Occupational Science & Technology Research Lectureship

Friday, December 14, 2018 • 9:00 am-1:00 pm

Union West Ballroom

Proceedings:

https://uwm.edu/healthsciences/event/occupational-science-technology-research-lectureship/

Schedule of Events	
8:00-9:00am	**Breakfast with Dr. James Patton** (Postdoctoral fellows, PhD students, and PTE officers)
9:00-10:15am	**Poster Presentations**
10:15-10:25am	**Introduction** Dr. Brooke Slavens
10:25-10:30am	**Welcome Remarks** Interim Dean Raymond Fleming
10:30am-Noon	**Podium Presentations** Introduced by Dr. Brooke Slavens
Noon-1:00pm	**Keynote by Dr. James Patton** Introduced by Dr. Roger Smith
1:00pm	**Concluding Remarks** Dr. Brooke Slavens
1:05-2:00pm	**Lunch**

Keynote Speaker

James L. Patton, PhD

Professor of Bioengineering at the University of Illinois at Chicago
Senior Research Scientist at Shirley Ryan Ability Lab

Research focus on computational modeling of biomechanics, the neural control of actions, motor learning, and neurorehabilitation

Occupational Science & Technology Research Lectureship Proceedings

Podium Presentations

Poster Presentations

Comparison of Glenohumeral Kinematics During the Overhead Lacrosse Throw in Able-Bodied and Wheelchair Lacrosse Players

Matthew M Hanks[1], Alyssa J Schnorenberg[1], Brian Robertson-Dick[2], Kenneth Lee[1,3], and Brooke A Slavens[1]
[1] University of Wisconsin-Milwaukee, Milwaukee, WI, USA
[2] Medical College of Wisconsin, Milwaukee, WI, USA
[3] Clement J. Zablocki Veterans Affairs Medical Center, Milwaukee, WI, USA

Introduction

Previous research in the sport of lacrosse has focused on the epidemiology of injury [1,2] and throwing mechanics [3,4]. Due to the increasing national participation [5,6], it is imperative to investigate the biomechanics of throwing in wheelchair lacrosse players, whom are already be at an increased risk of overuse upper extremity injury. The purpose of this study was to evaluate differences in glenohumeral joint kinematics during overhead throwing in wheelchair lacrosse players and able-bodied lacrosse players while standing and seated in a wheelchair. The outcomes of this work may lead to improved safety of the sport.

Methods

Three wheelchair (49.3 ± 20.8 years) users with spinal cord injury and three able-bodied (22.7 ± 4.7 years) lacrosse players were evaluated. Participants were affixed with reflective markers for biomechanical analysis using a 15-camera Vicon motion capture system [7] and performed multiple overhead throws with a lacrosse stick and ball. Mean values for the dominant arm's glenohumeral joint angles were determined three dimensionally for the duration of the throw.

Results

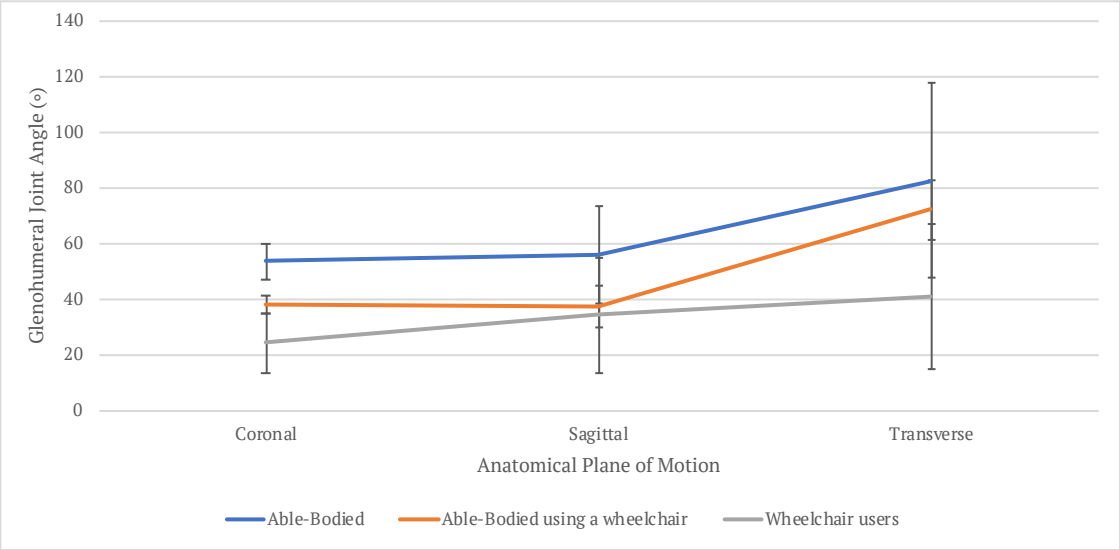

Figure 1. Comparison of mean glenohumeral joint motion during throwing in able-bodied individuals, able-bodied individuals using a wheelchair and wheelchair users.

Discussion/Conclusion

To the authors' knowledge, this was the first study to quantify glenohumeral joint kinematics in able-bodied and wheelchair lacrosse players. Findings suggest wheelchair lacrosse players have decreased mean glenohumeral joint motion when throwing overhead as compared to able-bodied players. This may result in greater demand being placed on the glenohumeral joint in wheelchair users to produce similar outcomes as their able-bodied counterparts. Future research is underway investigating muscle activity to better understand internal mechanisms utilized during wheelchair lacrosse throwing. These data will contribute to the Wheelchair Lacrosse USA rule book to maximize equality and player safety during wheelchair lacrosse.

Acknowledgments
This research was supported by the Medical College of Wisconsin, Department of Physical Medicine and Rehabilitation, Research Administration Committee Grant Program.

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Morphology of Human Lower Lumbar Spine: Pilot Results Learned from the Three-Dimensional MRI Scans

Ruoliang Tang[1], Celal Gungor[2], Richard Sesek[3]
[1]Occupational Science and Technology, UWM, Milwaukee, Wisconsin, USA
[2]Forest Industrial Engineering, Izmir Katip Celebi University, Cigli, Izmir, Turkey
[3]Industrial and Systems Engineering, Auburn University, Auburn, Alabama, USA

Introduction

One of the most challenging issues in occupational health practices has been the reliable estimation of the risk of work-related low back pain and establishes effective procedures to cope with low back pain. Human lower lumbar spine (L3/L4 to L5/S1) is a complex musculoskeletal structure that accommodates compression, bending, and twisting. However, its morphological characteristics are very difficult to obtain. Traditional methods include X-ray, CT scan, and traditional two-dimensional MRI scans in either sagittal or transverse plane. Fortunately, development in MRI hardware and sequences continues to increase our capability to approach the complexity of the human lower lumbar structure, particularly in high-resolution three-dimensional (3D) MRI scans, which provides great potential for research and clinical practices. In this work, we discuss the potential of using 3D MRI scans to reconstruct the shape of the lower lumbar intervertebral discs.

Methods/Design

A total of 35 subjects (22 males and 13 females) were included in the present study. All subjects were in good health and between 20 and 40 years of age. At the time of study, no subjects had any self-reported episodes of low back pain for the previous two years and no prior medical treatment for low back pain. In addition, subjects with chronic leg or foot pain were also excluded.

Lower lumbar spine 3D MRI scans were performed using a 70 cm Open Bore 3T scanner (MAGNETOM Verio, Siemens AG, Erlangen, Germany) at the Auburn University MRI Research Center. All subjects were examined in head-first-supine position with available arm and leg supports.

MRI scans were analyzed using an open-source, DICOM software, OsiriX©. Region of Interest (ROI) segmentations were performed in a series of sagittal scans. Three-dimensional representation of the lower lumbar spine was created by the OsiriX©, based on ROIs of the lower lumbar vertebral bodies and intervertebral discs. This pilot work was performed using a single subject's MRI scans.

Results

Based on the ROIs, the shape of the lower lumbar spine was reconstructed through high-resolution 3D MRI scans. Meanwhile, morphological characteristics of the spinal structure were also well captured and represented.

Discussion/Conclusion

High-resolution 3D MRI can be an effective means to approach the morphology of the lower lumbar spine and offers considerable opportunities for applications in biomechanics, biomedical engineering, and clinical practices.

Acknowledgements

National Institute for Occupational Safety and Health (NIOSH) Auburn University MRI Research Center

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Biomechanical Analysis of the Shoulder During Geared Manual Wheelchair Propulsion in Veterans with Spinal Cord Injury

Omid Jahanian[1], Alyssa J. Schnorenberg[1], Vaishnavi Muqeet[2], and Brooke A. Slavens[1]
[1] University of Wisconsin–Milwaukee, Milwaukee, WI, USA
[2]Medical College of Wisconsin, Milwaukee, WI, USA

Introduction

The prevalence of shoulder pain and injury in manual wheelchair users with spinal cord injury (SCI) has been reported to be up to be 73%, which is mainly due to unfavorably high loading during mobility [1,2]. Geared manual wheelchair wheels are a propulsion assistive device that may reduce the biomechanical demands of upper extremity [3]. The purpose of this study was to investigate the effects of using geared wheels on glenohumeral joint dynamics and muscle activity during manual wheelchair propulsion in individuals with spinal cord injury (SCI).

Figure 1. A subject wheeling on a carpeted level floor using the IntelliWheels geared manual wheelchair wheels.

Methods

Seven veterans with SCI (T1-L2) propelled their personal manual wheelchairs equipped with dual geared wheels (IntelliWheels, Inc.) over a carpeted floor (Figure 1). They used low gear (1.5:1) and standard gear (1:1). A custom force-instrumented geared wheel was used to measure the hand-rim kinetics of the dominant hand [4]. Tri-axial glenohumeral joint dynamics were calculated using a 15 camera Vicon motion analysis system and our established musculoskeletal model [5]. Delsys Trigno wireless surface electrodes were used to record electromyography data of the anterior deltoid and pectoralis major muscles of the dominant arm.

