National Rehabilitation Information Center

reSearch

A collection of research reviews on rehabilitation topics from NARIC and other information resources.

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Gaming and Disability: Fun and Function

In this edition of *reSearch,* we explore the topic of video games, including online and virtual games, as leisure and/or rehabilitation tools for individuals with disabilities. A video game is an electronic game that involves interaction with a user interface to generate visual feedback in a two- or three-dimensional video display device such as a TV screen, virtual reality headset, computer monitor, or other hand-held devices.

The first multi-player, multi-program game system that could be played on a television was created in 1967 and gaming console systems gained in popularity throughout the 1970s and 1980s. In the mid-1980s the Nintendo Entertainment System (NES) came to the United States and had improved 8-bit graphics, colors, sound, and gameplay over previous consoles. Since that time, various gaming console systems have been developed leading up to the modern age of high-definition gaming today. The latest examples of consoles include Microsoft Xbox 360, Sony's Playstation, and Nintendo's Wii.

These consoles use game controllers to play games and vary across platforms. Common controllers include game pads, joysticks, mouse devices, keyboards, touch screens of mobile devices, or even a person's body, using the Microsoft Kinect motion sensor. Some video games include interaction with players using headsets to talk through the online connection. Video games continue to be an extremely popular form of entertainment for all ages and abilities and provide an opportunity to foster interaction and connectivity with others.

In addition to entertainment and leisure, video games are used in rehabilitation to assist in the rehabilitation process. A scoping review of video gaming in rehabilitation by Hitzig, Ravenek, and Wolfe (2016) found that commercially available video gaming in rehabilitation was most commonly recommended by physiotherapists (50 percent of studies) for populations at risk for falls or with decreased balance. The Nintendo Wii was the most prevalent video gaming system (90 percent) used in identified studies. Moreover, preliminary findings showed that video gaming technology can be applied across a wide variety of rehabilitation populations, with some evidence showing clinical gains in physical functioning (i.e., gait and balance). During our review of the documents in our database, we noted that video gaming systems were also used in stroke rehabilitation to improve fine motor skills, strength and endurance, and balance and coordination. Additionally, video games were used therapeutically by individuals with multiple sclerosis, fibromyalgia, developmental disabilities, cerebral palsy, Parkinson's disease, brain injury, and motor function disabilities among others.

This edition of reSearch provides a 10 year "snapshot" of the use of video, online, and virtual games for a leisure and/or as rehabilitation tool for individuals with disabilities. The combined search terms for this edition of reSearch included: video games/gaming, virtual reality, adaptive, accessibility, and disability. A listing of over 200 additional descriptor terms between the NARIC, CIRRIE, ERIC, and PubMed databases can be found at the end of this document. A search of the REHABDATA database resulted in 24 documents published between 2009 and 2018. Additionally, a search of the international "CIRRIE" collection results in 36 documents published between 2008 and 2018. Finally, a search of the ERIC and PubMed databases resulted in nine documents between 2011 to 2018, and 14 documents between 2010 and 2018; respectively.

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NIDILRR Funded Projects Related to Gaming and Disability

In addition to document searches, we searched our NIDILRR Program Database to locate grantees/projects related to video games, systems, and adaptive devices for use for leisure and/or in the rehabilitation process with persons with disability. The search resulted in four currently funded and six projects that are no longer active. Project information and their publications are offered as additional resources for our patrons.

Interactive Exercise Technologies and Exercise Physiology for People with Disabilities
Project Number: 90RE5009
(formerly H133E120005)
Phone: 205/975-9010
Email: jrimmer@uab.edu.
http://www.rectech.org.

Patient-Centered, Home-Based Technologies to Assess and Treat Motor Impairment in Individuals with Neurologic Injury
Project Number: 90REGE0004
Phone: 202/319-5181
Email: lum@cua.edu.

RERC on Exercise and Recreational Technologies for People with Disabilities
Project Number: 90REGE0002
Phone: 205/975-9010
Email: jrimmer@uab.edu.

These projects have completed their research activities and are now closed.

Addressing Self-Management Skills Through Electronic Gaming: Meeting the Needs of Underserved Individuals with SCI
Project Number: H133G100118
Phone: 734/936-7205
Email: mameade@med.umich.edu.

Computer and Online Software that Provides ASL Translation and Publishing Capabilities
Project Number: H133S110002
Phone: 301/942-4326
Email: corinne@idrt.com.
http://www.idrt.com.

Rehabilitation Engineering Research Center for Successful Aging with Disability: Optimizing Participation Through Technology (OPTT-RERC)
Project Number: 90RE5002
(formerly H133E080024)
Phone: 323/442-2903
Email: winstein@usc.edu.
https://twitter.com/agingrerc.

RERC on Rehabilitation Robotics and Telemanipulation Machines Assisting Recovery from Stroke Rehabilitation Engineering Research Center (MARS-RERC)
Project Number: H133E020724
Email: medevitt@ric.org, j-patton@northwestern.edu.
http://www.smpp.northwestern.edu/MARS/mars.html.

Video Gaming Technology to Promote Health and Fitness Among Adolescents with Disabilities
Project Number: H133G100278
Phone: 409/772-9498
Email: jerowlan@utmb.edu.

Web-Based Telerehabilitation for Home Assessment and Monitoring
Project Number: H133S030037
Phone: 301/495-0770
Email: info@atinc.com.
http://www.atinc.com.

Why do I see different grant numbers?

In 2014, President Obama signed the Workforce Innovation and Opportunity Act (WIOA) into law. As part of WIOA, the institute changed its name from the National Institute on Disability and Rehabilitation Research (NIDRR) to the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR) and moved from the Department of Education to the Administration for Community Living (ACL) at the Department of Health and Human Services. Approximately 250 active grants received new ACL grant numbers and all new grants funded under NIDILRR have only an ACL grant number. For more information about NIDILRR/ACL grant numbers please visit: http://naric.com/?q=en/content/about-nidilrracl-grant-numbers-0.

Documents from NARIC's REHABDATA search listed are listed below:

2018

Kirkland, W.B., Malone, L.A., Misko, S.R., Padalabalanarayanan, S., & Thirumalai, M. (2018). **Adapting the Wii fit balance board to enable active video game play by wheelchair users: User-centered design and usability evaluation.** *JMIR Research Protocols, 5*(1), e2.
NARIC Accession Number: J78660
Project Number: H133E120005
ABSTRACT: Study designed an adapted version of the Wii Fit Balance Board to improve accessibility and evaluated the usability of the off-the-shelf (OTS) and adapted Wii Fit Balance Board (WFBB) in people with mobility impairments. Based on observed limitations, a team of engineers developed and adapted the design of the WFBB, which was then subjected to multiple iterations of user feedback and design tweaks. On design completion, participants with mobility impairments played 2 sets of games on both the OTS and adapted versions of the WFBB. After participants played each version, the System Usability Scale (SUS) was administered to examine the participants' perceived usability. The adapted controller (1) allowed manual wheelchair users to engage in game play, which was previously not possible; (2) included Americans with Disabilities Act-compliant handrails as part of the controller, enabling stable and safe game play; and (3) included a sensitivity control feature, allowing users to fine-tune the controller to match the users' range of motion. More than half the sample could not use the OTS version of the WFBB, while all participants were able to use the adapted version. All participants rated the adapted WFBB at a minimum as "good," while those who could not use the OTS WFBB rated the adapted WFBB as "excellent." A significant negative correlation was found between lower-extremity function and differences between OTS and adapted SUS scores, indicating that as lower-extremity function decreased, participants perceived the adapted WFBB as more usable. This study demonstrated a successful adaptation of a widely used active video game controller.

2017

Malone, L.A., McCroskey, J., Padalabalanarayanan, S., & Thirumalai, M. (2017). **Assessment of active video gaming using adapted controllers by individuals with physical disabilities: A protocol.** *JMIR Research Protocols, 6*(6), e116.
Project Number: H133E120005
NARIC Accession Number: J78262
ABSTRACT: Study compared the effect of off-the-shelf and adapted game controllers on quality of game play, enjoyment, and energy expenditure during active video gaming in people with physical disabilities, specifically those with mobility impairments. The gaming controllers evaluated included off-the-shelf and adapted versions of the Nintendo Wii Fit balance board and gaming mat. Participants came to the laboratory a total of three times. During the first visit, participants completed a functional assessment and became familiar with the equipment and games to be played. For the functional assessment, participants performed 18 functional movement tasks from the International Classification of Functioning, Disability, and Health. They also answered a series of questions from the Patient Reported Outcomes Measurement Information System and Quality of Life in Neurological Conditions measurement tools, to provide a personal perspective regarding their own functional ability. For Visit 2, metabolic data were collected during an initial 20-minute baseline, followed by 40 minutes of game play. The controller (balance board or gaming mat) played was randomly selected. A set of games was played for 10 minutes, followed by 5 minutes of rest, and then another set of games was played for 10 minutes, followed by rest. Quality of game play was observed and documented for each set. During rest, the participant completed questions regarding enjoyment. Following the same procedures, the participant then played the two sets of games using the other version (off-the-shelf or adapted) of the controller. The entire procedure was repeated during Visit 3 with the controller that was not played. Enrollment began in February 2016 and ended in September 2016. Study results will be reported in late 2017.

2016

Basseches, B., Brideau, H., Crisco, J.J., Kerman, K., Schwartz, J.B., Trask, C., Wilcox, B.J., & Wilkins, M.M. (2016). **Joint-specific play controller for upper extremity therapy: Feasibility study in children with wrist impairment.** *Physical Therapy, 96*(11), 1773-1781.
NARIC Accession Number: J74809
ABSTRACT: Study evaluated a specially designed wrist flexion and extension play controller in a group of 21 children with upper-extremity motor impairments (UEMIs). The aim was to understand the relationship among controller play activity, measures of wrist and forearm range of motion (ROM) and spasticity, and ratings of fun and difficulty. All children participated in a structured in-clinic play session during which measurements of spasticity and ROM were collected. The children were fitted with the controller and played with 2 toys and 2 computer games for 5 minutes each. Wrist flexion and extension motion during play was recorded and analyzed. In addition, children rated the fun and difficulty of play. Flexion and extension goal movements were repeatedly achieved by children during the play session at an average frequency of 0.27 Hz. At this frequency, 15 minutes of play per day would result in approximately 1,700 targeted joint motions per week. Play activity was associated with ROM measures, specifically supination, but toy perception ratings of enjoyment and difficulty were not correlated with clinical measures. These results indicate that the therapeutic controllers elicited repetitive goal movements and were adaptable, enjoyable, and challenging for children of varying ages and UEMIs.

