization with the interview transcripts, manual analysis was conducted through systematic organization, reduction, and categorization of the data to identify patterns and derive coherent themes.

2. RESULTS

Quantitative phase results

The results from pre-test and post-test assessments are presented below. These measurements were obtained before and after neurocognitive rehabilitation that incorporated the NeuronUP tool with subjects with HD and ABI.
The MEC-35 scale scores obtained by subjects with HD and ABI at the two assessment points (pre- and post-intervention) are presented in Table 2, including the dates of administration.

Table 2 - MEC-35 scores in subjects with HD and ABI (pre- and post-intervention)

Subject ID	Diagnosis	MEC pre	MEC post
S.1	HD	28-(03-2023)	31 (02-2025)
S.2	HD	30 (03-2023)	29 (02-2025)
S.3	HD	24 (09-2023)	27 (02-2025)
S.4	HD	35-(03-2023)	35 (02-2025)
S.5	HD	29 (12-2024)	32 (07-2025)
S.6	HD	33 (03-2024)	33 (07-2025)
S.7	ABI	27-(09-2022)	31-(02-2025)
S.8	ABI	24 (08-2022)	32 (02-2025)
S.9	ABI	29 (02-2022)	33 (02-2025)
S.10	ABI	25 (02-2022)	28-(02-2025)
S.11	ABI	30 (07-2023)	30 (07-2025)
S.12	ABI	29 (02-2022)	32 (07-2025)

In the intragroup comparison, subjects with HD (6) showed a slight tendency towards improvement of 3 points in three cases; maintained their pre-test scores in two cases; and showed a decrease of 1 point in one case. This limited improvement can be explained by the progressive nature of HD, a neurodegenerative disorder. In contrast, subjects with ABI (6) demonstrated a more pronounced increase in post-test scores, with improvement ranging from 3 to 8 points, except for one subject who maintained pre-test performance. These results suggest positive intervention effects. At pre-test, subjects with ABI obtained lower scores

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than subjects with HD, indicating slightly better initial cognitive performance in the HD group. However, post-test results revealed a contrasting pattern: subjects with ABI achieved greater improvements compared to subjects with HD, who demonstrated minimal changes and greater stability.
The non-parametric Wilcoxon test was applied to compare the pre- and post-intervention scores (Tables 3 and 4). No statistically significant differences were found in any variable between pre- and post-intervention measurements in either group. This lack of significance in both the HD and ABI groups reflects their similar progression trajectories following the NeuronUP intervention. Baseline scores were similar between groups, and statistical analysis revealed no significant differences at post-intervention (n = 12; z = -0.162; p = 0. 937).

Table 3 - Statistical analysis of MEC-35 scores in subjects with HD (pre- and post-intervention)

Variable	n	M (SD) pre	M (SD) post	*z*	*p*
Orientation	6	9.50 (0.84)	9.50 (0.84)	0.000	1.000
Attention and calculation	6	5.33 (2.16)	6.33 (2.07)	1.134	0.257
Short-term memory	6	2.00 (1.26)	2.33 (0.82)	1.000	0.317
Language and construction	6	10.00 (0.89)	10.00 (0.89)	0.000	1.000
Total	6	29.83 (3.87)	31.17 (2.86)	1.512	0.131

Table 4 - Statistical analysis of MEC-35 scores in subjects with ABI (pre- and post-intervention)

Variable	n	M (SD) pre	M (SD) post	*z*	*p*
Orientation	6	8.50 (1.05)	9.17 (0.75)	1.300	0.194
Attention and calculation	6	5.00 (3.03)	6.33 (1.97)	1.633	0.102
Short-term memory	6	1.33 (1.21)	2.33 (1.21)	1.857	0.063
Language and construction	6	9.50 (0.84)	10.17 (0.41)	1.633	0.102
Total	6	27.33 (2.42)	31.00 (1.79)	2.041	0.041