Results

The peak triaxial glenohumeral joint angles were similar during both wheel conditions. The peak glenohumeral joint anterior, inferior and medial forces as well as flexion, adduction, and internal rotation moments occurred during the push phase for both wheel conditions. The peak glenohumeral joint inferior force decreased by 26% (p = 0.036) and flexion moment decreased by 33% (p = 0.01) during geared wheel use compared with the standard gear. The peak muscle activity of the anterior deltoid and pectoralis major decreased by 31% (p = 0.032) and 35% (p = 0.029), respectively, and each of their integrated muscle activity decreased by 30% (p = 0.032, p = 0.004). The glenohumeral joint resultant force and peak internal rotation moment were substantially less during the geared condition, but were not statistically significant.

Discussion/Conclusion

In this study, we successfully quantified manual wheelchair geared wheel use in veterans with SCI. The notable decrease in the glenohumeral joint kinetics and muscle activity with geared wheel use implies that it would have the potential to ultimately decrease the risk of shoulder impingement and secondary shoulder pathologies [1]. The current investigation suggests that using geared wheels may be beneficial for manual wheelchair users for increased function and independent mobility in their home and community, while reducing the risk of secondary injuries.

Acknowledgements: This work was supported by a NIH SBIR grant (#2R44HD071653-02) and a student research grant from the University of Wisconsin-Milwaukee College of Health Sciences.

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Methods for Characterization of Gait Kinematics in Children with Hypermobile Ehlers-Danlos Syndrome

Anahita A. Qashqai[1], Melody K. Pournezam[1], Nicole G Vigon, Matthew M. Hanks[1], Alyssa J. Schnorenberg[1], Donald G. Basel[2], and Brooke A. Slavens[1]
[1] University of Wisconsin-Milwaukee, Milwaukee, WI, USA
[2] Medical College of Wisconsin, Wauwatosa, WI, USA

Introduction

Hypermobile Ehlers-Danlos syndrome (hEDS) is the most frequent subtype of the heritable connective tissue disorder, Ehlers-Danlos syndrome. Up to two-thirds of individuals with hEDS report musculoskeletal pain of the ankle and knee, and recurrent joint dislocations resulting from joint hypermobility [4,5]. These conditions lead to early onset osteoarthritis and osteoporosis [1-3]. Despite this, there are limited quantitative assessment methods and resulting evidence-based rehabilitation protocols for patients with hEDS. The goal of this study was to evaluate gait analysis methodology for application to children with hEDS.

Methods/Design

Two siblings with hEDS participated in the study to assess gait methodology. The Vicon Plug-in Gait model was applied to capture lower body movements during walking using a 15-camera Vicon T-Series motion capture system [6]. Each subject completed five gait trials at a self-selected speed. The lower extremity inverse dynamics model was utilized to compute temporal-stride parameters and lower extremity joint angles.

Results

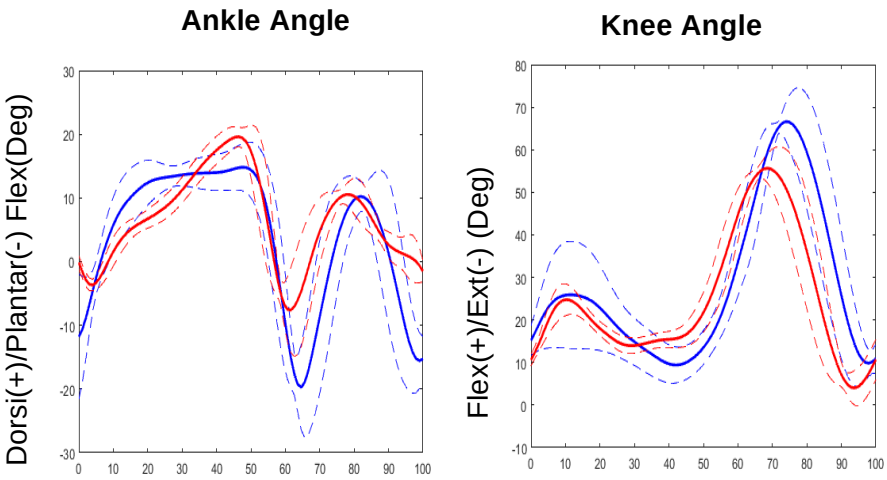

Figure 1: Mean (solid) +/- 1 standard deviation (dashed) of ankle and knee joint flexion-extension angles during the gait cycle for subject 1 (red) and subject 2 (blue).

Discussion/Conclusion

This study successfully quantified temporal-stride parameters and three-dimensional lower extremity kinematics of the ankle, knee, hip and pelvis during gait. Our results are in line with other findings from literature and thus seem appropriate for application to gait characterization in a larger population of children with hEDS. The knowledge of gait kinematics in children with hEDS may ultimately improve early diagnosis and intervention planning to reduce the development of secondary musculoskeletal pain and pathologies.

Acknowledgements
The contents of this work were developed through support by the University of Wisconsin-Milwaukee College of Health Sciences Stimulus Program to Accelerate Research Clusters (SPARC) award and a College of Health Sciences Student Research Grant Award (SRGA).

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Effects of Medical Home Access on Receipt of Educational Services in Children with Autism Spectrum Disorder (ASD)

Sabrin Rizk, MS, OTR/L[1] & Kris Barnekow, PhD, OTR/L, IMH-E®,[1]
[1]University of Wisconsin-Milwaukee

Introduction

One in 59 children has an autism spectrum disorder (ASD) in the U.S. (CDC, 2018). Lifetime costs for individuals with ASD are approximately between $1.4 and $2.4 million in the U.S., with significant costs incurred for early intervention for children under age 3 and special education services during school-age years (Buescher, Ciday, Knapp, & Mandell, 2014). The American Academy of Pediatrics (AAP) recommends a medical home for primary medical care for children, including children with ASD (AAP, 2002), in concert with educational services (AAP, 1999). Educational services, through early intervention under an Individualized Family Services Plan (IFSP) or school-based services through public school systems under an Individualized Education Program (IEP), are part of the repertoire of services for children with ASD. Despite AAP efforts to coordinate health and educational services, whether the medical home plays a role in educational services remains unclear. Fine and Kotelchuck's (2010) *Timeline, Timing, Environment, and Equity* (T2E2) model for *Life Course Approach* (Lu and Halfon, 2003) will frame the study variables and investigation of the association between service systems' performance (i.e., medical home and educational services) and children's health (Newacheck, Fine, Strickland, Antonelli, Wilhelm, Honberg, & Wells, 2014).

Methods/Design

Using the 2016/2017 National Survey of Children's Health (NSCH), this study will examine the prevalence of children, ages 1-17, with a parent-reported condition of ASD reporting receipt of care in a medical home, receipt of educational services (i.e., IFSP or IEP), and the association between medical home and educational service access, in a representative U.S. sample. The 2016/2017 NSCH is a national, telephone survey providing data on the health and well-being of children ages 0-17 in the U.S. and District of Columbia (U.S. Census Bureau, 2018a, U.S. Census Bureau, 2018b). The independent variable, care in a medical home, will be constructed matching the AAP definition (0 = Meets criteria; 1=Does not meet criteria). The dependent variable, receipt educational services (i.e., IFSP or IEP), will also be assessed (0=Yes, 1=No). Binomial logistic regression will be used, controlling for selected covariates (**Figure 1**), while modeling the association between receipt of care in a medical home and receipt of educational services

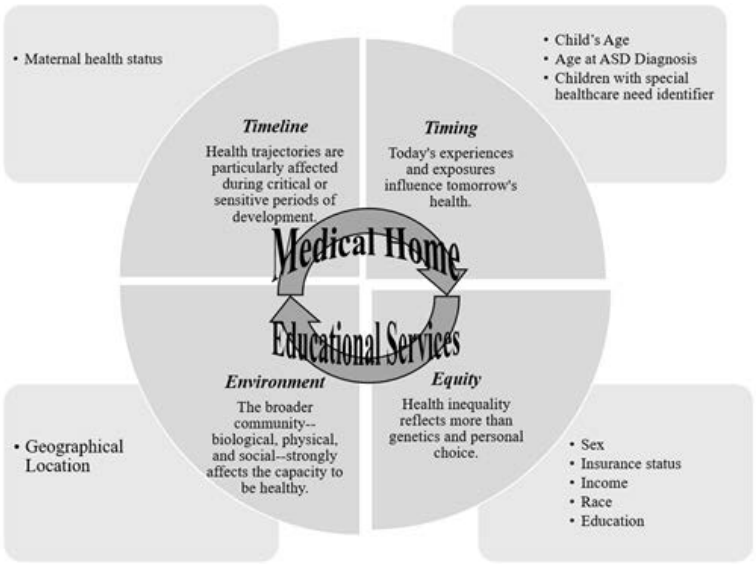

Figure 1: Timeline, timing, environment, & equity (T2E2) model for life course approach of the medical home, educational services, and selected covariates. (Lu & Halfon, 2003; Fine and Kotelchuck, 2010).

Results (Anticipated)
Children with ASD receiving care in a medical home will have a greater likelihood of receipt of educational services than children with ASD not receiving care in a medical home. Additionally, controlling for selected covariates (**Figure 1**), will attenuate the effect of receiving care in a medical home on receipt of educational services for children with ASD.

Discussion/Conclusion
The translational importance for healthcare and educational policy will provide evidence highlighting sociodemographic correlates of medical home access and added benefits of coordinated with educational systems reducing service gaps for children with ASD and families.