Crocher, V., Hur, P., Kumar, J., Lakshminarayanan, K., Motawar, B., & Seo, N.J. (2016). **Usability evaluation of low-cost virtual reality hand and arm rehabilitation games.** *Journal of Rehabilitation Research and Development (JRRD) (formerly the Bulletin of Prosthetics Research), 53*(3), 321-334.
NARIC Accession Number: J73902
ABSTRACT: Study surveyed 10 people with stroke regarding their expectations of and preferences for virtual reality rehabilitation games. The study also evaluated the usability of three lower-cost virtual reality rehabilitation games using questionnaires and the House of Quality analysis, a design-management method to enable product design based on customers' desires from product conception. The games (kitchen, archery, and puzzle) were developed in the laboratory to encourage coordinated finger and arm movements. Lower-cost motion tracking devices, the P5 Glove and Microsoft Kinect, were used to record the movements. People with stroke were found to desire motivating and easy-to-use games with clinical insights and encouragement from therapists. The House of Quality analysis revealed that the games should be improved by obtaining evidence for clinical effectiveness, including clinical feedback regarding improving functional abilities, adapting the games to the user's changing functional ability, and improving usability of the motion-tracking devices. This study demonstrated user-centered data collection and analysis that can help guide future rehabilitation product development to maximize target user satisfaction and successful device deployment.

Fidopiastis, C.M., Malone, L.A., Padalabalanarayanan, S., Rimmer, J.H., Rowland, J.L., & Thirumalai, M. (2016). **Perspectives on active video gaming as a new frontier in accessible physical activity for youth with physical disabilities.** *Physical Therapy, 96*(4), 521-532.
NARIC Accession Number: J73765
Project Number(s): H133E120005 & H133G080120
ABSTRACT: Article offers perspectives on the utility of active video games (AVGs) as a means of increasing physical activity among youth with physical disabilities and limitations in lower-extremity function who typically are excluded from mainstream exercise options. Youth with physical disabilities are disproportionately affected by health problems that result from sedentary behavior, lack of physical activity, and low fitness levels. The authors discuss the potential for AVGs as an accessible option to increase physical activity participation and present a conceptual model on the use of AVGs to increase physical activity participation for youth with physical disabilities. Future research potential is discussed, including a development project for game controller adaptations within the Rehabilitation Engineering Research Center on Interactive Exercise Technologies and Exercise Physiology for People with Disabilities (RERC RecTech) at the University of Alabama at Birmingham/Lakeshore Foundation Research Collaborative.

Hitzig, S.L., Ravenek, K.E., & Wolfe, D.L. (2016). **A scoping review of video gaming in rehabilitation.** *Disability and Rehabilitation: Assistive Technology, 11*(6), 445-453.
NARIC Accession Number: J76972
ABSTRACT: This scoping review examined how video gaming is being used in rehabilitation, by whom, for whom, gaming system utilized, setting, duration of interventions, target outcomes, and outcome measurement tools in order to better understand the applicability of video gaming to rehabilitation. Five databases (SCOPUS, Cochrane, PsycINFO, PubMed and CINAHL) were searched for articles published between January 1990 and January 2014. The reference lists of selected articles were also reviewed to identify other relevant studies. Thirty articles met the inclusion criteria. Commercially available video gaming in rehabilitation was most commonly recommended by physiotherapists (50 percent of studies) for populations at risk for falls or with decreased balance. The most commonly used target outcomes were those assessing balance and/or fall prevention, with the Berg Balance Scale being the most frequently used (53 percent) outcome measure. The Nintendo Wii was the most prevalent gaming system (90 percent) used in the identified studies. The review found that video gaming in rehabilitation is widely used by clinicians. Preliminary findings show that video gaming technology can be applied across a wide variety of rehabilitation populations, with some evidence showing clinical gains in physical functioning (e.g. gait and balance). There is a need for more robust clinical trials evaluating the efficacy of using video game systems as an adjunct to conventional rehabilitation.

2015

Ali, S., Carr, K., Crawley, J., Horton, S., McGowan, C., & Paquin, K. (2015). **Effectiveness of commercial video gaming on fine motor control in chronic stroke within community-level rehabilitation.** *Disability and Rehabilitation, 37*(23), 2184-2191.
NARIC Accession Number: J73189
ABSTRACT: Study investigated the effectiveness of commercial gaming as an intervention for fine motor recovery in chronic stroke. Ten participants in the post-stroke chronic phase completed a 16-session program using the Nintendo Wii for 15 minutes twice a week with their more-affected hand. The Jebsen Hand Function Test (JHFT), the Box and Block Test (BBT), and the Nine Hole Peg Test (NHPT) were used to assess fine motor control and the Stroke Impact Scale (SIS) provided and index of quality of life (QOL). The measures were collected at baseline (pre-testing), after 8 sessions (mid-testing), and after 16 sessions (post-testing). Significant improvements were found with the JHFT, BBT and NHPT from pre-testing to post-testing. Additionally, there was an increase in perceived QOL from pre-testing to post-testing, as determined by the SIS. The results suggest that commercial gaming may be a viable resource for those with chronic stroke. Future research should examine the feasibility of this as a rehabilitation tool for this population.

Bostrom, K., Forsberg, A., Nilsagard, Y. (2015). **Perceptions of using videogames in rehabilitation: A dual perspective of people with multiple sclerosis and physiotherapists.** *Disability and Rehabilitation, 37*(4), 338-344.
NARIC Accession Number: J71112
ABSTRACT: Study examined the experiences of using Nintendo Wii Fit™ for balance exercise from the perspectives of patients with multiple sclerosis (MS) and their physiotherapists (PTs). Individual interviews were conducted with 15 patients with MS recruited from a multi-center study investigating the effects of balance exercising using Wii Fit. In addition, a single focus group interview was conducted with 9 PTs involved in the study. The interviews were audio-recorded, transcribed, and analyzed using content analysis. Both patients and PTs said that exercising with Wii Fit games was fun, and that it challenged the patients' physical and cognitive capacities. The competitive content in the games provided motivation to continue playing. Patients and PTs reported improved body control and, more importantly, positive effects on balance and walking in daily life. The PTs regarded Wii training as an effective alternative to other balance training, but some felt unsure in how to manage the video game. The patients regarded Wii training as a possible home training solution. Patients with MS and their PTs considered Wii Fit exercises to be fun, challenging, and self-motivating. Exercising with Wii games can address balance impairments in MS, and can be performed at home as well as in rehabilitation settings.

Brooks, A.L., Brooks, E.P., Kristensen, L.Q., & Mortensen, J. (2015). **Women with fibromyalgia's experience with three motion-controlled video game consoles and indicators of symptoms severity and performance of activities of daily living.** *Disability and Rehabilitation: Assistive Technology, 10*(1), 61-66.
NARIC Accession Number: J71078
ABSTRACT: Study examined the experience of women with fibromyalgia syndrome (FMS) using commercially available Motion-Controlled Video Games (MCVGs) and investigated indicators of symptom severity and performance of activities of daily living (ADL). Seven female participants diagnosed with FMS completed a program of five sessions with Nintendo Wii (Wii), five sessions with PlayStation 3 Move (PS3 Move), and five sessions with Microsoft Xbox Kinect (Xbox Kinect). Interviews were conducted at baseline and postintervention and were supported by data from observation and self-reported assessment. Participants experienced play with MCVGs as a way to get distraction from pain symptoms while doing fun and manageable exercise. They enjoyed the slow pace and familiarity of Wii, while some considered PS3 Move to be too fast-paced. Xbox Kinect was reported as the best console for exercise. There was no indication of general improvement in symptom severity or performance of ADL. Findings suggest that MCVG may offer temporary pain relief and fun low-impact exercise for women with FMS.

Chiu, Wen-Hsin, Hsieh, Hsieh-Chun, Lin, Hung-Yu, Liu, C.K., & Meng, L.F. (2015). **Upper-limb rehabilitation with adaptive video games for preschool children with developmental disabilities.** *American Journal of Occupational Therapy (AJOT), 69*(4), 6904290020.
NARIC Accession Number: J71950
ABSTRACT: Study investigated video gaming rehabilitation for children with developmental disabilities (DD) using adaptive video games and a modified joystick to enhance motor training. Twenty children (13 boys, 7 girls; mean age 5.2 years) with DD received adaptive upper-limb motor rehabilitation consisting of fifteen 30-minute individual sessions 3 times per week for 5 weeks. Pre- and post-test assessments were performed using the Beery-Buktenica Developmental Test of Visual Motor Integration (visual-motor coordination) and Peabody Developmental Motor Scales, Second Edition (motor skills). The significant differences found between pretest and posttest scores suggests show that video gaming rehabilitation for children with DD may increase their visual-motor coordination and further improve their motor skill development. The authors conclude that the rehabilitation device modified for the needs of children with DD is effective in improving visual-motor performance of children with DD.

Deutsch, J., Malone, L.A., Rowland, J.L., Swartz, M.C., Wiemeyer, J., Xiong, J., & Zhang, F.F. (2015). **Recommendations for the optimal design of exergame interventions for persons with disabilities: Challenges, best practices, and future research.** *Games for Health Journal: Research, Development, and Clinical Applications, 4*(1), 58-62.
NARIC Accession Number: J73681
Project Number(s): H133E120005 & H133G100278
ABSTRACT: Article summarizes a group discussion of individuals with expertise working in the field of exergaming and rehabilitation that focused on the issue of designing exergames for people with disabilities as well as appropriate interventions using exergames. Exergames are a combination of exercise or exertion and (digital) games. The purpose of these discussions was to develop recommendations for the design, evaluation, and application of exergames in therapy serving as potential guidelines for researchers, developers, and therapists. The following key issues were addressed: (1) challenges in exergame design for people with disabilities, (2) adaptation of exergames for people with disabilities, (3) exergame interventions, and (4) future research directions. It is the hope of the group that the results of these recommendations will help improve the quality of exergame design and interventions and thereby increase opportunities for persons with disabilities to engage sustainably in exergaming.

Powers, G.M. (2015). **Video game accessibility: A legal approach.** *Disability Studies Quarterly, 35*(1).
NARIC Accession Number: J73702
Project Number: H133A110027
ABSTRACT: Article presents an argument for legally requiring that video games are accessible to everyone, including people with disabilities. Video game accessibility may not seem of significance to some, and it may sound trivial to anyone who does not play video games. This assumption is false. With the digitalization of culture, video games are an ever increasing part of life. They contribute to peer to peer interactions, education, music and the arts. A video game can be created by hundreds of musicians and artists, and they can have production budgets that exceed modern blockbuster films. Inaccessible video games are analogous to movie theaters without closed captioning or accessible facilities. The movement to have accessible video games is small, unorganized, and misdirected. Just like the other battles to make society accessible were accomplished through legislation and law, the battle for video game accessibility must be focused toward the law and not the market.