Qualitative phase results
Interview analysis revealed two main categories:

1) Regarding the diagnosis
Interviewees received the diagnosis differently depending on whether they had HD or ABI. For those with HD, as it is a hereditary disease with gradual onset, suspicion of transmission existed beforehand (n = 4 participants), and diagnostic testing confirmed this: *"Before the diagnosis, I already suspected it. The first symptoms I noticed were choreic movements"* (S.1); *"Mine was somewhat similar... because my older brother had the same symptoms as my grandfather..."* (S.4); *"They tested me, and it came back 100% positive"* (S.2). Those with ABI, by contrast, received the diagnosis with shock due to the acute and unexpected onset of the disease or because they had been in a coma (n = 3): *"[…] my family told me that I was in a coma for two months"* (S.10); *"When I woke up, I remember that I was in bed with tubes. Yes, I was in a coma for 6 months. My brother told me about it"* (S.11). Symptom presentation also differed by condition. Those with HD reported either no visible symptoms (chorea) or very mild symptoms (n = 5): *"That I didn't feel well"* (S.3); *"[…] and frankly, I didn't have many symptoms; nothing was noticeable"* (S.4). Those with ABI reported either no memory of the event or disparate symptom recall (n = 6): *" I didn't know what happened to me—I went to get up, to put on my gown, and I couldn't manage it... and I fell to the ground "* (S.7); *" Basically, everything suddenly... at 3 in the afternoon it started... half of my body became paralyzed, and on my head I have this... a mark... and it won't go away..."* (S.8); *"I hadn't noticed anything; I was a bit tired, but I didn't notice anything. […] I fainted and I don't remember..."* (S.9); *"The first thing I noticed was a sharp pain in my head [...] I ate, took a nap, and never woke up from it"* (S.10).
In four of the analyzed cases, anomia was observed, manifested as difficulties expressing their experience in a structured and fluent manner. This limitation in their ability to communicate resulted in prolonged pauses, lexical hesitations, and explicit statements of being unable to describe their lived experience: "*What the stroke does to me is... I find it difficult to say things [...] In what moments? Well, I don't know how to tell you [...] Yes, something, it does something. But I don't know how to tell you*" (S.8); "*I haven't noticed anything, no cognitive impairment*" (S.1). Notably, during the same interview, S.1 later acknowledged that her speech was affected—a discrepancy suggesting limited metacognitive awareness of the symptom. In another case (S.7), significant attentional impairment was evident. Both groups reported emotional reactions characterized by despondency, sadness, disbelief and confusion; emotional intensity varied according to condition (n = 6). Overall, both groups identified substantial disease-related changes in their lives (n = 8).
Four subjects reported employment-related consequences due to disability or job loss. However, the conditions have resulted in significant consequences for all participants across multiple domains: physical (n = 4), behavioral (n = 2), activities of daily living (n = 7), and cognitive (n = 12). Two participants described the distress caused by cognitive impairments in detail:

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"My memory problems started about two years ago. My memory has really frustrated me. I used to manage household finances, but now I can't remember people's names. I don't worry about addition and subtraction anymore because I don't handle the accounts now [...] [I feel] bad about myself, because I'll see people around the village and I don't remember their names, and that bothers me" (S.2).
"It affected me enormously. My short-term memory was completely destroyed. I couldn't recall anything I'd been told just five minutes before. Numbers... I lost all my numerical skills; I had to relearn basic arithmetic, and my entire math ability was wiped out [...] I couldn't concentrate on what people were saying to me—anything longer than thirty minutes was impossible [...] I couldn't read for more than five minutes. Reading became impossible; I couldn't comprehend what I had just read" (S.10).