Acknowledgements
UW-Milwaukee Graduate School, R1 Advanced Opportunity Program Fellowship (R1 AOP)

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A Review of Electroencephalogram Brain-Computer Interface (EEG-BCI) Systems and Applications in Occupational Therapy and Neurorehabilitation

Maysam M. Ardehali, Qussai M. Obiedat, MSOT, Roger O. Smith PhD, OT
University of Wisconsin-Milwaukee

Introduction

A brain-computer interface (BCI) is a combination of hardware and software that enables extraction and interpretation of brain activity data, and utilizing the data to interact with a computer or machine to control the environment and other systems [1]. There are many different methods to study the brain, each with their weaknesses and strengths. These methods fall under either structural or functional categories. Structural methods study the anatomy of the brain, while functional methods measure and locate brain activity. Structural methods include Magnetic Resonance Imaging, and Computed Tomography (CT) or Computerized Axial Tomography (CAT). Functional methods include Positron Emission Tomography (PET) or Single Photon Emission Computed Tomography (SPECT), Electroencephalography (EEG), Magnetoencephalography (MEG), Functional MRI (fMRI), and Functional Near-Infrared Spectroscopy (fNIRS) [2]. To study cognitive processing, functional methods are used in accordance with their strengths and weaknesses. Methods such as fMRI and fNIRS, measure the hemodynamic and metabolic response of areas of interest within the brain, while EEG and MEG measure the electrocortical activity [3]. Methods such as PET or SPECT use radioactive drugs (tracers) to map the activity of the brain tissue functioning, and hence are not appropriate methods for development of a BCI system. There are other functional methods of studying electrocortical activity in the brain, such as electrocorticography (ECoG), however these methods are not preferable due to issues such as possibility of infection.

fMRI data have the highest spatial resolution; however, they lack high temporal resolution and do not allow real-time monitoring of the brain activity. EEG and fNIRS have high temporal resolutions and can be used to study the brain activity almost in real-time, but they are unable to pinpoint the locus of activity in the brain due to their lack of spatial resolution caused by their placement on the scalp. MEG combines the spatial resolution of fMRI with temporal resolution of EEG and fNIRS, however MEG devices are almost the same size as fMRI machines and require the subject to sit still while undergoing scanning, limiting their application in BCI. Overall, EEG systems are the primary candidates for monitoring brain activity in real-time. Table 1 shows a summary of brain activity monitoring methods.

Method	Type of Activity	Type of Measurement	Temporal Resolution	Spatial Resolution	Invasive?	Portable?
fMRI	Metabolic	Indirect	1 s	~1 mm	No	No
EEG	Electrical	Direct	~0.05 s	~10 mm	No	Yes
fNIRS	Metabolic	Indirect	1 s	~5 mm	No	Yes
MEG	Electrical/Magnetic	Direct	~0.05 s	~5 mm	No	No
ECoG	Electrical	Direct	~0.003 s	~1 mm	Yes	Yes

Table 1. Methods of Brain Activity Monitoring [1]

EEG measures the electrical activity of the brain due to excitation of cortical neurons [4]. Because of the thickness of the scalp and the layers of connective tissue and hair, the EEG signal is weak, low-quality, and prone to external and internal noise. The electric potential of each electrode on the scalp (active electrode) is measured against a reference electrode, while a ground electrode measures the difference between active and reference electrodes [5]. Electrodes can be either wet (made of AgCl) or dry (made of stainless steel or titanium), depending on whether a conductive gel is applied between the electrode and scalp the to reduce impedance. Wet electrodes have better accuracy, while dry electrodes are more convenient to use and leave nothing on the scalp or in the hair after removal [6].

EEG-BCI systems also comprise of Analog to Digital Converters, amplifiers, and recording devices. Data from the electrodes are preprocessed to remove noise and become digitized, then the enhanced signal

is sent to the computer for analysis. Broadly speaking, there are two main steps of analysis: feature extraction, and feature classification. Feature extraction refers to the process where the software detects distinct characteristics of the acquired signal. After feature extraction, feature classification methods determine the output of the BCI system [2]. There are 4 prominent types of control signals in BCI systems that are targeted in the feature extraction phase: Visual Evoked Potentials, Slow Cortical Potentials, P300 Evoked Potentials, and Sensorimotor Rhythms [7-9]. Fig. 1 shows a diagram of an EEG-BCI system.

There are 6 primary fields of application for BCI research and implementation [2]:

1. Medical Applications:
    a. Monitoring and Prevention [10-12]
    b. Diagnosis [13-22]
    c. Rehabilitation [23-32] and [52-54].
2. Smart Environments [33-35].
3. Marketing and Advertisement [36-38].
4. Self-Regulation and Education [39, 43]
5. Entertainment [44-46].
6. Security Systems [47-50].

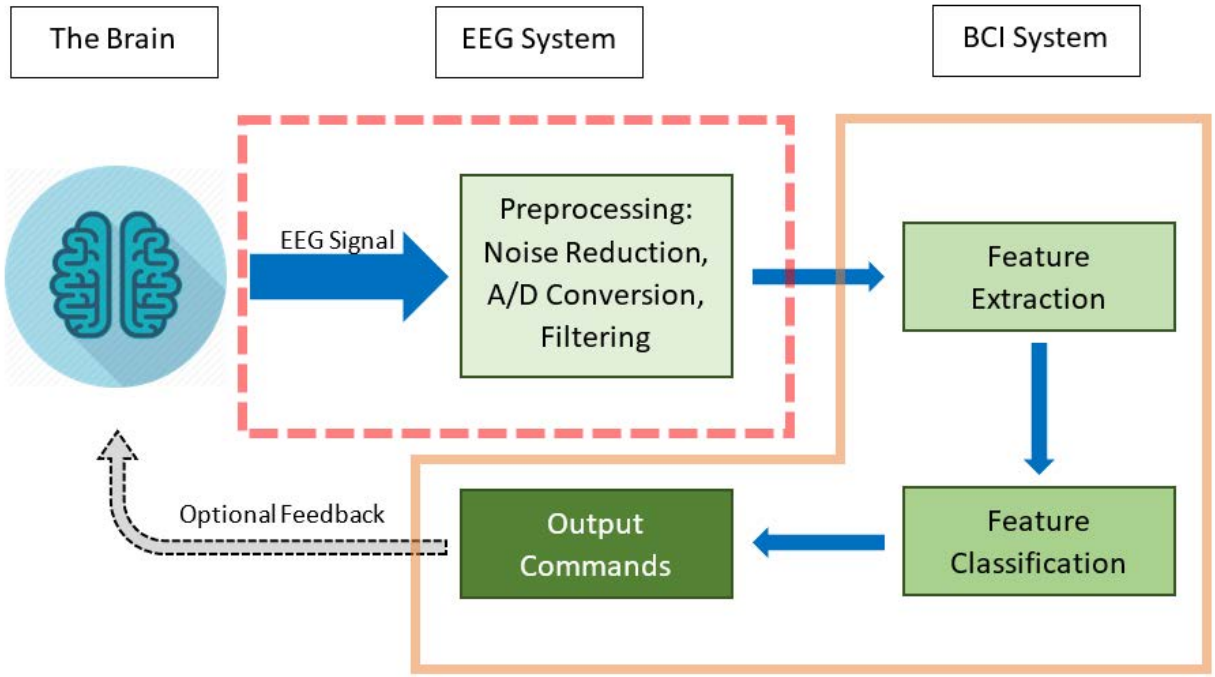

Figure 1. Components of an EEG-BCI System

Occupational Therapists are at the forefront of optimizing human-environment-occupation interfaces [51]. Of the 6 primary fields of EEG-BCI application mentioned above, 4 directly apply to occupational therapists and their practice (medical applications, smart homes and environments, self-regulation and education, and entertainment). However, considering all the potential of EEG-BCI systems and the role they can play in human interaction with occupations and environments, researching prominent occupational therapy journals for EEG-BCI interventions yield little to no results. Figure 2 shows the number of results found by searching for keyword "EEG" in some of the most prominent national occupational therapy journals and published articles and chapters:

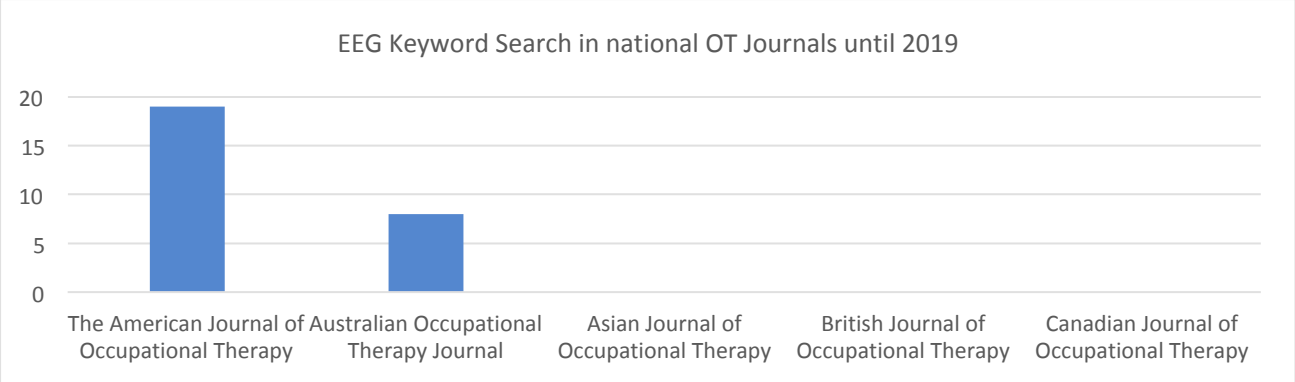

Figure 2. Number of Published Articles with the Keyword EEG in National OT Journals

This review intends to familiarize occupational therapist and OT students with the mechanism of EEG-BCI systems and introduce them to the potentials of these systems in the field of occupational therapy.

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Extended Captions/Equivalent Text Descriptions

Table 1: Table shows methods of brain activity monitoring and their features. Methods are listed vertically with their features listed in front of them.