2014

Fidopiastis, C. (2014). ***Active video games for children with disabilities.***
NARIC Accession Number: O20089
Project Number: H133E120005
Video is available at: https://www.youtube.com/watch?v=rRHMqRKCsLU.
ABSTRACT: Presenter discusses two phases of a research project that looked at how to create better video game controllers that allow people with a disability, no matter their age, to not only be able to interact with the game itself, but to also be able to play with family members. Phase one identifies barriers that youth with disabilities face when playing with controllers that are currently available and how to create game controllers that allow individuals to play active games that are motivating, engaging, and will improve cardio respiratory function. Phase two focused on measuring energy expenditure. Findings from the research shows that, by adapting active controllers, individuals with varying levels of disabilities can obtain similar improvements in cardio respiratory function as their peers. After using the wobble board controller, an amputee shares his opinion of it. Run time: 2 minutes.

2013

Breland, H., Holthaus, K., Kamen, D.L., Sword, D., Vogtle, L.K., & Yuen, H.K. (2013). **The process associated with motivation of a home-based Wii Fit exercise program among sedentary African American women with systemic lupus erythematosus.** *Disability and Health Journal, 6*(1), 63-68.
NARIC Accession Number: J65416
ABSTRACT: Individual telephone interviews were conducted with 14 sedentary African American women with systemic lupus erythematosus (SLE) to explore their experiences and reflect on their motivation for playing Wii Fit after completing a 10-week home-based Wii Fit exercise program. Interviews were audio-recorded, transcribed verbatim, and analyzed using the constant comparative method to identify categories related to participants' motivation. Three authors independently sorted, organized, and coded transcript text into categories, then combined the categories into themes and subthemes. In addition to the two themes generic to home-based exercise trials (Ethical principal of keeping a commitment, and Don't want to let anyone down), five themes were identified that revealed why the participants were motivated to play the Wii Fit (Enjoyment, Health Benefits, Sense of Accomplishment, Convenience, and Personalized). Enjoyment had three subthemes: Interactive, Challenging, and Competitive with an embedded social element. However, several participants commented they were not able to do many activities, master certain games, or figure out how to play some; as a result, they were bored with the limited selection of activities that they could do. The findings suggest that the motivational elements of the Wii Fit may contribute to improved exercise motivation and adherence in select sedentary African American women with SLE. Results provide a better understanding of the important elements to incorporate in the development of sustainable home-based exercise programs with interactive health video games for this population.

Greenlay, S., Marston, H.R., & van Hoof, J. (2013). **Understanding the Nintendo Wii and Microsoft Kinect consoles in long-term care facilities.** *Technology and Disability, 25*(2), 77-85.
NARIC Accession Number: J67679
ABSTRACT: Article presents a review of current studies documenting the benefits and detriments of using video game technology (Nintendo Wii and the Microsoft Kinect) within residential care facilities. Six studies were identified that utilized the Wii console for the purpose of well-being, physical, and/or social activity. A small number of studies which have utilized the Kinect console were identified but these studies did not fit the inclusion/exclusion criteria of this review. Analysis of the studies focused on the impact that video games could have on adults aged 60 years, concentrating on the common uses of the Wii in long-term care and nursing home facilities: maintaining physical fitness, promoting mental well-being, encouraging social interaction, and both physical and mental rehabilitation. Overall, the results showed a positive response to the use of

the Nintendo Wii console within this environment. In particular, the facilitation of spatial ownership, peer socialization, role creation during game play, and enjoyment. Results for the Wii suggest potential value for the use of the Kinect in care facilities but further exploration is required to assess the possible physical impact and interaction viability.

2012

Dock, K., Hager, C.K., Sandlund, M., & Waterworth, E.L. (2012). **Motion interactive video games in home training for children with cerebral palsy: Parents' perceptions.** *Disability and Rehabilitation, 34*(11), 925-933.
NARIC Accession Number: J63890
ABSTRACT: Study explored parents' perceptions of using low-cost motion interactive video games as home training for their children with mild/moderate cerebral palsy (CP). Semi-structured interviews were conducted with parents from 15 families after participation in an intervention where motion interactive games were used daily in-home training for their child with CP. A qualitative content analysis approach was applied. The parents' perception of the training was very positive. They expressed the view that motion interactive video games may promote positive experiences of physical training in rehabilitation, where the social aspects of gaming were especially valued. Further, the parents experienced less need to take on coaching while gaming stimulated independent training. However, there was a desire for more controlled and individualized games to better challenge the specific rehabilitative need of each child.

2011

Acosta, A.M., Dewald, H.A., & Dewald, J.P.A. (2011). **Pilot study to test effectiveness of video game on reaching performance in stroke.** *Journal of Rehabilitation Research and Development (JRRD) (formerly the Bulletin of Prosthetics Research), 48*(4), 431-444.
NARIC Accession Number: J61381
ABSTRACT: Study evaluated the effect of a video game environment (air hockey) on reaching in stroke with various levels of arm support. The Arm Coordination Training 3D system was used to provide variable arm support and to control the hockey stick. Seven subjects were instructed to reach to one of three targets covering the workspace of the impaired arm during the reaching task and to reach as far as possible while playing the video game. Results showed that across subjects, support levels, and targets, the reaching distances achieved with the reaching task were greater than those covered with the video game. This held even after further restricting the mapped workspace of the arm to the area most affected by the flexion synergy (effectively forcing subjects to fight the synergy to reach the hockey puck). The results from this study highlight the importance of designing video games that include specific reaching targets in the workspace compromised by the expression of the flexion synergy. Such video games would also adapt the target location online as a subject's success rate increases.

Brettler, A., Deutsch, J.E., Guarrera-Bowlby, P., John, R., Kafri, M., Smith, C., Welsh, J. (2011). **Nintendo Wii sports and Wii fit game analysis, validation, and application to stroke rehabilitation.** *Topics in Stroke Rehabilitation, 18*(6), 701-719.
NARIC Accession Number: J62708
ABSTRACT: Study analyzed Nintendo Wii interactive video games for their rehabilitation elements related to improving balance and mobility for individuals poststroke. Using a team of game players and raters, 5 tables (1 for the Wii Sports and 4 for the Wii Fit) were developed and validated. The tables consist of 3 categories: (1) game description; (2) impairments targeted (strength, endurance, balance, and coordination), and (3) feedback provided: knowledge of performance (KP) and knowledge of results (KR). Two domain content experts established face validity. Construct validity was performed by 2 therapist-raters who had more than 15 years' clinical experience and postgraduate training in motor learning. Observations about the games including the fidelity of the interfaces, the nature of the feedback, and some of the

challenges to adapting the games for rehabilitation are presented. An 80 percent agreement between raters set as the criterion for establishing the construct validity was met for feedback evaluation. There was 100 percent agreement on impairment ratings. The games provided a greater amount of KR compared with KP. Given the preponderance of KR, therapists will need to monitor motor performance. Adaptation of interactive video consoles for rehabilitation requires careful evaluation of the games' attributes using relevant rehabilitation constructs.

Lewis, G.N., McPherson, K.M., Rosie, J.A., & Woods, C. (2011). **Virtual reality games for rehabilitation of people with stroke: Perspectives from the users.** *Disability and Rehabilitation: Assistive Technology, 6*(5), 453-463.
NARIC Accession Number: J62148
ABSTRACT: Study evaluated the feasibility as well as users' perspectives of a novel virtual reality (VR) game-based rehabilitation intervention for people with stroke. Participants were 5 men and one woman aged 55 to 75 years who had upper limb hemiplegia following stroke. The VR intervention consisted of a series of eight progressively complex video games that required participants to navigate a submarine in a virtual ocean environment. Movement of the submarine was directed by forces applied to an arm interface by the affected limb. Outcome measures included assessments of arm function, questionnaires evaluating the intervention, and a semi-structured interview concerning participants' opinion of the intervention. All participants improved their performance on the games, although there were limited changes in clinical measures of arm function. All participants also reported that they enjoyed the intervention with a wide range of overall perceptions of the experience of using VR. Three themes emerging from the interview data were: stretching oneself, purpose and expectations of the intervention, and future improvements. Implications for further development of the VR game-based intervention are discussed.

2010

Ahmed, A., Chang, C.Y., Cheng, S., Flynn, S.M., Geng, Y., Lange, B.S., Rizzo, A.A., Seok, D., Utsav, K., Xu, M. (2010). **Development of an interactive rehabilitation game using the Nintendo® WiiFit™ balance board for people with neurological injury.** *In P.M. Sharkey and J. Sánchez (Eds.), Proceedings of the 8th International Conference on Disability, Virtual Reality and Associated Technologies*, Viña del Mar/Valparaíso, Chile, 31 Aug. - 2 Sept. 2010, 249-254.
NARIC Accession Number: J62807
Project Number: H133E080024
ABSTRACT: Article describes the development and testing of an interactive game that assists in the treatment of balance and mobility disorders following neurological injury, using the Nintendo® WiiFit™ balance board as a rehabilitation tool. The game was designed to be customizable and used by therapists to train patients with a range of levels of ability to transfer weight onto the impaired limb in order to improve weight shift in standing and during gait. The prototype underwent initial usability testing with a sample of four physical therapists and four patients with neurological injury or disease. Overall, feedback was positive and areas for improvement were identified. The use of a video game for balance training has the potential to increase motivational factors, collect quantitative data from the training session, and customize the level of difficulty to each patient's specific needs.

Blochinger, S., & Irving, A. (2010). ***Create an adaptable video games activity program that integrates academic, speech, occupational and physical therapy IEP goals using HandsUp!***
NARIC Accession Number: O18201
Project Number: H133E050011
Available at https://www.resna.org/sites/default/files/legacy/conference/proceedings/2010/CAC/IrvingA.html.
ABSTRACT: This paper describes the development of HandsUp!, an adaptable video game platform that can be used to create and play customized

games for children with cognitive and physical disabilities. The HandsUp! activity program was designed to meet the needs of the education and therapy providers at two schools based on their students' Individualized Educational Programs (IEP) goals. Games were developed that focus on letter recognition, color, letter and number identification, and matching sight words. The parameters of the game can be easily modified to promote increased reaching range of motion, smoother movements and, depending on the type of colored marker used, improvement in fine motor skills. Colored markers include mittens, socks placed over the children's hands, small balls, colored cylinders, and a pair of tongs in combination with a colored ball to promote a pincer grasp. Multiple positions are also used to incorporate motor skills such as standing balance, sit to stand, and one footed stance. Custom games were made for children with a range of physical and cognitive profiles, including a Spiderman-themed game for a boy with autism and a High School Musical-themed game developed for a girl with spinal muscular atrophy. This paper was presented at the 2010 annual conference of the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA).