2) Working on rehabilitation
Rehabilitation was described in emotional terms (interview notes) by most of interviewees (n = 7), who reported multiple cognitive benefits: "*Ahh, that's great for me, because you're aware that you have to connect and it pushes you, it makes you think, it's great [...] I'm better now in every way*" (S.4); "*No, it doesn't just happen progressively over time, over time it gets better [the memory]. Because I remember... it makes me remember with my head... and I do it, yes I do*" (S.8); "*In short-term memory especially, I regained math and concentration*" (S.10). As well as in other domains: "*It gives me everything, because otherwise I wouldn't be here. [...] This level of activity helps me to keep going, because otherwise I wouldn't come here. [...] I feel better after being here [...] And on a personal level it gives me more [...] and emotionally too*" (S.2); "*I can do things I couldn't do before [...] Rehabilitation has helped me in every way [...] Now I am a self-sufficient person*" (S.10).
Additionally, improvements in attention, memory, and concentration were explicitly reported by six participants. Participant S.9 explained in particular detail the benefits experienced through use of the NeuronUP tool:
"*It's good for me because I'm entertained, I do read, and I also practice social skills. The exercises I do at home with the NeuronUP computer keep me entertained and active […] It's effective for exercising my memory—for remembering and paying more attention. It gives me a routine and keeps me engaged. […] Yes, I think I've improved a lot; my memory is better*" (S.9).
Several users (n = 8) reported positive aspects of both the tool and the rehabilitation program as a whole: "*The cognitive part, the computer exercises, the memory exercises. […] The cognitive part, especially the memory exercises*" (S.1); "*Eh… the words, and especially the numbers" (S.4); "Ah, that's very good, I like that a lot, and it's good for me*" (S.8); "*I like everything […] It gives me a routine, keeps me entertained and I like coming here*" (S.9). Five participants also noted aspects related to difficulty or high attentional demand, but accepted the challenge for its benefits: "*The thing I like least is the calculation exercises*" (S.1); "*[...] maybe what I like least are the music ones... I get a little distracted because the sounds are a bit like that... very similar, but I do them anyway*" (S.9).
All twelve interviewees reported satisfaction with their rehabilitation experience, due to the recovery of physical and cognitive abilities: "*Man, don't hesitate, because anything, manual dexterity, you also tell me to pick up tweezers and move them around, all of that works really well for me*" (S.4); "*Very good, my experience has been very good in all aspects, very positive, both physical and cognitive therapy*" (S.7). They also valued the recovery of activities of daily living and maintaining engagement: "*Well, very good, because it makes me do things and keeps me active*" (S.3). Additionally, they appreciated enjoying attending the occupational therapy center, having contact with the therapists and the recovery of social relationships: "*Wonderful, I feel 99% [...] because I like being here with you*" (S.2); "*Your ability to understand me. Not only in communication but in everything. How well you know me. [...] How well you treat me. I can see that you know how to help me, and I feel good here*" (S.11). Finally, they highlighted developing autonomy: "*Yes, because when you lose everything and you start to recover little by little, little by little, of course it helps you, and a lot*" (S.7).

3. DISCUSSION

The study aimed to examine the effectiveness of the NeuronUP platform in individuals affected by HD and ABI and to explore and analyze their experiences and satisfaction with the application.
Both HD and ABI are diseases with impacts across different areas of a person's functioning, and rehabilitation is key to improving quality of life. Once individuals receive a medical diagnosis and treatment, they often seek support from local organizations for disease management. Associations of affected individuals and their families collaborate with care centers, such as the occupational therapy service center in this study, which offer specific rehabilitation services where cognitive work is a fundamental component in improving functions such as memory, attention, and language.
Regarding the results obtained in this study, no statistically significant differences emerged in most analyses. However, a statistically significant difference was identified in the total score of the ABI group ($p = 0.041$), a result that, due to the small sample size and absence of a control group, should be interpreted with caution. This indicates that a consistent improvement cannot be demonstrated in quantitative terms. In this context, the objective of this intervention, especially in progressive pathologies such as HD, is to prevent significant cognitive decline. At a quantitative level, a trend toward score maintenance emerges; notably, most

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subjects (8 of 12) improved their scores on the MEC, three maintained their initial scores, and one experienced a slight decrease. However, these changes should be interpreted with caution due to the absence of statistical significance in most analyses.