Figure 1: Figure shows 3 main components of an EEG-BCI system. The brain is the source of extracted EEG Signal. Signal collected via the EEG system undergoes preprocessing. Preprocessing includes noise reduction, analog to digital conversion, and basic filtering. Preprocessed data is then fed to the BCI system for feature extraction. After features are extracted, the features are classified in the next block.

After classification, the BCI system sends the corresponding commands. There is an optional feedback arrow that indicates the possibility of showing feedback to the EEG-BCI system user.

Figure: This graph shows lack of OT involvement in EEG-BCI research despite important applications. Keyword “EEG” was searched in multiple national OT journals, including The American Journal of Occupational Therapy, Australian Journal of Occupational Therapy, Asian Journal of Occupational Therapy, Canadian Journal of Occupational Therapy, and British Journal of Occupational Therapy. Only two journals returned results for the search: The American Journal of Occupational Therapy returned 19 articles, and Australian Journal of Occupational Therapy returned 8 articles with the keyword EEG. The rest returned zero, overall indicating absence of contribution from OTs in EEG-BCI research.

A Closed Loop Neural Activity Triggered Stroke Rehabilitation Using an EEG-Based Brain-Computer Interface (BCI)

Qussai M. Obiedat, MSOT, Maysam M. Ardehali, Roger O. Smith Ph.D., OT

Rehabilitation Research Design & Disability (R2D2) Center, Department of Occupational Science & Technology, University of Wisconsin-Milwaukee, Milwaukee, WI

Introduction

One of the most devastating disabilities after stroke is the loss of upper extremity motor function, leading survivors to suffer from an increased dependency in their activities of daily living and a general decrease in their overall quality of life (1-3). Therefore, the restoration of arm and hand function to improve survivors' independency is crucial. Despite several advances in the context of upper extremity stroke rehabilitation interventions, survivors generally do not reach their full recovery potential thus increasing the demand for advanced, personalized rehabilitation. Brain-computer interfaces (BCI) present the potential to provide personalized interventions and enhance upper extremity motor rehabilitation in stroke survivors.

An electroencephalography (EEG) based BCI system can be utilized to provide automated functional electrical stimulation (FES) neurofeedback through detecting either actual movement or motor imagery (MI). The rationale of using the MI approach is founded in the neural stimulation of action theory. The theory states that executing and imagining the same movement results in a similar activation of brain regions in the primary sensorimotor area (4, 5). Specifically, the actual movement or MI will result in the generation of neurophysiological phenomena called event-related desynchronization or synchronization (ERD or ERS). ERD or ERS can be observed from mu (9–13 Hz) or beta rhythms (22–29 Hz) extracted from EEG over the primary sensorimotor area contralateral to the imagined part of the body (6). The motor system constantly adapts to external changes to achieve optimum motor performance. A study suggests that the lesioned and unlesioned hemispheres respond differently to intervention using the BCI system and leads to increased bilateral activation in the motor network (7). An EEG-based BCI system can detect the ERD or ERS to control the provision of FES neurofeedback in real-time. The aim of this study is to determine if functional muscle stimulation, directed by electroencephalogram (EEG) output, can increase the extent of stroke recovery on behavioral measures and induce brain plasticity.

Methods/Design

40 adult stroke patients between the ages of 21-85 with upper extremity motor impairments will be recruited. The subjects will receive the EEG-BCI training ("closed-loop") and will receive training on the BCI task along with muscle stimulation (FES). Subjects will undergo a total of 12 intervention sessions over the course of 4-6 weeks. Four sessions of behavioral assessments will be conducted before, during, and after the intervention (see Figure 1).

The behavioral assessments include: The Fugl-Meyer Assessment (FMA), Action Research Arm Test, 9 Hole Pegboard, Stroke Impact Scale (SIS), Barthel Index, NIH Stroke scale, Mini-Mental State Examination (MMSE), etc.

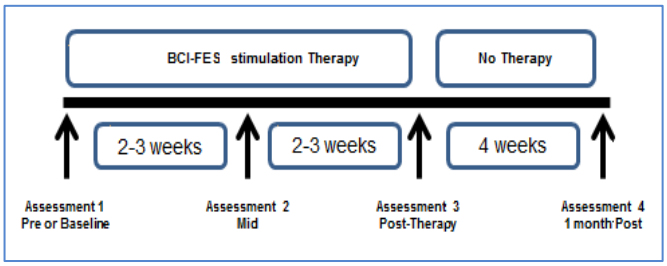

Figure 1: Study Timeline

Data Analysis

Repeated measures ANOVA will be performed on the behavioral data across the different timepoints. In order to assess the overall effect of the testing device after training on the Brain Computer Interface task, multiple regression analyses will be performed to determine the extent to which data from each modality explains the proportion of the variance in the behavioral outcomes.

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Equivalent Text Description

Figure 1:

Brief description: an illustration of the study timeline.

Essential Descriptions: an illustration of the overall study timeline. The study is divided into two main portions, an intervention part and a no therapy part. The intervention part will last between 4-6 weeks, followed by 4 weeks of no therapy. Four assessment sessions will be administered during the study. Assessment 1 will take place at the baseline, assessment 2 in the middle of the intervention part, assessment 3 at the end of the intervention, and assessment 4 after the four weeks of no therapy.

SURF Project: Measuring the Effect of Multifocal Lens Spectacles on VOR

Kathryn Neave, Lindsey Skinner, Dennis Tomashek
University of Wisconsin-Milwaukee

Introduction

The objective of this research is to use the BERTEC Vision Advantage system as a tool to examine the relationship between the Vestibulo-Ocular Reflex (VOR) and balance with and without multifocal lens (i.e., bifocals and progressives) spectacles. Vision is closely associated with balance, and impaired vision is a factor for falls, especially in the elderly. Some studies have linked multifocal lens spectacles to decreased vision while walking and impaired balance. The BERTEC Vision Advantage system measures baseline visual acuity, visual processing time, dynamic visual acuity, and gaze stabilization, all important factors of vision while ambulating.

Methods

We are currently developing a protocol to test patients using the BERTEC Vision Advantage System. This protocol includes testing older adults with the BERTEC Vision Advantage system while sitting and standing. We want to determine if there is an effect on the data whether participants are sitting or standing. Our team has developed a test protocol, incorporating tests of vision, including the BERTEC Vision Advantage system, the Freiberg Visual Acuity Test (FrACT) to test contrast sensitivity, and the Howard Dolman Test of depth perception, as well as dynamic and standing balance, using the Timed up and go (TUG) Test, and the Berg Balance Scale.

Research Question: If deterioration of VOR is compounded by multifocal lens glasses will there be an increase falls in elderly?

Hypotheses

We expect that wearing multifocal eyeglasses will compound the deterioration of VOR leading to greater impaired balance in older adults.

Specific Aim: To test older adults both with and without multifocal lens glasses to determine their effect on vision, depth perception, VOR, and their relation to balance.

The HESTIA Home Evaluation App: Usability Analysis

Rochelle J. Mendonca, PhD, OTR/L[1], Suzanne Perea Burns, PhD, OTR[2,3],
Noralyn Davel Pickens, OT, PhD[3], Nathan Spaeth[4], & Roger O. Smith, PhD, OT[4]
Temple University[1], Medical University of South Carolina[2], Texas Woman'sUniversity[3], University of Wisconsin-Milwaukee[4]

Introduction

An increasing number of individuals with disabilities and older adults are living longer and desire to remain in their homes (Cook, 2006; Wiles, Leibing, Guberman, Reeve, & Allen, 2012). This leads to a greater demand for home evaluations and modifications to ensure that their home environments support independent living. App-based technology has the capacity to meet the needs of home evaluators and address the limitations of implementing evidence-based practice in home safety evaluations. HESTIA, the Home Evaluation with a Strategic Triangulating Integrative Approach, is a new home safety assessment and reporting app that fully integrates a Person-Environment-Occupation (PEO) approach to home environmental evaluation. Formative research was completed during the development of the content and features of the HESTIA to meet stakeholder and end user needs. HESTIA is also currently being tested for its reliability and validity. An additional crucial development step for app based evaluation systems is usability, referring to how people interact with products to make sure they can use the functions of the product in meeting their needs (Benton & Bove, 2011).

Methods/Design

A convenience sample of 83 healthcare professionals examined HESTIA. HESTIA has approximately 1500 questions that are divided into assessment basics, and sections on the person, occupation, and the environment. HESTIA also includes questions to evaluate the homeowner's quality of life and problem list by level of concern. Six detailed case studies of either older adults or individuals with disabilities who had different home independent living needs were used. Participants were required to work in pairs or groups of three to rate the HESTIA app using one case study. Upon completion of navigating through the app, each group answered 7 questions. This study qualitatively analyzed the feedback from the participants.

Results

Each of the questions were individually analyzed related to the content and structure of the app. In general, responses to the design and usability of the HESTIA app were positive. Examples were 'straightforward', 'easy to use', 'flexible', 'definitions great for the home evaluation team to convey specifics'. While respondents did note some missing or desired features (e.g., search box for diagnosis, adding a fall risk assessment), participants reported that they would use the app for home assessment, family education and training, care planning, conferences, from an inpatient and outpatient perspective for the home consultations, for ensuring safety in the home, as an educational tool for health professional students and for communicating with administrators. Negative responses included that it was time consuming to complete the assessment and a learning curve was required.

Participants mostly agreed that the app increased their awareness of different aspects of home safety assessment, and that they appreciated the step-by-step process which provide guidance for new therapists. Participants also indicated that they appreciated the camera feature, the comment box, ability to customize the app, dictation features, and links to abledata.com. Participants identified that they would use the app for home assessment, family education and training, care planning, conferences, from an inpatient and outpatient perspective for the home consultations, for ensuring safety in the home, as an educational tool for health professional students and for communicating with administrators.