Chang, C.Y., Chieng, C.L., Flynn, S.M., Lange, B.S., Liang, W., Nanavati, C., Rizzo, A.A., Si, Y. (2010). **Development of an interactive stepping game to reduce falls in the elderly.** *In P.M. Sharkey and J. Sánchez (Eds.), Proceedings of the 8th International Conference on Disability, Virtual Reality and Associated Technologies*, Viña del Mar/Valparaíso, Chile, 31 Aug. - 2 Sept. 2010, Pgs. 223-228.
NARIC Accession Number: J62808
Project Number: H133E080024
ABSTRACT: Article describes the development of a prototype rhythm game that leverages the benefits of step-based exercise and dance video games to improve balance and reduce falls in older adults. Modified dance-based exercises that include step-based movements have been demonstrated to improve endurance and balance in older adults. This computer-based activity interfaces with camera tracking equipment that sends real time information about the player's foot movements to the game. The system incorporates an algorithm of feature point-based motion tracking using two web cameras. The algorithm was developed to track two objects attached to the right and left shoe of the user with an adjustable band. The prototype system underwent preliminary usability assessment with a sample of three physical therapists and four young healthy participants aged 16 to 43 years. All participants reported enjoying the experience. Following improvements, this low-cost tracking system and interactive stepping game prototype will be further assessed for usability with a sample of healthy older adults.

Gordon, A.M., & Okita, S.Y. (2010). **Augmenting pediatric constraint-induced movement therapy and bimanual training with video gaming technology.** *Technology and Disability, 22*(4), 179-191.
NARIC Accession Number: J61044
ABSTRACT: Article describes how video gaming technology can be used to enhance intensive treatment approaches in children with cerebral palsy (CP). It provides a brief review of the etiology and neural basis of hemiplegic CP, followed by a description of the residual motor capabilities in the involved upper extremity and the potential role of intensive practice. Two promising intensive treatment approaches that target residual motor function, constraint-induced movement therapy and bimanual training, are then described. Recent evidence suggests that such task-oriented training approaches to rehabilitation are enhanced when the tasks are meaningful to the performer. Increasingly, this means use of current technology, specifically video gaming, to maintain salience and motivation and target specific motor impairments. Examples are provided of how commercially available video gaming, including the Nintendo Wii, can be used to augment such intensive treatment approaches. It is suggested that with such intensive treatment programs, gaming can be an important compliment to, but not a replacement for, relevant task-oriented activities in the real world and that video gaming and virtual reality training will be an important part of future rehabilitation efforts.

2009

Foulds, R., Irving, A., & Odle, B.M. (2009). ***Usability of an adaptable video game platform for children with cerebral palsy.***
NARIC Accession Number: O17645
Project Number: H133E050011
Available at: https://search.naric.com/research/rehab/download.cfm?ID=110288.
ABSTRACT: Study evaluated the usability of a low-cost, adaptable video game platform for upper extremity rehabilitation in children with orthopedic disabilities. The platform, called "Hands-Up", allows users to play video games for therapeutic purposes by tracking speed, accuracy, level of difficulty, and duration of game play. Participants were 3 children with different forms of cerebral palsy and their therapists. The evaluation consisted of exposing the children to 5 weekly intervention sessions with the platform and obtaining feedback via questionnaires from their therapists. During the intervention sessions, the children played games using markers that were selected based on their therapeutic goals. The usefulness of the platform, or the platform's ability to assist them with achieving those goals, was assessed with functional tasks. The results of the questionnaires and functional tasks revealed that Hands-Up assisted the participants in achieving their therapeutic goals.

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There is a charge of 5 cents for copying and shipping with a $5 minimum on all orders.

Documents from the International Research Collection available through REHABDATA are listed below:

2018

Cano-de la Cuerda, R., Ortiz-Gutiérrez, R.M., & Ramírez-Nieto, M. (2018). **Effectiveness of commercial video games in balance and gait treatment in Parkinson's disease. [Eficacia de los videojuegos comerciales en el tratamiento del equilibrio y la marcha en la enfermedad de Parkinson]**. *Rehabilitación, 52*(2), 114-124.
NARIC Accession Number: I244647
ABSTRACT: The objective of this study was to perform a systematic review of the effectiveness of commercial video games in the rehabilitation of balance and gait disorders in Parkinson's disease. A systematic search of scientific articles published in English or Spanish from September 2011 to December 2016 was carried out in the PubMed, PEDro, Science Direct, CINAHL, and Cochrane databases. Methodological quality was assessed using the Jadad scale. Twelve articles and two scientific posters were finally included. A detailed description was made of the characteristics of the included articles (with a total of 276 participants), specifying the number of participants, type of intervention, comparison of interventions with other therapies, brief description of the results, and their score on the Jadad scale. Results of the review indicate that commercial video games produce benefits on balance and postural control, as well as on certain gait parameters, such as step length, cadence, and walking speed, thus improving the quality of life of patients with Parkinson's disease. However, it cannot be stated that the effects of these devices exceed those of conventional treatments; furthermore, the articles published were of low methodological quality.

2016

Amiano, L.A., Rubio, S.M.C., Sebastián, Y.M.M., & Sebastián, Y.M.P. (2016). **Video games in physiotherapy of cerebral palsy.[Los videojuegos en el tratamiento fisioterápico de la parálisis cerebral]**. *Fisioterapia, 38*(6), 295-302.
NARIC Accession Number: I242961
ABSTRACT: The main objective of this study was to improve psychomotor development of children with CP using video games in physical therapy. Participants were 8 patients with CP aged between 6 and 12, I-II level in GMFCS and score between 75%-100% in GMFM-88. The physiotherapy intervention used the Nintendo Wii console and the Wii-fit balance board game for 15 sessions. Balance (Berg scale), location load-distribution center of gravity (with the software of the balance board), and motivation in physical therapy sessions (measured by an ad-hoc scale) were studied. The study was conducted during the 2013-2014 school year in the physiotherapy room of a school. Study results show statistically significant evidence supporting improvement in balance, in patient satisfaction, and more adequate distribution in the load of the lower limbs. Based on results, the authors conclude that virtual reality helps in achieving different objectives of physiotherapy, with interesting use to improve balance and postural control. The results support the use of the Wii console as a complement to, never a substitute of, physiotherapist-led treatment of children with CP.

Bauer, A., Beutner, K., Boese, S., Golla, A., Jahn, P., Lau, A., Mau, W., & Schlitt, A. (2016). **Exergames as an exercise therapy: User acceptance and physical cost in inpatient oncologic rehabilitation. [Exergames als bewegungstherapeutisches Angebot – Nutzerakzeptanz und Beanspruchung im Rahmen der stationären onkologischen Rehabilitation]**. *Wissenschaft und Forschung, 26*, 32-38.
NARIC Accession Number: I241599
ABSTRACT: This study analyzed the feasibility and acceptance of a cardiac exercise program using gaming consoles in an inpatient oncologic rehabilitation clinic. A total of 62 patients undergoing rehabilitation participated in the exploratory mono-center trial with pre-post design. The exercise program consisted of 6 units of individual training for 30 minutes with the Nintendo Wii administered by sports therapists. The exercise program was received well regardless of age and gender. Ninety-five percent of the participants rated the program as a useful addition to standard therapy and 56% would have liked to practice more frequently. In general, the intervention led to slightly increased physical strain, resulting in peak strains of moderate to high intensity levels being reached. Overall, the positive response in the heterogeneous patient sample and the high variability of training load showed promising potential of exergames in oncologic rehabilitation settings.

2015

Bernard, J., & Gadioux, C. (2015). **"Wii-habilitation" in Parkinson's disease and multiple sclerosis. [Oui à la Wii™ pour la rééducation dans la maladie de Parkinson et la sclérose en plaques]**. *Kinésithérapie, la Revue, 15*(162), 63-69.
NARIC Accession Number: I241758
ABSTRACT: This literature review was undertaken to inventory the use of video games in balance rehabilitation for patients with Parkinson's disease and multiple sclerosis. For the review, a search of the PubMed database between September and October 2013 was carried out, and nine English-language studies were selected. The review found video games to be promising for static and dynamic rehabilitation of balance disorders, although less effective than work with a physiotherapist. They are a good complement to conventional rehabilitation and can be used at home by patients on a good functional level.

da Costa, F.A., de Melo, L.P., dos Santos, J.K.V., & Soares, M.D. (2015). **Wii rehabilitation and neurological physiotherapy: A systematic review. [Wii reabilitação e fisioterapia neurológica: Uma revisão sistemática]**. *Revista Neurociencias, 23*(1), 81-88.
NARIC Accession Number: I243597
ABSTRACT: The aim of this study was to observe the effects of using Wii rehabilitation in physical therapy for neurological disorders. A systematic

review was conducted of studies published between August and November 2012, in the electronic databases BIREME, SciELO (Scientific Electronic Library), Science Direct, and Lilacs, using the keywords in the Portuguese language jogos de video (video games), reabilitação (rehabilitation), acidente vascular cerebral (cerebral vascular accident/stroke), doença de Parkinson (Parkinson's disease), paralisia cerebral (cerebral palsy), and their translations into English and Spanish. Of the 326 articles found and submitted to careful evaluation, 10 articles were selected. These were evaluated for methodological quality, study type, number, age and gender of participants, assessment, intervention type, results, and conclusion regarding the use of Wii rehabilitation in these neurological disorders. Results indicate that Wii rehabilitation yields effective results in the treatment of impairments of neurological pathologies, depending on aspects such as duration, frequency, or types of games used during treatment.

Etsuji, I., Morihiro, T., Motohide, A., & Mutsumi, O. (2015). **Influence of virtual reality gaming using bio-sensing technology on the motor function of the elderly. [生体センシング技術を使った仮想現実によるゲームが高齢者の運動機能に及ぼす影響について]**, *Physical Therapy Science* [理学療法科学],*30*(6), 811-815.
NARIC Accession Number: I242050
ABSTRACT: Study examined the effect of virtual-reality gaming using bio-sensing on the motor function of older adults. Twenty-three elderly persons played virtual-reality games more than twice a week for 4 weeks. Pre- and post-intervention performances for the 10-meter walking time, the Timed Up and Go test (TUG), and the 5-step test (5ST), as well as functions measured by the games, average reaction speed and game success rates, were compared. Exercise habits were also investigated using a questionnaire. Post-intervention TUG, 5ST, average reaction speed and success rate results were significantly better than at pre-intervention, and significantly more subjects who successfully completed the games had exercise habits. Post-intervention motor function was significantly improved, but the results suggest the possibility that it was influenced by audio-visual function or TV game experience.