This finding was further supported by participants' experiences with the occupational therapy intervention using the NeuronUP platform, who reported high satisfaction. The integration of quantitative and qualitative data enabled a more comprehensive interpretation of the findings: while standardized measures revealed limited statistical changes, participant accounts provided valuable insight into subjective experience, suggesting perceived benefits in daily functioning and well-being.

Taken together, these results suggest that platforms like NeuronUP represent useful tools for stimulating and maintaining cognitive functions. Their application appears particularly promising across diverse neurological profiles, such as those in this study, as they could not only enhance certain cognitive abilities but also help slow cognitive decline while addressing the specific needs of each condition.

The results obtained are consistent with those of other studies on the use of technology-based cognitive rehabilitation programs, which demonstrate the effectiveness of NeuronUP in the cognitive rehabilitation of patients with Alzheimer's disease. Specifically, the combination of conventional occupational therapy with daily platform sessions improved cognitive abilities, quality of life, motivation, and treatment adherence (Fabara-Rodríguez et al., 2024). Both computerized and traditional cognitive rehabilitation are effective in improving attention and executive functions (Kim et al., 2021). These findings underscore the importance of keeping patients actively involved in their treatment, especially in conditions such as ABI and HD, where active monitoring is crucial for therapeutic success. Notably, both HD and Alzheimer's disease are neurodegenerative conditions, which means that observable short-term benefits are often limited due to disease progression.

A systematic review of various clinical trials concluded that computerized interventions have positive effects on cognitive functions (Alashram, 2026). Similarly, one study documented the usefulness of NeuronUP in treating patients with ABI, improving key cognitive functions such as attention, working memory, and executive functions (Gómez, 2023). In our study, interviews revealed users' recognition of improvements in attention, memory, and autonomy. Recently, additional research reinforced the effectiveness of computer-based cognitive retraining (CBCR) and ICT use, demonstrating improvements in cognitive functions and psychosocial well-being in patients with HD (Huynh et al., 2025). Consistent with these findings, recent HD reviews have highlighted the increasing use of technology-based interventions for cognitive rehabilitation, including computer programs and virtual reality, which enable adaptation of task difficulty and enhance patient motivation (Maggio et al., 2024).

The playful component of NeuronUP, combined with the social dimension of conventional rehabilitation conducted in local settings such as those in this study, likely contributed to the perceived positive effects, as reported by interview participants. Research has shown that computerized programs enhance attention and motivation in people with ABI through the engaging nature of technological stimuli, functioning as a support tool within a comprehensive rehabilitation framework (Rey-Fuentes et al., 2021). In general, little is known about patients' perspectives on neurocognitive rehabilitation following neurological conditions. Therefore, the qualitative results of our study provide specific evidence regarding the positive user experience with NeuronUP, highlighting cognitive and emotional benefits, as well as enhanced motivation for creating routines and improving memory and attention. These findings aligned with those from previous qualitative studies examining similar interventions, such as GRADIOR (Irazoki et al., 2021), strengthening the coherence of our results and underscoring the importance of engagement and positive perception for the success of digital interventions. Importantly, these results highlight the potential of combining conventional therapies with ICT-based interventions in rehabilitation, emphasizing their benefits from the patients' perspective (Irazoki et al., 2021).

All reviewed studies consistently emphasize the need for further research to confirm these findings and evaluate the effectiveness of interventions. Specific recommendations include expanding sample sizes, employing more homogeneous intervention protocols and outcome measures, and conducting longer follow-up studies to assess long-term effects on cognitive functions and functional outcomes in daily life. These recommendations underscore the heterogeneity across studies and the limited available evidence regarding the sustained effects of technology-based interventions (Alashram, 2026; Huynh et al., 2025; Kim et al., 2021; Maggio et al., 2024).