Discussion/Conclusion

Results from the qualitative analysis of the usability testing provided valuable feedback regarding the content and the structure of the app. Participants were also able to go through the app to identify areas that were confusing or missing. The feedback is currently being evaluated for integration in the app. Based on the feedback, we are also clarifying the areas that appeared to be confusing to the

participants. Integrating usability analyses into the evaluation and app development process ensures the creation of products that best meet the needs of the end users and stakeholders.

Acknowledgements

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AccessRatings for Buildings (AR-B): Development and Next Gen

Roger O. Smith, Nathan Spaeth, Dennis Tomashek, Drew Williams, Iqbal Sheihk Ahamed

Introduction

Over 56.7 million Americans have a disability, which may impair their ability to walk, climb stairs, think, hear, or see for example [1, 2]. Because of these limitations, persons with disabilities frequently experience difficulties using public buildings. While the Americans with Disabilities Act of 1990 [3] has greatly improved access, people with disabilities continue to be challenged in the community by buildings with architectural barriers. Currently very little information is available to inform people about accessibility information in advance of a visit. The high burden of participating in the community is often too high, causing many persons with disabilities to opt out of community events.

While several attempts have been made to create web databases on accessibility, they tend to focus on specific types of buildings. They also provide only summary data that do not detail accessibility issues or allow for customization by an individuals' functional impairments. Additionally, many of these attempts have not been successful due to a lack of data. Crowdsourced databases are only as good as the information provided by users of the site. If there is little or no data available, people will not use the site. Given the large scope and need to share mass amounts of information, we decided an application would be the best modality for our intervention [4]. We developed two apps, AccessPlace and AccessTools, along with a suite of "mini-apps" that use sensors to measure elements of the environment (AccessSlope, AccessSound, AccessRuler, plus the use of photos and videos.)

Methods/Design

The AR-B system was developed in four main steps; content development, prototype development, creation of the application, and iterations to incorporate feedback and fix bugs in the system. First, experts in the field of accessibility developed items using the standards present in the Americans with Disabilities Act Accessibility Guidelines and a literature review of accessible features. Items were developed for specific building elements commonly found in public buildings. Early in the development of the project, mobile computing devices became common, and it was determined that these offered the best solution to the problem. Thus, AccessTools, an app developed to complete a detailed accessibility rating score for a building, was developed for use on ipads. AccessPlace was conceptualized as a "Yelp for disability", and was thus programmed as a web-based app accessible to any type of device or operating system that can provide customized accessibility information based on a user profile [5]. Programming for these apps began in 2011, and continue to be refined through an iterative development process. Several teams, including programmers in the R_2D_2 Center, Marquette University, and the UWM App Brewery have contributed to the program development [5-8]

The underlying AccessTools data collection system is based on the Trichotomous Tailored Scoring System (TTSS), a branching question taxonomy that allows users to answer questions, add more depth to replies, or skip irrelevant sections for quick and intuitive data entry.

Discussion/Conclusion

Continuing funding was acquired through a NIDILRR Field Initiated-Development Grant in 2018. This grant allows us to complete development of the ARB suite of apps, begin populating the database, test reliability and validity, and develop educational and promotional materials and will be going through the year 2021.

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The Impact of Universal Design on Research Quality

Drew Williams[1], Colleen Regan[2], Sheikh Iqbal Ahamed[1], Roger O. Smith[2]
[1]Math, Statistics and Computer Science Dept., Marquette University, Milwaukee, Wisconsin
[2]R_2D_2 Center, University of Wisconsin-Milwaukee, Milwaukee, WI

Introduction

The Fred Sammons Archive contains numerous digital artifacts (documents, images, and video) spanning the life of Fred Sammons. [1] The work exists to give the new occupational therapist, researcher, and curious passerby insight into the life and work of this prominent occupational therapist. The developers of the project worked to ensure that all media within the archives met accessibility guidelines, as put forth by the WCAG. [2] While this universal design certainly had benefits for users with disabilities, significant improvements in archive research quality were also secured.

Methods/Design

To ensure that all users were able to take advantage of the Fred Sammons Archives, additional media of varying types was added to complement existing media in the archives. Images and illustrations were offered alongside Equivalent Text Descriptions (EqTDs), which offered varying levels of text descriptions for non-text items. [3] One main audio description for videos in the archives was created (due to the relatively similar context of each video), along with multiple audio "introductions" that offered insight as to what each video was about. [3] Videos and audio were accompanied by closed captions, and downloadable transcripts of these captions. PDFs that were typed were designed to be compatible with screen-reading programs, while handwritten documents had their contents read aloud and explained in separate audio files by Sammons. [3] Transcripts for these audio files were created and provided, as often new information was presented. [3] All additional media was presented on the same page as the artifact it sought to enhance, for easy discovery.

Results

Adding accessibility data for each piece of media in the archives resulted in new text data for each media item, such as transcripts for videos and audio, and EqTDs for images. This text data gave insight to (or a direct transcription of) the content of media. This content information was able to be added to our pool of searchable information for an artifact, along with the title, description and metadata. [3] This greatly improved the searchability of the archives, as now content of the media items could be searched instead of simply an artifact title or a movie description. Though work is being done to discern media content automatically [5, 6], the work is not yet mature. Content transcription needs to be done manually at this time. Combining it with the task of integrating accessibility data works well for all parties.

Table 1: Image metadata and accessibility metadata for artifact #921. [4] Metadata includes title (T), description (DS), and keywords (KW). EqTD information includes brief description (BD) and essential description (ED).

Title, Description, Keywords	Equivalent Text Description
T: Artifact #931 - Photograph of Fred Sammons and Colleague at RIC (Picture) DS: Photo with Fred with a fellow counselor at RIC. KW: photograph, fred, sammons, colleague, ric	BD: Photo of Fred standing next to a colleague. ED: The picture was taken at the Rehabilitation Institute of Chicago and the man standing next to Fred is either a doctor or a vocational counselor.

Figure 1: Artifact #921, a photo of Fred standing next to a colleague. [4]

Conclusion

Adding accessibility data about media in the Fred Sammons Archives resulted in marked improvements for all users. Media access was greatly improved – users with disabilities had the appropriate provisions in place, so they could access media of interest to them. Our design integrated these provisions in the website design, such that users didn't have to hunt for "accessibility" features or options located elsewhere on the site. However, the searchability of the website was also improved, as the text relaying the content of site media could be included as searchable information. This was an unpredicted consequence, and certainly proof that universal design does improve access and understanding for all.

Acknowledgements

These results were previously presented at the 2018 Rehabilitation Engineering and Assistive Technology Society of North America's Annual Conference in Washington, DC.

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Extended Captions/Equivalent Text Descriptions

Table One (Brief): A table depicting the difference between the data conveyed by an artifact's keywords, title, and description, and the artifact's EqTD.

Table One (Essential): A two-column table, with a single row, depicting the difference in information conveyed via an artifact's metadata and an artifact's accessibility information. Artifact #931, the artifact being examined, is a photograph of Fred Sammons – with simply the description, title and metadata, one can discern that the photo is of Fred and a colleague at 'RIC'. The EqTD helps one understand that the photo is of Fred and a doctor or vocational counselor at the Rehabilitation Institute of Chicago.

Figure One (Brief): Photo of Fred standing next to a colleague. (via the Fred Sammons Archives [4])

Figure One (Essential): The picture was taken at the Rehabilitation Institute of Chicago and the man standing next to Fred is either a doctor or a vocational counselor. (via the Fred Sammons Archives [4])

The xFACT Taxonomy Editor: Designing Usable Complex Data Collection Protocols

Drew Williams[1], Sheikh Iqbal Ahamed[1], Roger O. Smith[2]
[1]Math, Statistics and Computer Science Dept., Marquette University, Milwaukee, Wisconsin
[2]R_2D_2 Center, University of Wisconsin-Milwaukee, Milwaukee, WI

Introduction

Complex data collection requires ensuring protocols are comprehensive, but not overwhelming for a user – for computerized assessments, this means balancing many data collection questions with a simple user interface. To facilitate the development of robust complex data collection protocols, we developed the xFACT Taxonomy Editor.

Methods/Design

xFACT is designed to build and score assessments with trichotomous, tailored, sub-branching scoring (TTSS). Smith (1993) utilized trichotomous, tailored, sub-branching scoring (TTSS) when developing a functional assessment for people with disabilities. [1] The assessment was designed to be comprehensive, with a vast number of questions about a user's abilities. Questions were created to be answered with a specific (no deficit/partial deficit) response, an uncertain (partial deficit) response, or "non-applicable," where the last option removed questions from an assessment, tailoring it to a patient's needs. [1] Answering with an uncertain response caused the assessment to branch and offer additional questions, asking for more detail. [1] The software handles large numbers of questions via a branching outline. To the right of the outline, additional detail for a question and its answer choices are shown. [2] A user can build outlines, response sets, and prompts throughout a taxonomy, all which confine to the rules of TTSS assessments. [2] Finally, completed assessments can be scored in the editor to ensure an appropriate flow and structure of questions.

Results

Fig. 1: An image of the xFACT Tax. Editor [7]

Table 1: xFACT-Compatible Studies and Question Counts for the Study

Study Name	Outcomes Studies	Question Count
OTFACT [2]	Functional assessment for assistive technology outcomes.	965
RATE-IT [3]	Evaluation of restaurant accessibility.	964
Trans-Fact [4]	Evaluation of public transit accessibility.	284

The xFACT Taxonomy Editor has been used to create several different assessments, [2-4] with different question counts. These assessments have been used (and are used) in a multitude of studies requiring complex data collection. [5, 6] In each case, xFACT appropriately handles comprehensive question sets, organizing questions in an easy-to-follow branching outline and creating an efficient procession through the assessment by tailoring the questions seen by the user as they go. These assessments are often found to be more user-friendly and efficient than checklists for gathering data that may already exist in the field. [5] The trichotomous answer set of each question helps a user make a quick decision before proceeding to the next question, again facilitating large amounts of data collection in a usable manner. Due to the extensive yet adaptive and user-friendly nature of these assessments, they are quite useful for complex data collection tasks, such as assessing restaurants for accessibility purposes. [5]

Conclusion

xFACT balances the need for a large, tailored question set and a simplistic user interface for data collection tasks. By organizing data collection tasks in a branching hierarchy, it handles comprehensive question sets with ease. Users are only required to complete those questions that are directly relevant to their needs. The xFACT approach also allows a user to view data being collected in an understandable format as they proceed through the assessment, helping a user understand what data is being collected. This approach allows for the generation of comprehensive and reusable data collection protocols which adapt to a users' needs.