2014

Hyungjun, I., Jeonghun, Ku., & Youn, J.K. (2014). **Upper extremity rehabilitation using virtual reality after stroke.** 뇌졸중 환자에서 가상현실을 이용한 상지 재활 훈련 (*Brain & NeuroRehabilitation*), *7*(1), 30-38.
NARIC Accession Number: I242230
ABSTRACT: Article reviews the literature on the use of virtual reality for upper-extremity rehabilitation in stroke survivors. Virtual-reality applications are novel and potent technologies for upper-extremity rehabilitation after stroke because the interface technologies, augmented reality technologies, and various sensorimotor feedback techniques are rapidly advancing. Going forward, virtual-reality technology should be designed to provide the possibility of intense functional repetitive practice for patients. There is limited evidence regarding the use of virtual reality and interactive video gaming for improving arm function because there are few such commercial devices and little relevant research. However, evidence of the greater effectiveness of upper-extremity virtual-reality training over that of conventional therapy after stroke has recently grown due to the adoption of various therapeutic devices. The combination of virtual reality with robotic devices, neuromodulation, mirror therapy, and telerehabilitation may synergistically improve upper extremity function after stroke. In severely injured patients, robotic interfaces should be considered, the level of difficulty should be fitted appropriately to the severity of the deficits, and the fact that it is difficult to train patients repeatedly and effectively in a real-world environment should be considered. Further research should be conducted on the application of virtual reality in larger populations, involving various training paradigms, at different exercise levels, and the long-term sustained effects of virtual reality. In addition, synergistically enhanced effects of combining other treatments and feedback paradigms with well-designed interfaces should be investigated.

2013

Alguacil, D.I.M., de la Cuerda, R.C., Del Río, G.F., González, R.A., Gutiérrez, R.O., & Page, J.C. (2013). **A telerehabilitation program by virtual reality-video games improves balance and postural control in multiple sclerosis patients.** *Neuro Rehabilitation, 33*(4), 545-54.
NARIC Accession Number: I240698
Document is available in full-text at: https://content.iospress.com/download/neurorehabilitation/nre995?id=neurorehabilitation%2Fnre995.
ABSTRACT is available at: https://www.ncbi.nlm.nih.gov/pubmed/24029009.

Chen, Y.L., Hsiao, Y.L., Huang, C.P., Lai, C.H., & Peng, C.W. (2013). **Effects of interactive videogame based system exercise on the balance of the elderly.** *Gait & Posture, 37*(4), 511-5.
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Fleming, J., Gesch, J., Kuys, S.S., McClanachan, N.J., Wuthapanich, N. (2013). **Feasibility of gaming console exercise and its effect on endurance, gait and balance in people with an acquired brain injury.** *Brain injury, 27*(12), 1402-8.
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Bateni, H. (2012). **Changes in balance in older adults based on use of physical therapy vs the Wii Fit gaming system: A preliminary study.** *Physiotherapy, 98*(3), 211-6.
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Atay, M.B., Senel, A., Stam, H.J., & Yavuzer, G. (2008). **''Playstation eyetoy games'' improve upper extremity-related motor functioning in subacute stroke: A randomized controlled clinical trial.** *European Journal of Physical and Rehabilitation Medicine, 44*(3), 237-44.
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Broeren, J., Claesson, L., Goude, D., Rydmark, M., & Sunnerhagen, K.S. (2008). **Virtual rehabilitation in an activity centre for community-dwelling persons with stroke: The possibilities of 3-dimensional computer games.** *Cerebrovascular Diseases, 26*(3), 289-296.
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2018

Floros, A., Giannakopoulos, G., Giannakopoulos, V., Katsoulis, P., & Tatlas, N.A. (2018). **Accessible electronic games for blind children and young people.** *British Journal of Educational Technology, 49*(4), 608-619.
ERIC Number: EJ1186244
ABSTRACT: We present a suite of inclusive games designed to address the needs of people with blindness or low vision. Particularly, through the employment of modern sonification strategies that achieves efficient perceptual representation of the game-play, several audio-games with different scenarios and application scope (entertainment and education) were developed and demonstrated. A platform called "Memor-i studio" that allows nontechnical users (including blind ones under supervision) to create such inclusive games has also been developed. The overall presentation includes the detailed description of the outcome of the evaluation process involved children and young people aged between 7 and 20 years old from the Special Elementary School for the Blind in Athens and the Education and Rehabilitation Centre for the Blind in Athens, Greece. The description is also extended to include the design framework of Memor-i studio. The conclusions of this evaluation are unexpectedly encouraging, showing that the specific type of inclusive games genre may be a strong alternative toward the development of accessible games for blind people, providing a secure starting point for future developments on this field.

2017

Arner, T., McMahon, D.D., Rosenblatt, K., & Walker, Z. (2017). **Beyond Pokémon: Augmented reality is a universal design for learning tool.** *SAGE Open, 7*(4).
ERIC Number: EJ1197993
ABSTRACT: The success of Pokémon Go is demonstrating that augmented reality (AR) is reaching the masses quickly and can be a robust tool to enhance student engagement and learning. Leveraging AR for instructional purposes has the potential to become a powerful medium for Universal Design for Learning (UDL) by providing new tools for multiple means of representation, action and expression, and engagement. One of the advantages of using AR applications and AR platforms is the ability to display context relevant digital information to support students' needs in real time and in specific contexts. Although many educational AR applications are in their developmental stages, the rapid growth of AR is likely to continue. The examples presented in this article focus on how educators can use mobile devices and AR to apply the principles of UDL. Combining AR with the principles of UDL can help educators create lessons that are accessible, engaging, and powerful for a diverse range of learners.

Çagiltay, K., Karasu, N., & Nazirzadeh, M.J. (2017). **Developing a gesture-based game for mentally disabled people to teach basic life skills.** *International Association for Development of the Information Society (IADIS) International Conference on Educational Technologies (5th, Sydney, Australia, Dec 11-13, 2017).*
ERIC Number: ED579313
Available in full-text at: https://files.eric.ed.gov/fulltext/ED579313.pdf.
ABSTRACT: It is understood that, for mentally disabled people, it is hard to generalize skills and concepts from one setting to another. One approach to teach generalization is solving the problems related to their daily lives, which helps them to reinforce some of their behaviors that would occur in the natural environment. The aim of this study is to develop a gesture based game to teach basic life skills to mentally disabled kids by a motion sensing device. To this end, a vacuum cleaning digital video game was designed by using the Unity3D game engine, and Microsoft Kinect, based on spiral development methodology. Tests were conducted in two special education schools with the help of a special education expert. The game prototypes were

tested on various spectrum of mentally disabled children, and a final game was designed after several iterations. Results were extracted by observation of the participant's performances. Results have shown that this system positively helps children's basic life skills learning. [For the complete proceedings, see ED579282.]

2016

Knight, V.F., Sherrow, L.A., & Spriggs, A.D. (2016). **Using video models to teach students with disabilities to play the Wii.** *Focus on Autism and Other Developmental Disabilities, 31*(4), 312-320.
ERIC Number: EJ1119312
ABSTRACT: This study investigated effects of video modeling (VM) when teaching recreation and leisure skills to three high school students with moderate intellectual disabilities and autism spectrum disorder. Results, evaluated via a multiple probe across participants design, indicated that VM was effective for teaching all students to play the Wii. Students were able to maintain high levels of accuracy in follow-up probes. Study limitations and implications for future research are discussed.

2015

Koivisto, A., Merilampi, S., & Sirkka, A. (2015). **Mobile games individualise and motivate rehabilitation in different user groups.** *International Journal of Game-Based Learning, 5*(2),1-17.
ERIC Number: EJ1111068
ABSTRACT: Trials on Mobile Games are presenting a huge potential in cognitive, physical and mental rehabilitation. This paper is to discuss user viewpoints of trials with mobile games combining cognitive stimulation and physical exercise in rehabilitation: Game#1 controlled by tilting the mobile phone embedded in a balance board; Game#2 controlled by tilting the tablet PC; and Game#3 a modified game version of Trail Making--A memory test played by tapping figures on the tablet PC touch screen. The total amount of participants was 89 of which 74% were older adults (women = 24; men = 33; average age 85.9 years) and 26% people with learning disabilities (n = 23; a 38.9 years). The gameplay setting was similar for all target groups, although the game graphics (Game#1) were slightly modified based on each user group. Mobile devices were used as the game platform to create easily approachable games of low costs and suitable for the majority of people.

2013

Huang, Y.H., Lee, H.P., & Sheu, T.F. (2013). **An interactive training game using 3D sound for visually impaired people.** *International Association for Development of the Information Society (IADIS) International Conference on e-Learning (Prague, Czech Republic, Jul 23-26, 2013).*
ERIC Number: ED562281
Available in full-text at: https://files.eric.ed.gov/fulltext/ED562281.pdf.
ABSTRACT: The number of visually impaired people is increasing year by year. Although attention has been given to the needs of people with disabilities, most of the discussion has focused on social welfare, while talk about assistive technology for people with disabilities is rare. The blind need training courses for reconstruction and rehabilitation. Orientation and mobility (O&M) training is important for visually impaired people, teaching safe, efficient and effective travel skills. Skills learned from O&M training courses can help the blind walk on the street safely. Crossing the street is especially dangerous, since blind people cannot see traffic lights, and rely mostly on sound for information about their environment. Thus, learning to recognize the varied sounds of vehicles and determining the direction and speed of moving vehicles is critical. In this paper, we propose an interactive game with 3D sound that simulates a busy street environment. The proposed game tries to build a virtual environment with 3D sound to help visually impaired people learn to cross the street safely. As the proposed training game is designed for the blind, the technologies of Kinect and Text-to-Speech (TTS) are used in the human-computer interface in the proposed game, so that they can use the game independently. [For the full proceedings, see ED562127.]

2012

Cai, S.X., & Kornspan, A.S. (2012). **The use of exergaming with developmentally disabled students.** *Strategies: A Journal for Physical and Sport Educators, 25*(3), 15-18.
ERIC Number: EJ976337
ABSTRACT: The physical activity patterns of students with disabilities have been studied in order to understand how much moderate and vigorous daily physical exercise is obtained. Literature suggests that students with disabilities are less physically active as compared to children without disabilities. As a result of being less physically active, these students' fitness levels appear to be much lower than the general population. Consequently, these students have a higher body fat percentage. Therefore, one strategy that may be effective to increase these students' physical activity is through the use of exergaming and interactive video games. This article explains the benefits of exergaming, describes specifically how Nintendo Wii Tennis can been used for students with disabilities, and how these interactive video games could be implemented in an adapted physical education setting. (Contains 1 table).