One of the main strengths of our study is the combination of quantitative and qualitative methodologies, which provided a more comprehensive understanding of the impact of cognitive rehabilitation on individuals with ABI and HD. Furthermore, the use of innovative technology, such as the NeuronUP platform, represents a potentially valuable tool for cognitive rehabilitation. The prolonged duration of the intervention also constitutes an advantage compared to shorter-term studies, yielding more consistent and detailed findings.

Among the limitations, the small sample size (n = 12) stands out, which limits the generalizability of the results to a broader population. Furthermore, dividing the sample into subgroups reduced statistical power, which may explain the lack of statistical significance. Moreover, the absence of a control group precludes attribution of the observed changes solely to the intervention. Regarding the MEC-35 scale, although useful due to its brief administration time, it limits in-depth analysis of specific cognitive areas. Therefore, these results should be interpreted cautiously, and firm conclusions about intervention effectiveness cannot be drawn.

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Future research should include larger samples and employ more comprehensive assessment instruments to enable precise evaluation of affected cognitive areas. Future studies should incorporate a control group to strengthen evidence on the effectiveness of digital platforms in cognitive rehabilitation. Additionally, research should explore the impact of such interventions in advanced stages of HD and subacute phases of ABI, extend inclusion criteria to users with other conditions such as ALS or dementia, and examine how motivation and treatment perception influence long-term adherence and cognitive outcomes.

CONCLUSION

The NeuronUP tool represents a suitable option for local entities, not only because of its growing implementation, wide variety of cognitive stimulation resources, and ease of use, but also because of its ability to adapt to different neurological profiles and promote treatment continuity through an accessible and innovative approach. ICT-based rehabilitation therapies combined with conventional therapies produce better outcomes than traditional interventions applied in isolation, as they promote greater motivation, adherence, and personalization of treatment. Establishing a therapeutic bond and creating a safe space during intervention are essential. This climate of trust and mutual understanding not only encouraged engagement in the intervention but also strengthened the effectiveness of the work performed, underscoring the value of humanized therapeutic support. This study provides preliminary evidence of the effectiveness of digital tools in cognitive rehabilitation while highlighting the irreplaceable value of human relationships in the therapeutic process—an aspect often overlooked.

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AUTHORS' CONTRIBUTION

Conceptualization, S.C.O., M.F.H. and C.V.V.; data curation, S.C.O., M.F.H. and C.V.V.; formal analysis, M.F.H. and C.V.V.; investigation, S.C.O.; methodology, M.F.H. and C.V.V.; supervision, M.F.H. and C.V.V.; writing – original draft, M.F.H.; writing – review & editing, M.F.H.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Alashram, A.R. (2026). Computerized cognitive rehabilitation for patients with traumatic brain injury: A systematic review of randomized controlled trials. *Applied Neuropsychology: Adult, 33*(2), 578-587. https://doi.org/10.1080/23279095.2024.2350607

Arango Lasprilla, J. C., & Olabarrieta Landa, L. (2019). *Daño cerebral*. El Manual Moderno.

Calderón-Chagualá, J. A., Montilla-García, M. Á., Gómez, M., Ospina-Viña, J. E., Triana-Martínez, J. C., y Vargas-Martínez, L. C. (2019). Rehabilitación neuropsicológica en daño cerebral: uso de herramientas tradicionales y realidad virtual. *Revista Mexicana de Neurociencia, 20*(1) 29-35. https://doi.org/10.24875/rmn.m22000089

Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research* (3ª ed.). SAGE.