Acknowledgments

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Extended Captions/Equivalent Text Descriptions

Table One (Basic): A table illustrating a series of assessments built using the xFACT Taxonomy Editor, and how many questions are included in each.

Table One (Essential): A table of three assessments built using the xFACT Taxonomy Editor. The first is OTFACT, a functional assessment for assistive technology outcomes, which has 965 questions. The second is RATE-IT, an evaluation of restaurant accessibility, which has 964 questions. The last is Trans-Fact, an evaluation of public transit accessibility, which has 284 questions. The different question counts illustrate how exhaustive the question sets xFACT organizes can be.

Figure One (Basic): A screenshot of the xFACT Taxonomy Editor software.

Figure One (Essential): A screenshot of the xFACT Taxonomy Editor software, on the Outline Editor view. The header "xFACT Taxonomy Editor" is seen at the top of the screen, with a navigation menu made up of dark buttons leading to different parts of the app (scoring, loading a taxonomy) are aligned on the right side of the app. A teal-grey color surrounds the main part of the screen in the center. On the left side of the center view is an outline view, featuring a light background and dark text, displaying a branching outline of items. The right side of the screen features details about the selected question and answers to choose from, all light text on a dark background. The contrast helps a user focus on a particular question (which, when highlighted, also features a dark background with light text).

Research and Development Needs And The Role Of Rehabilitation Engineering In Combining Therapy And Social Robot Applications

Maysam M. Ardehali, Qussai M. Obiedat, Roger O. Smith
Rehabilitation Research Design & Disability (R_2D_2) Center
Department of Occupational Science & Technology
University of Wisconsin-Milwaukee

Introduction

Rehabilitation robotics is an emerging field of research with substantial potential to assist therapists and clients in a variety of settings and populations. Assistive Robots (AR) and Therapeutic Robots (TR) are two main types of rehabilitation robotics that can include social interaction features [1]. Both social and non-social assistive and therapeutic robots have been found to improve physical and mental health. However, it seems that with some social robots, social features and activities are the goal of human-robot interaction (HRI), as opposed to being used for increasing motivation for therapeutic and assistive activities.

Social Therapeutic Robots (STRs) are currently facing many challenges that impede their effective use. These challenges and needs can be classified into two categories of technological and clinical. Lack of awareness of the participants' situation and background, physical-sensory limitations of STRs, social abilities versus therapeutic capabilities, complexity of programming, and connection between robots and computers are all technological challenges of Social Therapeutic Robots. A STR is unable to understand feelings and base the participant's exercise and activities off their goals, which results in the robots lacking awareness of the participant. The inability of STRs to utilize their sensors to achieve the same perception of the events as the clients, as well as physical restraints are technological limitations. Another challenge is that all the robots that are being used in geriatric or pediatric settings are designed with "social" features in mind first, and then "therapeutic". Current programming software that are used to program social robots for therapeutic activities are either too complicated for therapists (low-level), or are too limited due to simplicity (high-level). Lastly, social robots are either completely autonomous or are connected to a computer. The completely autonomous robots have limited function and programmability, and maintenance of the connection between the connected robots and the computer is often an overlooked challenge. In addition, exploration, development of activities, and validation of outcomes are clinical needs.

Methods

Engineers are well-equipped to address the technical challenges, where therapists have the knowledge of the therapeutic and clinical needs. Lack of a common ground between the two professions, impedes the abilities of both sides to address the needs of rehabilitation. One possible approach to address the challenges is a multidisciplinary approach. Currently there are programs that provide a great opportunity for experts and students from both sides to collaborate on resolving such challenges.

Conclusion

Social Therapeutic Robots have substantial potential to revolutionize therapeutic activity's administration. However, in order to facilitate wider acceptance and application of STRs in therapeutic activities, technical and clinical needs must be addressed. The field of Rehabilitation Engineering has the potential to bring together engineers and therapists to address these impairing challenges. Resolving these needs could result in wider acceptance of STRs, which in turn improves the outcomes of therapy by increasing the motivation of clients, and by reducing the need for therapists to engage in high-intensity and repetitive therapeutic activities.

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Extended Captions

Figure 1: PARO robot

Picture shows two PARO robots next to each other. These robots look like seals, and are designed to interact and react to touch and other stimuli.

Figure 2: MIT-MANUS robot

Picture shows MANUS robot designed by MIT researchers. A person is using the robot for therapy purposes.

Figure 3: NAO robot

Picture shows NAO robot, a humanoid, posing for the camera. This picture shows how much NAO is close to imitating natural human gestures and poses.

Next Generation of Assistive Social Robotics: Therapeutic Applications

Qussai M. Obiedat, Maysam M. Ardehali, Roger O. Smith

Rehabilitation Research Design & Disability (R2D2) Center, Department of Occupational Science & Technology, University of Wisconsin-Milwaukee, Milwaukee, WI

Introduction

Socially assistive robotics (SAR) is a growing area of research with the potential to provide several benefits to a wide variety of contexts including elder care, education, rehabilitation, and for people with social and cognitive disorders (1). Although these applications yielded several beneficial outcomes, the utilization of SAR in the current practice is still limited to the social capabilities of the robots, and mainly focus on socialization goals. However, there are several therapeutic potentials for the use of SAR in the context of physical, emotional, and cognitive rehabilitation, especially considering the recent development of humanoid robotics and sensor technologies.

Methods/Design

The human-like movement capabilities of these robots make it possible for therapists to program a robot to execute a certain sequence of movements and to independently coach a therapeutic session. Extrinsic feedback in therapy is crucial, as the existing research findings suggest that the provision of feedback may enhance motor learning and functional performance (2). In conventional rehabilitation, the therapist is the one responsible for providing extrinsic feedback during therapy. Advances in sensors technology made it possible to measure several aspects of movement's characteristics and performance. Therefore, several sensors can be implemented in a robot which can enhance the capabilities of providing various objective extrinsic feedback about the performance of a client in rehabilitation.

Another critical factor that needs to be considered is the psychosocial aspect of the rehabilitation process. Since participation is a prerequisite to increased treatment, motivation is a key factor in sustained participation which will lead to greater recovery during the rehabilitation process (3). In occupational therapy (OT) interventions, the therapist plays an essential role in providing individualize and goal-directed motivation and encouragement for the client to complete a therapeutic task. SAR can provide the needed encouragement and motivation.

The recovery process after stroke is complex and requires a combination of spontaneous and learning-dependent processes (4). Humanoid SAR are excellent candidates to provide therapists with the needed assistant in this field. In order to use SAR to provide coaching for repetitive, task-specific, and high-intensity interactive treatment of the impaired limb, it needs to perform movements/tasks in front of the client or be able to describe the movement/task. Another key factor that needs to be considered is the ability of the robot to recognize human movements, to provide autonomous task-specific feedback and motivation, and monitor and report clients' progress objectively.

Discussion

Several key factors need to be considered and implemented to the next generation of humanoid SAR to advance the therapeutic application. For SAR to be effective in coaching a therapeutic session, the robots should not have any mechanical limitation in terms of executing human-like movements, including normal ROM specifically in upper extremities. Maximizing the productivity in the delivery of rehabilitation without sacrificing the quality of care patients receive can be achieved by developing evidence-based therapy, or by increasing the productivity of the therapists which can be achieved by providing therapists with appropriate tools. Thus, developing the next generation of humanoid SAR is essential.

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Increasing Community Participation for People With Disabilities: Enhancing AccessTools

Zak Gast, OTS, Carly Meyer, OTS, Christina Meyer, OTS and Roger O. Smith, PhD, OT, FAOTA, RESNA Fellow

Introduction

This study is contributing to the development of the Access Ratings for Buildings (AR-B) project by enhancing AccessTools. The AR-B Project's goal is to provide accurate and up-to-date accessibility information regarding public buildings for people with disabilities, caregivers, and business owners [1]. The long-term goal of our project is to increase community participation among people with disabilities. Specific to this project, we aimed to improve the questions and taxonomy framework, establish interrater reliability, and generally strengthen the functional use of AccessTools and the encompassing mini-applications [3.,4.,5.]. AccessTools utilizes a Trichotomous Tailored Sub-branching Scoring (TTSS) taxonomy that directs rater's to assess how accessible building features are [7].

Methods/Design

To date, the project team applied a multi-stage critical review of the app through a two-trial piloting process using the AccessTools and embedded mini-app assessments. The review process consisted of team scrutiny of a) the taxonomy content and b) the user interface of AccessTools. The piloting process consisted of two data collection runs; one for usability review and one for piloting an interrater-reliability process. Following IRB approval, a review phase was conducted using AccessTools and its mini-applications to rate the Spaights Plaza entrance and the Burger King food court restaurant. Next, an initial interrater-reliability trial was run to create an assessment protocol. The accessibility of 3 local restaurants were rated by the three researchers using AccessTools: Qdoba, Subway, and Noodles & Company.

Results

Following the review phase, the developers created a new version of the app that was used in the second trial phase due to overarching taxonomy issues and data collection function. Utilizing the revised AccessTools software, the three raters were able to collaborate in their collection of three full data sets, that are summarized as a total accessibility score. E.g. 100% is the best accessibility for each unique venue. This permits comparisons between normalized building scores as all buildings range from 0-100%. The team data collection process also provided experience to the team to enable them to generate a more guided interrater reliability protocol for future data collection.