Chen, L.C., Shih, C.H., & Shih, C.T. (2012). **Assisting people with disabilities to actively improve their collaborative physical activities with Nintendo Wii balance boards by controlling environmental stimulation.** *Research in Developmental Disabilities: A Multidisciplinary Journal, 33*(1), 39-44.
ERIC Number: EJ947535
ABSTRACT: The latest researches have adopted software technology to modify the Nintendo Wii Balance Board functionality and used it to enable two people with developmental disabilities to actively perform physical activities. This study extended the latest research of the Wii Balance Board application to assess whether four people (two groups) with developmental disabilities would be able to actively improve their physical activities collaboration--walking to the designated location following simple instructions, by controlling their favorite environmental stimulation through using three Nintendo Wii Balance Boards. We employed an A-B-A-B design, with A represented the baseline and B represented intervention phases. Data showed that both groups of participants significantly increased their collaborative target response (collaboratively performing designated physical activities) by activating the control system to produce their preferred environmental stimulation during the intervention phases. Practical and developmental implications of the findings are discussed. (Contains 3 figures.).

2011

Brown, D., Evett, L., Keating, L., Merritt, L., Merritt, P., Ridley, A., & Shopland, N. (2011). **Designing serious games for people with disabilities: Game, set, and match to the Wii.** *International Journal of Game-Based Learning, 1*(4), 11-19.
ERIC Number: EJ1113813
ABSTRACT: Serious games are effective and engaging learning resources for people with disabilities, and guidelines exist to make games accessible to people with disabilities. During research into designing accessible interfaces and games, it was noted that people who are blind often report enjoying playing Wii Sports. These games are pick-upand- play games for casual and non-gamers. They have simplified rules and a natural and intuitive feel. Games designed specifically for players with particular disabilities are often not of interest to other players and take a lot of development time. Because of their niche market, these games are not widely available, developed, or maintained. In contrast, games like Wii Sports are cheap and available, and represent an exciting opportunity as inclusive games. Two blind players were introduced to the games and found Wii Tennis the most accessible. The blind players learned to play the game quickly and easily, found it enjoyable and engaging, and could play competitively against each other, as well as a sighted opponent. Small accessibility enhancements of the existing game could enhance the game for other players. In this paper, implications for the design of accessible, inclusive games are discussed.

Documents from the National Library of Medicine PubMed search at www.pubmed.com are listed below:

2018

Anokye, N., Athanasiou, D.A., Baker, K., Butcher, T., Kilbride, C., Norris, M., Nowicky, A., Ryan, J.M., Scott, D.J.M., Singla-Buxarrais, G., & Warland, A. (2018). **Rehabilitation via HOMe Based gaming exercise for the Upper-limb post Stroke (RHOMBUS): Protocol of an intervention feasibility trial.** *BMJ Open, 8*(11), e026620.
PMID: 30467137
Document available in full-text at: https://bmjopen.bmj.com/content/bmjopen/8/11/e026620.full.pdf.
ABSTRACT: INTRODUCTION: Effective interventions to promote upper-limb recovery poststroke are characterised by intensive and repetitive movements. However, the repetitive nature of practice may adversely impact on adherence. Therefore, the development of rehabilitation devices that can be used safely and easily at home, and are motivating, enjoyable and affordable is essential to the health and well-being of stroke survivors. The Neurofenix platform is a non-immersive virtual reality device for poststroke upper-limb rehabilitation. The platform uses a hand controller (a NeuroBall) or arm bands (NeuroBands) that facilitate upper-limb exercise via games displayed on a tablet. The Rehabilitation via HOMe Based gaming exercise for the Upper-limb post Stroke trial aims to determine the safety, feasibility and acceptability of the Neurofenix platform for home-based rehabilitation of the upper-limb poststroke. METHODS AND ANALYSIS: Thirty people poststroke will be provided with a Neurofenix platform, consisting of a NeuroBall or NeuroBands (dependent on impairment level), seven specially designed games, a tablet and handbook to independently exercise their upper limb for 7 weeks. Training commences with a home visit from a research therapist to teach the participant how to safely use the device. Outcomes assessed at baseline and 8 weeks and 12 weeks are gross level of disability, pain, objectively measured arm function and impairment, self-reported arm function, passive range of movement, spasticity, fatigue, participation, quality of life (QOL) and health service use. A parallel process evaluation will assess feasibility, acceptability and safety of the intervention through assessment of fidelity to the intervention measured objectively through the Neurofenix platform, a postintervention questionnaire and semistructured interviews exploring participants' experiences of the intervention. The feasibility of conducting an economic evaluation will be determined by collecting data on QOL and resource use. ETHICS AND DISSEMINATION: Ethics approval granted from Brunel University London (10249-MHR-Mar/2018-12322-2). Trial results will be submitted for publication in journals, presented at national and international conferences and distributed to people with stroke. TRIAL REGISTRATION NUMBER: ISRCTN60291412

Barry, A.J., Kamper, D.G., Stoykov, N., Thielbar, K.N., Triandafilou, K.M., & Tsoupikova, D. (2018). **Development of a 3D, networked, multi-user virtual reality environment for home therapy after stroke.** *Journal of Neuroengineering and Rehabilitation, 15*(1), 88.
PMID: 30290777
Document available in full-text at: https://jneuroengrehab.biomedcentral.com/track/pdf/10.1186/s12984-018-0429-0.
ABSTRACT: BACKGROUND: Impairment of upper extremity function is a common outcome following stroke, to the detriment of lifestyle and employment opportunities. Yet, access to treatment may be limited due to geographical and transportation constraints, especially for those living in rural areas. While stroke rates are higher in these areas, stroke survivors in these regions of the country have substantially less access to clinical therapy. Home therapy could offer an important alternative to clinical treatment, but the inherent isolation and the monotony of self-directed training can greatly reduce compliance. METHODS: We developed a 3D, networked multi-user Virtual Environment for Rehabilitative Gaming Exercises (VERGE) system for home therapy. Within this environment,

stroke survivors can interact with therapists and/or fellow stroke survivors in the same virtual space even though they may be physically remote. Each user's own movement controls an avatar through kinematic measurements made with a low-cost, Kinect™ device. The system was explicitly designed to train movements important to rehabilitation and to provide real-time feedback of performance to users and clinicians. To obtain user feedback about the system, 15 stroke survivors with chronic upper extremity hemiparesis participated in a multisession pilot evaluation study, consisting of a three-week intervention in a laboratory setting. For each week, the participant performed three one-hour training sessions with one of three modalities: 1) VERGE system, 2) an existing virtual reality environment based on Alice in Wonderland (AWVR), or 3) a home exercise program (HEP). RESULTS: Over 85% of the subjects found the VERGE system to be an effective means of promoting repetitive practice of arm movement. Arm displacement averaged 350 m for each VERGE training session. Arm displacement was not significantly less when using VERGE than when using AWVR or HEP. Participants were split on preference for VERGE, AWVR or HEP. Importantly, almost all subjects indicated a willingness to perform the training for at least 2-3 days per week at home. CONCLUSIONS: Multi-user VR environments hold promise for home therapy, although the importance of reducing complexity of operation for the user in the VR system must be emphasized. A modified version of the VERGE system is currently being used in a home therapy study.

Griscti, J., Kilbride, C., Levings, H., Nowicky, A., Paraskevopoulos, I., Ryan, J., Tsekleves, E., & Warland, A. (2018). **The feasibility, acceptability, and preliminary efficacy of a low-cost, virtual-reality based, upper-limb stroke rehabilitation device: A mixed methods study.** *Disability and Rehabilitation, 12*, 1-16.
PMID: 29644897
ABSTRACT: PURPOSE: To establish feasibility, acceptability, and preliminary efficacy of an adapted version of a commercially available, virtual-reality gaming system (the Personalised Stroke Therapy system) for upper-limb rehabilitation with community dwelling stroke-survivors. METHOD: Twelve stroke-survivors (nine females, mean age 58 years, [standard deviation 7.1], median stroke chronicity 42 months [interquartile range 34.7], Motricity index 14-25 for shoulder and elbow) were asked to complete nine, 40-min intervention sessions using two activities on the system over 3 weeks. Feasibility and acceptability were assessed through a semi-structured interview, recording of adverse effects, adherence, enjoyment (using an 11-point Likert scale), and perceived exertion (using the BORG scale). Assessments of impairment (Fugl-Meyer Assessment Upper extremity), activity (ABILHAND, Action Research Arm Test, Motor Activity Log-28), and participation (Subjective Index of Physical and Social Outcome) were completed at baseline, following intervention, and at 4-week follow-up. Data were analysed using Thematic Analysis of interview and intervention fieldnotes and Wilcoxon Signed Ranks. Side-by-side displays were used to integrate findings. RESULTS: Participants received between 175 and 336 min of intervention. Thirteen non-serious adverse effects were reported by five participants. Participants reported a high level of enjoyment (8.1 and 6.8 out of 10) and rated exertion between 11.6 and 12.9 out of 20. Themes of improvements in impairments and increased spontaneous use in functional activities were identified and supported by improvements in all outcome measures between baseline and post-intervention ($p < 0.05$ for all measures). CONCLUSIONS: Integrated findings suggested that the system is feasible and acceptable for use with a group of community-dwelling stroke-survivors including those with moderately-severe disability. Implications for rehabilitation to ensure feasibility of use and maintenance of an appropriate level of challenge, gaming technologies for use in upper-limb stroke rehabilitation should be personalised, dependent on individual need. Through the use of hands-free systems and personalisation, stroke survivors with moderate and moderately-severe levels of upper-limb impairment following stroke are able to use gaming technologies as a means of delivering upper-limb rehabilitation. Future studies

should address issues of acceptability, feasibility, and efficacy of personalised gaming technologies for delivery of upper-limb stroke rehabilitation in the home environment. Findings from this study can be used to develop future games and activities suitable for use in stroke rehabilitation.

2017

Akalin, N., Gurpinar, C., Kose, H., & Uluer, P. (2017). **Interactive games with an assistive robotic system for hearing-impaired children.** *Studies in Health Technology and Informatics, 242*, 298-305.
PMID: 28873814
ABSTRACT: This paper presents an assistive robotic system, which can recognize and express sign language words from a predefined set, within interactive games to communicate with and teach hearing-impaired children sign language. The robotic system uses audio, visual and tactile feedback for interaction with the children and the teacher/researcher.