Cuaspud Naranjo, Á. G., & Ardila Villareal, G. M. (2024). Neuroplasticidad cerebral en pacientes con daño cerebral adquirido. *CEI Boletín Informativo, 11*(3), 48-50. https://shre.ink/jYKP

Cusme Yagual, J. A., & Pucuna Guapi, E. E. (2024). Enfermedad de Huntington. En D. S. Ponce Miranda, G. A., Paz Sánchez, M., Quimbayo Polo, J. P., Acosta Dlyuz, H. A., Parrales Briones, E. F., Hualpa Galarza, B. S., Pazmiño Antepara, J. J., Tituana Moreira, J. A., Cusme Yagual, E. E., Pucuna Guapi, G. C., Villamar Flores, D., Flores Lucas, S., & Matute Solís, D. M. *Actualización en Neurología Vol. 1*, 116-132. Cuevas Editores SAS. https://doi.org/10.56470/978-9942-660-18-3

Daiver, A., Doria Mass, C. L., Doria Pedraza, C., & Salas Álvarez, D. J. (2021). Implementación de una aplicación móvil como herramienta de prevención del Alzheimer y el deterioro cognitivo en adultos mayores. *Revista Infométrica, 4*(1), 1-10. https://www.infometrica.org/index.php/syh/article/view/169

DOI: https://doi.org/10.29352/mill0230.47011

European Parliament and the Council. (2016). EU General Data Protection Regulation 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC. *Official Journal of the European Union, L 119*, 2016, May 4 (pp. 1-88). http://data.europa.eu/eli/reg/2016/679/oj

Fabara-Rodríguez, A. C., García-Bravo, C., García-Bravo, S., Quirosa-Galán, I., Rodríguez-Pérez, M. P., Pérez-Corrales, J., Fernández-Gómez, G., Donovan, M., & Huertas-Hoyas, E. (2024). Quality-of-Life- and Cognitive-Oriented Rehabilitation Program through NeuronUP in Older People with Alzheimer's Disease: A Randomized Clinical Trial. *Journal of Clinical Medicine, 13*(19), 5982. https://doi.org/10.3390/jcm13195982

Fernández-Sánchez, M., Aza-Hernández, A., & Verdugo-Alonso, M. Á. (2022). Modelos de atención pública a la población con daño cerebral adquirido en España: Un estudio de la situación por comunidades autónomas. *Revista de Neurología, 74*(8), 245-257. https://doi.org/10.33588/rn.7408.2021372

Fritz N. E., Rao A. K., Kegelmeyer, D. A., Kloos, A., Bussed, M., Harlel, L., Carrier, J., & Quinn, L. (2017). Physical therapy and exercise interventions in Huntington's disease: a mixed methods systematic review. *Journal of Huntington's Disease, 6*(3), 217-236. https://doi.org/10.3233/JHD-170260

Gómez Pulido, M. A. (2023). Rehabilitación neuropsicológica holística: Evolución cognitiva y calidad de vida de pacientes con daño cerebral adquirido. *Siglo Cero, 54*(2), 93-114. https://doi.org/10.14201/scero202354227894

Guadamuz Delgado, J., Miranda Saavedra, M., & Mora Miranda, N. (2022). Actualización sobre neuroplasticidad cerebral. *Revista Médica Sinergia, 7*(6). https://doi.org/10.31434/rms.v7i6.829

Guest, G., & Fleming, P. (2015). Mixed Methods Research. In G. Guest, G. & E. Namey (Eds.), *Public Health Research Methods* (pp. 581-614). SAGE. https://doi.org/10.4135/9781483398839

Huynh, K., Jamadar, S. D., Lampit, A., Siddiqui, M. N., Stout, J. C., & Georgiou-Karistianis, N. (2025). Feasibility and effects of cognitive training on cognition and psychosocial function in Huntington's disease: a randomised pilot trial. *Journal of Neurology, 272*(2), 159. https://doi.org/10.1007/s00415-024-12855-7