	Accessibility Score
Qdoba	217/314 = 69%
Subway	131/260 = 50%
Noodles & Company	289/386 = 75%

Table 1: Preliminary Trial Accessibility Data

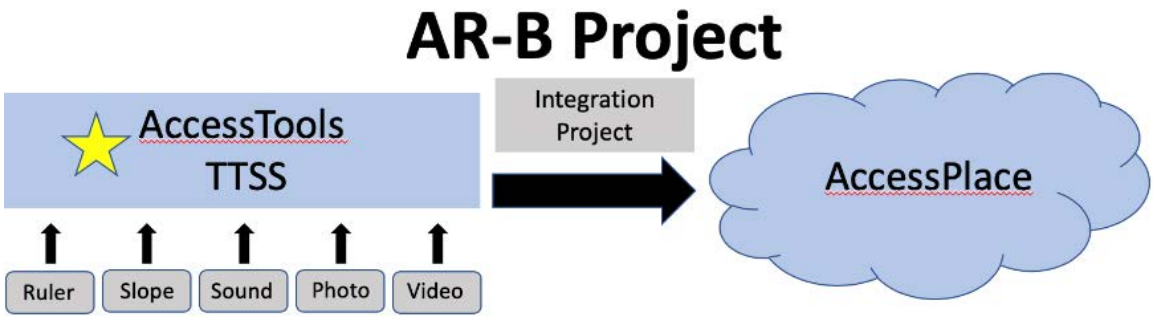

Figure 1: AR-B Project Overview

Conclusion

Our project to date has forwarded the development of the AR-B Project and functional use of the web-based applications by establishing a standardized AccessTools assessment protocol and enhancing its current taxonomy. This protocol will be tested with trained, novice raters and then implemented into the next phase of our study. Following development of the interrater reliability protocol, a large group of raters will be paired and instructed to rate public buildings. These findings will then be analyzed in terms of inter-rater reliability and consistency between the taxonomy of questions.

Acknowledgments

This project was supported and based in part on the work of the Access Rating for Buildings project, grants from the National Institute on Disability, Independent Living, and Rehabilitation Research, NIDILRR grant number (NIDIRR) H133G100211, H133G100211. NIDILRR is a Center within the Administration for Community Living (ACL), Department of Health and Human Services (HHS). The contents of this work do not necessarily represent the policy of NIDILRR, ACL, HHS, and you should not assume endorsement by the Federal Government.

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Equivalent Text Descriptions

Figure 1

Brief: A figure of the breakdown of Access Ratings for Buildings (AR-B) Project.

Essential: This illustration shows the breakdown of the AR-B Project. AccessTools is connected to AccessPlace via the Integration Project. The mini-app assessments of Ruler, Slope, Sound, Photo, and Video are connected to AccessTools.

Table 1

Brief: A table of accessibility scores from AccessTools of Qdoba, Subway, and Noodles & Company.

Essential: The illustration shows the accessibility scores and corresponding percentage from AccessTools for each restaurant. Qdoba's score 217/314, which is 69%. Subway's score is 131/260, which is 50%. Noodles &

Company's score is 289/386, which is 75%. The table portrays that Noodles & Company was rated most accessible, then Qdoba, and Subway was rated least accessible.

The Development of an iPad Application for the Assessment of Pain in Individuals with Developmental Disabilities and Complex Communication Needs

Alyssa Guard, MS, OTR/L, Michelle Konz, MS, OTR/L, Roger O. Smith, PhD, OT, FAOTA, RESNA Fellow, Joyce M. Engel, PhD, OT, FAOTA, & Tom Keating, PhD

Introduction

Chronic pain is persistent and no longer serves a biological purpose resulting in it being a serious developmental health concern that interferes with daily functioning [1;2]. Konz (2016) completed a scoping review of 8 current pain measures revealing current assessments are limited in the domains assessed in addition to usability for youth who have Developmental Disabilities (DD) and complex communication needs. From this review, a new pain assessment for self-report is needed to address this gap. The gPAD is a prototype of a pain assessment created with aims to encompass all pain domains and accessibility features to service a wide population, including individuals with complex communication needs.

Methods/Design

A two-phase process developed the design for an app, created an interactive prototype, and tested its face validity and user interface. This work included a review of current assessments and pain apps, as well as a survey to obtain descriptive data on the clinical practicality of the created prototype [6]. Fifteen occupational therapists (OT) reviewed the gPAD assessment design and reported their experience.

Results

Thirteen of the 15 respondents (87%) agreed to the statement that they would use the gPAD for this population. School-based practitioners seemed to identify the most significant need for this app. Overall, 53% identified as not assessing pain in practice, suggesting limited availability and encouragement of use of assessments for pain. The prototyped app addressed domains of: location (Figure 1), duration, frequency, intensity (Figure 2), alleviators, aggravators, and impact on daily activities. Through the survey of OTs they provided additional qualitative feedback about development of the app. Some respondents suggested improvements include using a 5-point scale instead of 11-point. Others included increased picture cues for questions.

Figure 1: Location

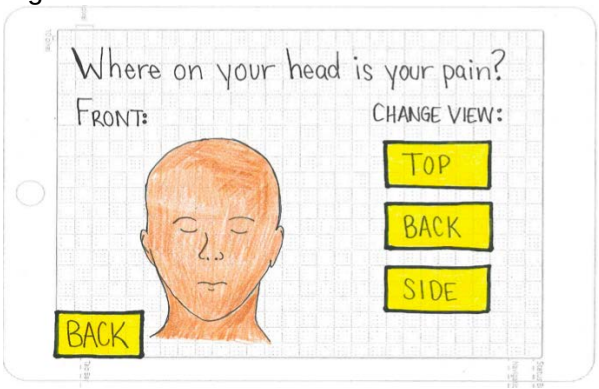
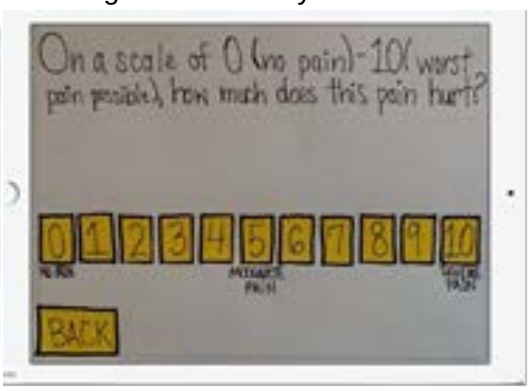


Figure 2: Intensity



Discussion/Conclusion

Advancement of this app could mainstream the assessment of pain in youth with DD, communication challenges, and other potential populations. Further development changes and accessibility options that are not possible with the prototype but are intended to be included such as: scrolling on a page with multiple selections, tracking of data, text-to-speech of all written content, switch capability, simplified version of assessment after initial baseline data collection. When developed into a testable version with accessibility features the gPAD would require further testing with the intended population of youth with DD.

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Extended Captions/Equivalent Text Descriptions

Figure 1: Location

Outline of iPad screen with question heading the top of the screen stating "Where on you head is your pain?" The title "Front" then shows an image of the front of a face, head, and neck on the left half of the screen. On the right side is a list of "Change view" buttons titled "Top", "Back" and "Side" all with black outline and yellow fill for contrast. In the bottom left corner is a button titled "Back" with black outline and yellow fill.

Figure 2: Intensity

Outline of iPad screen with question heading the top of the screen stating "On a scale of 0 (no pain) to 10(worst pain possible), how much does this pain hurt?" Under this is a row of 11 black outlined buttons with yellow fill for contrast. From left to right they read as follows: 0 no pain, 1, 2, 3, 4, 5 moderate pain, 6, 7, 8, 9, 10 severe pain. Under this in the bottom left corner is a button titled "Back" with black outline and yellow fill.

A Systematic Comparison of Two Mindfulness-Based Interventions for Individuals with Upper-Limb Musculoskeletal Disorders

Hanna Paul, Stephanie Anderson, Vanessa Bravo, Danielle Hobach, Sami Basnet, Bhagwant S. Sindhu

Introduction

The rotator cuff is composed of four muscles; supraspinatus, infraspinatus, teres minor, and subscapularis. Rotator cuffs are at increased risk for tearing due to genetics, frequent overhead activity, and age-related degeneration. Rotator cuff tears come along with lengthy rehabilitation times causing barriers in performing Activities of Daily Living (ADLs), Instrumental Activities of Daily Living (IADLs), and may result in psychological distress. Mindfulness is a strategy that helps reduce psychological distress by achieving a mental state of awareness in the present moment. Being mindful means an individual accepts their own thoughts, feelings and bodily sensations without judgement. Current evidence suggest that mindfulness-based interventions support an individual in self-management of pain and associated psychological distress, which may present as a mental health disorder, in patients with chronic musculoskeletal conditions, such as rotator cuff tears. The purpose of the study will be to determine similarities and differences between two mindfulness interventions: Mindfulness-Based Stress Reduction (MBSR) and Headspace. MBSR has been described as, “a group program that focuses upon the progressive acquisition of mindfulness.” In contrast, Headspace is a mobile application that provides guided meditation for individuals to achieve a mental state.

Methods/Design

We conducted a literature review to assess the applicability of two mindfulness-based interventions, MBSR and Headspace, to an individual undergoing rotator cuff repair. To achieve this, we explored various databases including, UW Libraries, Google Scholar, and Pubmed. Terms that we searched for included, Headspace, MBSR, mindfulness-based interventions, and mindfulness meditation. Additionally, we critically compared both interventions.

Results

We found Mindfulness-Based Stress Reduction (MBSR) to have greater limitations than Headspace for our intended population. MBSR required a greater one-time fee whereas Headspace allowed the user to pay for a monthly or annual subscription. This is important to consider because individuals recovering from a rotator cuff tear may be out of work for an extended period of time and be concerned about the financial burden of the cost of surgery and therapy. Headspace also seems to be more accessible for individuals, considering the application was launched in 2010 and has reached 8 million users compared to MBSR that has only reached 24,000 users. These finding show the flexibility that a mobile application has among the population.