2016

Bentley, P., Burdet, E., Fayer, S., Liardon, J.L., Mace, M., Nakornchai, T., Rinne, P., Sharma, P., & Zimmerman, K. (2016). **Democratizing neurorehabilitation: How accessible are low-cost mobile-gaming technologies for self-rehabilitation of arm disability in stroke?** *PloS One, 11*(10), e0163413.
PMID: 27706248
Document available in full-text at: https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0163413&type=printable.
ABSTRACT: Motor-training software on tablets or smartphones (Apps) offer a low-cost, widely-available solution to supplement arm physiotherapy after stroke. We assessed the proportions of hemiplegic stroke patients who, with their plegic hand, could meaningfully engage with mobile-gaming devices using a range of standard control-methods, as well as by using a novel wireless grip-controller, adapted for neurodisability. We screened all newly-diagnosed hemiplegic stroke patients presenting to a stroke centre over 6 months. Subjects were compared on their ability to control a tablet or smartphone cursor using: finger-swipe, tap, joystick, screen-tilt, and an adapted handgrip. Cursor control was graded as: no movement (0); less than full-range movement (1); full-range movement (2); directed movement (3). In total, we screened 345 patients, of which 87 satisfied recruitment criteria and completed testing. The commonest reason for exclusion was cognitive impairment. Using conventional controls, the proportion of patients able to direct cursor movement was 38-48%; and to move it full-range was 55-67% (controller comparison: $p>0.1$). By comparison, handgrip enabled directed control in 75%, and full-range movement in 93% (controller comparison: $p<0.001$). This difference between controllers was most apparent amongst severely-disabled subjects, with 0% achieving directed or full-range control with conventional controls, compared to 58% and 83% achieving these two levels of movement, respectively, with handgrip. In conclusion, hand, or arm, training Apps played on conventional mobile devices are likely to be accessible only to mildly-disabled stroke patients. Technological adaptations such as grip-control can enable more severely affected subjects to engage with self-training software.

Brady, M.C., Bugge, C., Pollock, A., & Thomson, K. (2016). **Commercial gaming devices for stroke upper limb rehabilitation: A survey of current practice.** *Disability and Rehabilitation: Assistive Technology, 11*(6), 454-61.
PMID: 25634339
ABSTRACT: PURPOSE: Stroke upper limb impairment is associated with disability in activities of daily living. Gaming (Nintendo Wii) is being introduced to rehabilitation despite limited evidence regarding effectiveness. Little data exists on how gaming is implemented resulting in a lack of clinical information. We aimed to gather therapists' opinions on gaming. METHODS: A survey was posted to therapists, identified from stroke services across Scotland. A second survey was posted to non-responders. Survey data were analysed using

descriptive statistics and thematic coding. RESULTS: Surveys were sent to 127 therapists (70 stroke services) and returned by 88% (112/127). Gaming was used by 18% of therapists, 61% (68/112) stated they would use this intervention should equipment be available. The most commonly used device was Nintendo Wii (83% of therapists using gaming) for 30 min or less once or twice per week. Half of therapists (51%) reported observing at least one adverse event, such as fatigue, stiffness or pain. Gaming was reported to be enjoyable but therapists described barriers, which relate to time, space and cost. CONCLUSIONS: Gaming is used by almost a fifth of therapists. Adverse events were reported by 51% of therapists; this should be considered when recommending use and dosage. Implications for Rehabilitation Commercial gaming devices are reported to be used by 1/5th of therapists for stroke upper limb rehabilitation, 3/5ths would use gaming if available. Adverse events were reported by 51% of therapists; this should be considered when recommending use and dosage. Current use of gaming in practice may not be achieving intense and repetitive upper limb task-specific practice.

2015

Deutsch, J., Malone, L.A., Rowland, J.L., Swartz, M.C., Wiemeyer, J., Xiong, J., & Zhang, F.F. (2015). **Recommendations for the optimal design of exergame interventions for persons with disabilities: Challenges, best practices, and future research.** *Games for Health Journal, 4*(1), 58-62.
PMID: 26181682
Document available in full-text at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4601672/pdf/g4h.2014.0078.pdf.
ABSTRACT: A group discussion of individuals with expertise working in the field of exergaming and rehabilitation focused on the issue of designing exergames for persons with disabilities as well as appropriate interventions using exergames. The purpose of these discussions was to develop recommendations for the design, evaluation, and application of exergames in therapy serving as potential guidelines for researchers, developers, and therapists. The following key issues were addressed: (1) Challenges in exergame design for persons with disabilities, (2) adaptation of exergames for persons with disabilities, (3) exergame interventions, and (4) future research directions. It is the hope of the group that the results of these recommendations will help improve the quality of exergame design and interventions and thereby increase opportunities for persons with disabilities to engage sustainably in exergaming.

Frère, A.F., & Scardovelli, T.A. (2015). **The design and evaluation of a peripheral device for use with a computer game intended for children with motor disabilities.** *Computer Methods and Programs in Biomedicine, 118*(1), 44-58.
PMID: 25459524
ABSTRACT: Many children with motor impairments cannot participate in games and jokes that contribute to their formation. Currently, commercial computer games there are few options of software and sufficiently flexible access devices to meet the needs of this group of children. In this study, a peripheral access device and a 3D computerized game that do not require the actions of dragging, clicking, or activating various keys at the same time were developed. The peripheral access device consists of a webcam and a supervisory system that processes the images. This method provides a field of action that can be adjusted to various types of motor impairments. To analyze the sensitivity of the commands, a virtual course was developed using the scenario of a path of straight lines and curves. A volunteer with good ability in virtual games performed a short training with the virtual course and, after 15min of training, obtained similar results with a standard keyboard and the adapted peripheral device. A 3D game in the Amazon forest was developed using the Blender 3D tool. This free software was used to model the characters and scenarios. To evaluate the usability of the 3D game, the game was tested by 20 volunteers without motor impairments (group A) and 13 volunteers with severe motor limitations of the upper limbs (group B). All the volunteers (group A and B) could easily execute all the actions of the game using the

adapted peripheral device. The majority positively evaluated the questions of usability and expressed their satisfaction. The computerized game coupled to the adapted device will offer the option of leisure and learning to people with severe motor impairments who previously lacked this possibility. It also provided equality in this activity to all the users.

Furöstam, M., Mozelius, P., Norberg, L., Westin, T., Wiklund, M., & Yasasindhu, R. (2015). **Balancing game universes for playing without sight or hearing.** *Studies in Health Technology and Informatics, 217*, 372-7.
PMID: 26294500
ABSTRACT: Equal access to cultural activities is important for inclusion and computer gaming is one of the most common activities in digital culture. However, many people with impairments are excluded from participating. While parallel game universes (PGUs) provide a method to achieve equal access, the question is: how can a balanced collaborative real-time game be designed with the help of PGU for playing without sight or hearing? Balance is a central concept in game design and is important to avoid perceived cheating or disadvantages due to individual or environmental differences. The question was examined with a design science approach, where a game prototype was created in two iterations with a structured design method and evaluated using interviews and observations. In this first step of a more long-term study, ten experienced gamers without impairments were selected with purposive sampling to provide relevant data through simulation of temporary impairments or environmental issues, which can affect many or all gamers. By sorting out these issues first, later testing with actual blind and deaf gamers can focus on more specific issues for each group. The ten participants played either without sight or hearing. The results confirm the use of PGUs for creating a balanced experience but also finds that while multiplayer feel is not optimal, it is a reasonable trade-off for universal access for blind and deaf being able to play together. The results also show that a help system and equal understanding of the game play between the blind and deaf players are important aspects to achieve game balance. Further research should be done involving actual blind and deaf gamers, and similar evaluations of game balance should be conducted with users having other types of impairments.

2014

Baad-Hansen, L., Ghovanloo, M., Holm, T.D., Jensen, J., Kothari, M., Mosegaard, T., Nielsen, J.F., Nielsen, M.S., & Svensson, P. (2014). **Tongue-controlled computer game: A new approach for rehabilitation of tongue motor function.** *Archives of Physical Medicine and Rehabilitation, 95*(3), 524-30.
PMID: 23994051
Document available in full-text at: https://www.archives-pmr.org/article/S0003-9993(13)00620-5/pdf.
ABSTRACT: OBJECTIVE: To investigate the influence of tongue disability, age, and sex on motor performance for a tongue-training paradigm involving playing a computer game using the Tongue Drive System (TDS). DESIGN: Two controlled observational studies. SETTING: A neurorehabilitation center and a dental school. PARTICIPANTS: In study 1, tongue-disabled patients with symptoms of dysphagia and dysarthria (n=11) and age- and sex-matched controls (n=11) participated in tongue training. In study 2, healthy elderly persons (n=16) and healthy young persons (n=16) volunteered. INTERVENTION: In study 1 and study 2, the tongue training lasted 30 and 40 minutes, respectively. Participants were instructed to play a computer game with the tongue using TDS. MAIN OUTCOME MEASURES: Motor performance was compared between groups in both studies. Correlation analyses were performed between age and relative improvement in performance. Subject-based reports of motivation, fun, pain, and fatigue evaluated on 0-to-10 numeric rating scales were compared between groups. RESULTS: In study 1, tongue-disabled patients performed poorer than healthy controls (P=.005) and with a trend of a sex difference (P=.046). In study 2, healthy young participants performed better than healthy elderly

participants (P<.001), but there was no effect of sex (P=.140). There was a significant negative correlation between age and relative improvement in performance (δ=-.450; P=.009). There were no significant differences in subject-based reports of motivation, fun, pain, and fatigue between groups in any of the studies (P>.094). CONCLUSIONS: The present study provides evidence that tongue disability and age can influence behavioral measures of tongue motor performance. TDS may be a new adjunctive neurorehabilitation regimen in treating tongue-disabled patients.

2013

Abdulsatar, F., Choong, K., Timmons, B.W., & Walker, R.G. (2013). **"Wii-Hab" in critically ill children: A pilot trial.** *Journal of Pediatric Rehabilitation Medicine, 6*(4), 193-204.
PMID: 24705654
Document available in full-text at: http://tinyurl.com/y373cyng.
ABSTRACT: PURPOSE: To evaluate the safety and feasibility of virtual reality (VR) exercise as a novel acute rehabilitation intervention in a Pediatric Critical Care Unit (PCCU) setting. METHODS: Children aged 3-18 years with an anticipated PCCU stay > 48 hours, and baseline normal to moderate cognitive and functional disability were eligible. Exclusion criteria included: anticipated death, physical inability, or a contraindication to mobilization. Nintendo Wii™ Boxing was prescribed for a minimum of 10 minutes twice a day for 2 days. Primary outcomes were feasibility and safety. RESULTS: Of 21 eligible patients, 12 (57.1%) were enrolled and 8 completed the study. 41.7% (5/12) were males, and the median age was 11 (3,16) years. Four of the 8 participants who received the intervention were mechanically ventilated during Wii™ play. Participants used the Wii™ a median of 2 times (1,5) over the 2-day intervention period, for a median total duration of 54.5 (15, 224) minutes. There were no adverse events attributable to the intervention. Upper limb activity during Wii™ was significantly greater than the average daily activity (p=0.049). Grip strength did not change significantly from baseline (p=0.20). CONCLUSION: While the results of this pilot trial suggest that VR exercise may be safely applied in a subset of critically ill children, we observed several threats to its feasibility in this population.