Irazoki, E., Sánchez-Gómez, M. C., Contreras-Somoza, L. M., Toribio-Guzmán, J. M., Martín-Cilleros, M. V., Verdugo-Castro, S., Jenaro-Río, C., & Franco-Martín, M. A. (2021). A Qualitative Study of the Cognitive Rehabilitation Program GRADIOR for People with Cognitive Impairment: Outcomes of the Focus Group Methodology. *Journal of Clinical Medicine, 10*(4), 859. https://doi.org/10.3390/jcm10040859

Kim, H. S., Choi, Y. H., Lee, K. M., Kim, B. R., Han, E. Y., & Kim, S. H. (2021). The efficacy of computerized cognitive rehabilitation in improving attention and executive functions in acquired brain injury patients, in acute and postacute phase. *European Journal of Physical and Rehabilitation Medicine, 57*(1), 19-27. https://doi.org/10.23736/S1973-9087.20.06275-0

Lobo, A., Ezquerra, J., Gómez Burgada, F., Sala, J. M., & Seva Díaz, A. (1979). El Mini-Examen Cognoscitivo: Un test sencillo y práctico, para detectar alteraciones intelectuales en pacientes médicos. *Actas Luso-Españolas de Neurología, Psiquiatría y Ciencias Afines, 7*(3), 189-202. *https://shre.ink/jYK0*

Lobo, A., Saz, P., & Marcos, G. (2002). *Manual MMSE. Examen cognoscitivo Mini-Mental*. TEA.

Lopes, A. J. O., Martins, V., & Ribeiro, J. (2017). Dementia Approach and Follow-up in Primary Care. *Millenium - Journal of Education, Technologies, and Health*, *2*(3), 37–44. https://doi.org/10.29352/mill0203.04.00114

López Miquel, J., & Martí Agustí G. (2011). Mini-Examen Cognoscitivo (MEC). *Revista Española de Medicina Legal, 37*(3), 122-127. https://doi.org/10.1016/S0377-4732(11)70075-X

Lorente Aznar, T., Olivera Pueyo, F. J., Benabarre Ciria, S., Rodríguez Torrente, M., Solans Aisa, B., Giménez Baratech, A. C. (2009). Rendimiento diagnóstico de los test cognitivos aplicados desde atención primaria. Concordancia y validez de los test de cribado. *Atención Primaria, 42*(4), 226-232. https://doi.org/10.1016/j.aprim.2009.07.014

Magaldi, D., & Berler, M. (2020). Semi-structured Interviews. In V. Zeigler-Hill & T. Shackelford (Eds.), Encyclopedia of Personality and Individual Differences (pp. 4825-4830). Springer. https://doi.org/10.1007/978-3-319-24612-3_857

Maggio, M. G., Billeri, L., Cardile, D., Quartarone, A., & Calabrò, R. S. (2024). The role of innovative technology in the rehabilitation of patients affected by Huntington's disease: A scoping review. *Biomedicines, 12*(1), 39. https://doi.org/10.3390/biomedicines12010039

Martínez Sánchez, I. (2023). Metodología cualitativa. En J. Quintanal Díaz y J. C. Sánchez-Huete (Coords.). *Métodos y diseños de investigación en contextos socioeducativos* (pp. 133-160). CCS.

Mejía Gallegos, A., García Tobon, M., Guamán Mariscal, E., & Murillo Brunes, A. (2024). La enfermedad de Huntington, síntomas y tratamiento. *Journal of Science and Research, 9*(1), 128-143. https://doi.org/10.5281/zenodo.10515711

DOI: https://doi.org/10.29352/mill0230.47011

Muñoz Marrón, E., De Noreña Martínez, D., & Sanz Cortes, A. (2017). *Neuropsicología del daño cerebral adquirido. Traumatismos craneoencefálicos, accidentes cerebrovasculares y tumores del sistema nervioso central*. UOC. https://shre.ink/jYKO

NeuronUP. (2024). *Marco teórico y evidencia científica sobre cognición y neuropsicología. NeuronUP*. https://shre.ink/jYKw