2012

Reinkensmeyer, D., Secoli, R., & Zondervan, D. (2012). **Using a smart wheelchair as a gaming device for floor-projected games: A mixed-reality environment for training powered-wheelchair driving skills.** *Studies in Health Technology and Informatics, 173*, 450-6.
PMID: 22357035
ABSTRACT: For children with a severe disability, such as can arise from cerebral palsy, becoming independent in mobility is a critical goal. Currently, however, driver's training for powered wheelchair use is labor intensive, requiring hand-over-hand assistance from a skilled therapist to keep the trainee safe. This paper describes the design of a mixed reality environment for semi-autonomous training of wheelchair driving skills. In this system, the wheelchair is used as the gaming input device, and users train driving skills by maneuvering through floor-projected games created with a multi-projector system and a multi-camera tracking system. A force feedback joystick assists in steering and enhances safety.

2010

Badia, L., Caporusso, N., & Mkrtchyan, L. (2010). **A multimodal interface device for online board games designed for sight-impaired people.** *IEEE Transactions on Information Technology in Biomedicine, 14*(2), 248-54.
PMID: 19858031
ABSTRACT: Online games between remote opponents playing over computer networks are becoming a common activity of everyday life. However, computer interfaces for board games are usually based on the visual channel. For example, they require players to check their moves on a video display and interact by using pointing devices such

as a mouse. Hence, they are not suitable for visually impaired people. The present paper discusses a multipurpose system that allows especially blind and deafblind people playing chess or other board games over a network, therefore reducing their disability barrier. We describe and benchmark a prototype of a special interactive haptic device for online gaming providing a dual tactile feedback. The novel interface of this proposed device is able to guarantee not only a better game experience for everyone but also an improved quality of life for sight-impaired people.

Baker, L., Flynn, S.M., Lange, B.S., Requejo, P., Rizzo, A.A., Valero-Cuevas, F.J., & Winstein, C. (2010). **The potential of virtual reality and gaming to assist successful aging with disability.** *Physical Medicine and Rehabilitation Clinics of North America, 21*(2), 339-56.
PMID: 20494281
ABSTRACT: Using the advances in computing power, software and hardware technologies, virtual reality (VR), and gaming applications have the potential to address clinical challenges for a range of disabilities. VR-based games can potentially provide the ability to assess and augment cognitive and motor rehabilitation under a range of stimulus conditions that are not easily controllable and quantifiable in the real world. This article discusses an approach for maximizing function and participation for those aging with and into a disability by combining task-specific training with advances in VR and gaming technologies to enable positive behavioral modifications for independence in the home and community. There is potential for the use of VR and game applications for rehabilitating, maintaining, and enhancing those processes that are affected by aging with and into disability, particularly the need to attain a balance in the interplay between sensorimotor function and cognitive demands and to reap the benefits of task-specific training and regular physical activity and exercise.

Quick Looks

Online Resources Related to Gaming and Disability

The following are a selection of resources related to video games, adaptive gaming systems, and controllers, as well as online/virtual games for leisure and/or as rehabilitation tools for individuals with disabilities.

AbleGamers
Founded in 2004, AbleGamers enables gamers with disabilities to continue playing games for recreation and rehabilitation regardless of their physical and/or financial challenges. AbleGamers also provides game developers with game accessibility guidelines.
Phone: 703/891-9017
Email: inquiries@ablegamers.com.
https://ablegamers.org.

AccessibleGames
AccessibleGames, powered by the AbleGamers Charity website provides resources and services to assist game professionals in accessible game design and provides an outlet for gamers with disabilities to give feedback to game designers and developers and contribute toward making games more accessible.
https://accessible.games/.

Adaptive Gaming Resources from Craig Hospital
Tech Lab at Craig Hospital works with gamers with disabilities to find gaming options and equipment that best meets their interests and abilities. Resources include a list of informational sites on gaming controllers, game reviews/user forum sites, among others.
https://craighospital.org/services/assistive-technology/assistive-tech-gaming-resources.

AppleVis
AppleVis is a community-powered website for blind and low-vision users, and publishes accessibility reviews of iOS applications, including more than four hundred games submitted by Apple users who are blind or have visual disabilities.
Contact: https://www.applevis.com/contact-us.
https://www.applevis.com.

AudioGames.net
Audiogames.net is a community portal for developers and players of audiogames, or games whose main output is sound rather than graphics (video games). Registration is required to access the forum boards.
https://www.audiogames.net.

Best Adapted Video Game Controllers from SpinalCord.com
https://www.spinalcord.com/blog/best-adapted-video-game-controllers.

The Controller Project
The Controller Project provides a place where people can volunteer to modify/build custom game controllers for individuals with unique physical needs, or a person with a disability may request a customized controller.
http://thecontrollerproject.com.

DAGERS
DAGERS is a leading game journalism site for gamers with disabilities, featuring game reviews and perspectives on video game accessibility. The site is supported by the Minnesota Department of Human Services and The Arc of Minnesota.
https://dagersystem.com.

Ingenious Video Game Controllers Made for People with Disabilities by Nathan Gibson at Total Nerd powered by Ranker.
https://www.ranker.com/list/video-game-controllers-for-people-with-disabilities/nathan-gibson.

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International Game Developers Association: Game Accessibility Special Interest Group
This special interest group brings together developers with an interest in game accessibility to share resources, educate members, and foster collaborates to make more video games accessible.
https://igda-gasig.org.

Reddit Disabled Gamers Community
https://www.reddit.com/r/disabledgamers.

Warfighter Engaged
Warfighter Engaged is a charitable non-profit with a mission to improve the lives of veterans with disabilities through custom adapted devices; specifically, game controller modification for individuals with upper-limb mobility issues or single-hand amputees.
Email: info@warfighterengaged.org.
https://warfighterengaged.org.

Search Terms for Gaming and Disability: Fun and Function

- 🕮 Access to Education
- 🕮 3D Games
- 🕮 Access to Education
- 🕮 Acoustic Stimulation/Methods
- 🕮 Active Video Gaming
- 🕮 Activities of Daily Living
- 🕮 Acute Rehabilitation
- 🕮 Adapted Peripheral Device/Physical Education
- 🕮 Adolescents
- 🕮 Adults
- 🕮 Aging
- 🕮 Assessment
- 🕮 Assistive Technology
- 🕮 Attitudes Toward Disability
- 🕮 Audio Equipment
- 🕮 Auditory Perception/Stimuli
- 🕮 Autism
- 🕮 Balance/Disabilities/Disorders/Gait
- 🕮 Blindness
- 🕮 Body Movement
- 🕮 Case Studies
- 🕮 Cerebral Palsy
- 🕮 Children
- 🕮 Client Satisfaction
- 🕮 Cognition Development/Disorders/Processes/ Rehabilitation
- 🕮 Comparative Analysis
- 🕮 Competition
- 🕮 Computer Applications/Games/Interfaces/ Peripherals/Simulation/Software
- 🕮 Computer-Oriented Programs
- 🕮 Controls
- 🕮 Cooperation
- 🕮 Critical Care/Illness
- 🕮 Daily Living Skills
- 🕮 Design
- 🕮 Developmental Disabilities
- 🕮 Devices Selection
- 🕮 Disabilities
- 🕮 Education/Physical/Special
- 🕮 Educational Games/Strategies/Technology
- 🕮 Energy Expenditure
- 🕮 Enjoyment
- 🕮 Equipment Design
- 🕮 Evaluation
- 🕮 Exercise
- 🕮 Feasibility
- 🕮 Feedback
- 🕮 Foreign Countries
- 🕮 Functional Status
- 🕮 Game-Based Rehabilitation
- 🕮 Games and Gamification
- 🕮 Gaming/Consoles/Systems/Technologies
- 🕮 Gender
- 🕮 Guidelines
- 🕮 Hand Strength
- 🕮 Handheld Devices
- 🕮 Health Promotion
- 🕮 Hemiplegia
- 🕮 Human-Robot Interaction
- 🕮 Imaging
- 🕮 Improvement
- 🕮 Intellectual Disability
- 🕮 Interactive Video
- 🕮 Internet
- 🕮 Intervention
- 🕮 Learner Engagement
- 🕮 Learning Disabilities
- 🕮 Leisure
- 🕮 Likert Scales
- 🕮 Literature Reviews
- 🕮 Memory
- 🕮 Metabolism
- 🕮 Mobile Applications
- 🕮 Mobility Disabilities
- 🕮 Modalities
- 🕮 Modeling
- 🕮 Motion
- 🕮 Motor Activity/Disabilities/Disorders/Skills
- 🕮 Nonverbal Communication
- 🕮 Obesity
- 🕮 Observation
- 🕮 Occupational Therapists
- 🕮 Orientation
- 🕮 Outcomes

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Search Terms for Gaming and Disability: Fun and Function Continued ....

- 🕮 Pediatrics
- 🕮 People with Disabilities
- 🕮 Performance
- 🕮 Persons with Hearing Impairments
- 🕮 Physical Activity
- 🕮 Physical and Rehabilitation Medicine
- 🕮 Physical Disabilities/Environment/Fitness
- 🕮 Physical Therapists
- 🕮 Physiology
- 🕮 Play
- 🕮 Playstation
- 🕮 Program Effectiveness
- 🕮 Psychomotor Performance
- 🕮 Quality of Life
- 🕮 Reading
- 🕮 Recovery of Function
- 🕮 Recreation/Activities
- 🕮 Rehabilitation/Centers/Instrumentation/ Methods/Technology
- 🕮 Robotics
- 🕮 Sedentary Behavior/Lifestyle
- 🕮 Sensation Disorders
- 🕮 Sensory/Aids
- 🕮 Sign Language/Recognition
- 🕮 Simulated Environment
- 🕮 Skill Development
- 🕮 Software Design
- 🕮 Sports
- 🕮 Stimulation
- 🕮 Stroke
- 🕮 Students with Disabilities
- 🕮 Task Performance and Analysis
- 🕮 Teaching Methods
- 🕮 Technology
- 🕮 Telecommunications
- 🕮 Therapy
- 🕮 Three-Dimensional
- 🕮 Time Factors
- 🕮 Tongue Disability/Diseases
- 🕮 Tongue Drive System/Training
- 🕮 Touch
- 🕮 Toys
- 🕮 Traffic Safety
- 🕮 Training Methods
- 🕮 Travel Training
- 🕮 Treatment Outcome
- 🕮 Upper Extremity/Limb
- 🕮 Usability
- 🕮 User-Computer Interface
- 🕮 Video Games/Technology
- 🕮 Virtual Reality/Gaming
- 🕮 Visual Impairments/Perception
- 🕮 Wheelchairs
- 🕮 Wii Fit
- 🕮 Xbox

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- 🕮 REHABDATA and the NIDILRR Program database
- 🕮 Education Resources Information Center
- 🕮 National Clearinghouse of Rehabilitation Training Materials
- 🕮 Campbell and Cochrane Collaborations
- 🕮 PubMed and other National Library of Medicine databases
- 🕮 Agency for Health Care Policy and Research databases
- 🕮 and other reputable, scholarly information resources.

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