Parsons, M. P., & Raymond, L. A. (2023). Neurobiology of Huntington's disease. En *Neurobiology of Brain Disorders* (pp. 275-291). Elsevier. https://doi.org/10.1016/B978-0-323-85654-6.00042-3

Paz Sánchez, G. A (2024). Accidente cerebro vascular. En D. S. Ponce Miranda, G. A. Paz Sánchez, M. Quimbayo Polo, J. P., Acosta Dlyuz, H. A., Parrales Briones, E. F., Hualpa Galarza, B. S., Pazmiño Antepara, J. J., Tituana Moreira, J. A., Cusme Yagual, E. E., Pucuna Guapi, G. C., Villamar Flores, D., Flores Lucas, S., y Matute Solís, D. M. *Actualización en Neurología Vol. 1.* (pp. 27-50). Cuevas Editores SAS. https://doi.org/10.56470/978-9942-660-18-3

Petrozziello, T., Huntress, S., S. Castillo-Torres, A. L., Quinn, J. P., Connors, T. R., Auger, C. A., Mills, A. N., Kim, S. E., Liu, S., Mahmood, F., Boudi, A., Wu, M., Sapp, E., Kivisäkk, P., Sunderesh, S. R., Pouladi, M. A., Arnold, S. E., Hyman, B, T., Rosas, D. R., … & Sadri-Vakili, G. (2023). Age-dependent increase in tau phosphorylation at serine 396 in Huntington's disease pre-frontal cortex. *Journal of Huntington's Disease, 12*(3), 267-281. https://doi.org/10.3233/JHD-230588

Quinn, L., & Busse, M. (2017). Chapter 13 - The role of rehabilitation therapy in Huntington disease. *Handbook of Clinical Neurology, 144*, 151-65. https://doi.org/10.1016/B978-0-12-801893-4.00013-4

Rey-Fuentes. R. I., Jiménez-Maldonado, M. E., Arroyo-Medrano, M., & Villaseñor-Cabrera, T. (2021). El uso de programas computarizados y su efectividad en la rehabilitación de funciones ejecutivas en daño cerebral adquirido. *Revista Ecuatoriana de Neurología, 30*(1), 135-144. https://doi.org/10.46997/revecuatneurol30100135

Sánchez-Rojas, M., Puentes Rozo, P., Pineda, D. A., Acosta-López, J., Mejía-Segura, E., Cervantes-Henríquez, M., Martínez-Banfi, M., Ahmad, M., Ríos Anillo, M. R., Pineda-Alhucema, W., Noguera-Machacón, L. M., De la Hoz, M., Jiménez-Figueroa, G., Escudero-Cabarcas, J., Arcos-Burgos, M., Vélez, J. I., Montoya Grajeda, J., Rodríguez Gómez, O., Ruvalcaba Medina, A., … & Sánchez-Barrios, C. (2021). *Enfermedad de Huntington: Una aproximación desde la investigación*. Ediciones Universidad Simón Bolívar. https://doi.org/10.1007/978-628-7533-04-2

Sastre Barrios, C. (2020). Neurorrehabilitación y nuevas tecnologías. *Revista Iberoamericana de Neuropsicología, 3*(2), 157-170. https://neuropsychologylearning.com/wp-content/uploads/pdf/pdf-revista-vol3/vol3-n2-3.pdf

Vidal, C. (2017). Tratamiento neuropsicológico en la enfermedad de Huntington: Una revisión sistemática. *Revista de Discapacidad y Neurociencias Clínicas, 4*(1), 57-70. https://doi.org/10.14198/DCN.2017.4.1.05

World Medical Association (WMA) (2024). *WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects*. https://www.wma.net/policies-post/wma-declaration-of-helsinki/

Xu, J. B. (2024). *Conducting Semi-Structured Interviews in Social Service Research: A Practical Guide*. National University of Singapore. https://shre.ink/jYCp