Table 1. A comparison of Mindfulness-Based Stress Reduction (MBSR) & Headspace

	Mindfulness-Based Stress Reduction (MBSR)	**Headspace**
Operational Definition of Mindfulness	The effective use of the present moment as the core indicator of the appropriateness of particular choices.	The ability to be present, to rest in the here and now, fully engaged with whatever one is doing in the moment.
Type of Mindfulness-Based Intervention	Retreat	Mobile Application
Founder	Dr. Jon Kabat-Zinn	Andy Puddicombe & Rich Pierson
Year Founded	1979	2010
Cost	$275-$575	Monthly $9.99 Annual $72.00 ($5.99/month) Lifetime $399.99
Length of Intervention	8-10 weeks	Limitless
Number of Users	24,000	8 million

Discussion/Conclusion

Throughout our literature review we did not find any studies comparing the effect of MBSR versus Headspace on reducing psychological stress. Based on our review of various literature, MBSR may not be appropriate for individuals undergoing post-surgical rehabilitation because of the amount of time the intervention consumes and its ease of access. Future studies need to be conducted to compare MBSR and Headspace.

The limitation of the study includes individuals not being able to dedicate over 2 months of intense meditative interventions. Headspace is currently only available in English, which limits the user base and fails to include people who aren't fluent in English.

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Accuracy of 3D Analysis of Mimicked Postures Compared to Ground Truth Postures to Estimate Shoulder Positioning During Task Performance

Alana Hasse, Lindsey Melotik, Brandon Vetterkind, Gregg Voboril, Anny West,
Alyssa Schnorenberg, MS, Jay Kapellusch, PhD, and Brooke Slavens, PhD
University of Wisconsin—Milwaukee, WI, USA

Introduction: Injuries to the shoulder are one of the most common injuries in the workplace. These types of injuries have been mentioned throughout previously published literature looking at a variety of populations from around the world. Costs of shoulder injuries both through worker's compensation claims and out-of-pocket expenses have been on the rise. Various data collection strategies have been used in past studies of workplace shoulder injuries, but the most accurate form of collection is most likely direct measurement. The purpose of this study was to perform a quantitative analysis to determine the accuracy of subject mimicking of pre-recorded tasks and accuracy of video observation methods.

Methods: Two participant groups were established: an original, ground truth group and a mimicked group. Five repetitive motion tasks (three below, above, and at 90 degrees of shoulder flexion, and two using "combined" variations of shoulder flexion) with props were performed by the original group and measured using 3D Vicon motion-capture technology and 2D video recording. The mimicked group attempted to replicate the motions in the ground truth 2D task videos without the use of any props.

Results: We categorized shoulder posture into four distinct categories of shoulder flexion with corresponding scores of 1-4. The 3D motion captured data was analyzed by first taking the average time (in frames) spent in each postural category of three trials of each task per subject. The distributions of average frames were compared using Pearson's Chi-square test between the ground truth and mimicked subjects.

Table 1

Groups	Category Score	Mimicked*	Ground Truth*
Above Shoulder	1	108	87
	2	36.33	37
	3	390.67	174.33
	4	1105	1948.33
At Shoulder	1	46.67	80.33
	2	50	30
	3	183.67	1604.33
	4	1506.33	547.67
Below Shoulder	1	0	370
	2	2002.67	2247.67
	3	90.33	0
Mixed Shoulder 1	1	8.5	21.33
	2	120	115
	3	1020	1147
	4	936.67	1194.67
Mixed Shoulder 2	1	46.33	465.67
	2	633	1396.33
	3	788.67	366
	4	644.33	588.67

*Average of total frames between three trials

Conclusion/Discussion: The 3D mimicked methodology used did not demonstrate to be an effective way to measure ground truth 2D video data. Therefore, this would not be an effective way to measure shoulder postures within industrial settings. Further research should be conducted with larger sample sizes and different methods to verify our findings.

Acknowledgments: We would like to extend our thanks to Jared Bonak, and Austin Hart for their extensive support and guidance throughout the process of this study.

Evaluating Shoulder Postures During Tasks: Comparing Video and Motion Capture Analysis

Mackenzie Gravely, Nina Gutmanis, Meredith Mathson, Mary McNally, Alyssa Schnorenberg, MS,
Jay Kapellusch, PhD, and Brooke Slavens, PhD
Department of Occupational Science & Technology and Biomedical Engineering
University of Wisconsin - Milwaukee

Introduction: The rotator cuff muscles are key stabilizers during shoulder flexion tasks, and are commonly injured [1, 2]. Certain postures may put an individual at risk for developing shoulder pathology [1, 2]. There is currently no gold-standard method for retroactively evaluating shoulder postures during tasks. Video cameras are an inexpensive method for collecting visual data, but it is not known how well video (2D) motion analysis would correspond with actual joint angles. The purpose of this study is to determine the association between 2D motion analysis and actual joint angles, as determined by motion capture analysis of shoulder position. Motion capture (3D) analysis has been used to measure a variety of shoulder movements across a range of ages [3, 4]. This research was part of a larger study to see if subjects can observe videos and accurately mimic those movements in the motion capture laboratory.

Methods/Design: A convenience sample of one subject completed five tasks in different shoulder positions (above, at, and below 90°, and two mixed condition). The subject's upper extremity motions were recorded by a 15 camera Vicon motion capture system and mobile device cameras. Each task's mobile video was subjectively analyzed by three raters using aspects of the Rapid Upper Limb Assessment (RULA) to determine right shoulder flexion at one-second intervals [5]. 3D motion analysis provided an objective measure of shoulder flexion, which was then converted to its corresponding RULA score by hand [5]. Total time spent in each postural range was then calculated and compared between 2D and 3D motion analysis data.

Results: The time spent in each shoulder flexion range during all five tasks was identified. The Vicon motion capture system analyzed shoulder flexion when an individual started to move, while 2D methods analyzed shoulder flexion during movement and rest periods. Thus 2D motion analysis recorded more time spent in low flexion ranges (when subject stood still) and more time per task compared to 3D motion analysis. A chi-square test of association revealed the association between 2D and 3D motion analysis was not significant (χ^2=266.67; p=.251).

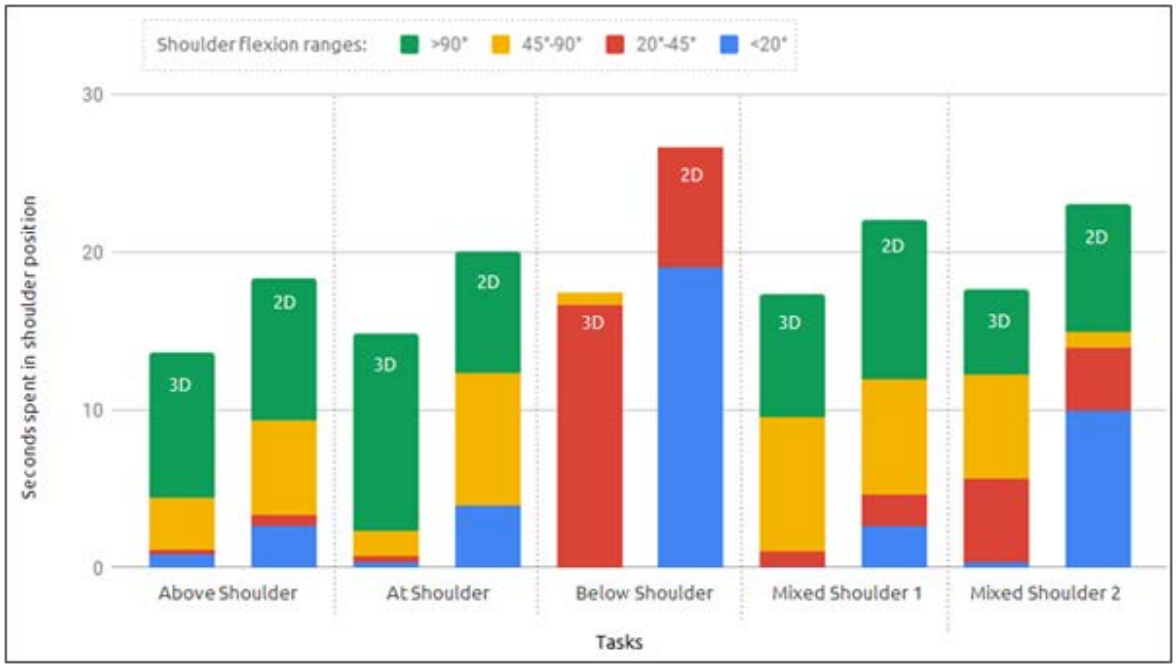

Figure 1. Comparing objective 3D motion analysis and 2D video data during shoulder flexion.

Discussion/Conclusion: This research was not able to determine a valid method of video motion analysis. Rather, our methods provide structure for future research into whether or not 2D motion analysis can correspond with actual joint angles. Further studies should be done with larger sample sizes to verify our findings. Further research should also determine the extent to which different tasks can affect consistency between 3D and 2D motion analysis methods.

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Glenohumeral Joint Kinematics and Functional Outcomes Scores for ADL Task Following Supraspinatus Rotator Cuff Repair

Margaret E. French[1], Alyssa J. Schnorenberg, MS[1,2], Briana N. Magruder[1], Dana H. Washburn, MS,OTR/L[1], Dara J. Mickschl, PA[3], Steven I. Grindel, MD[3], and Brooke A. Slavens, PhD[1-3]

[1]University of Wisconsin-Milwaukee; [2]Marquette University; [3]Medical College of Wisconsin

Introduction

Approximately one quarter of U.S. adults will have a rotator cuff (RC) tear in their lifetime, and about 300,000 RC repair surgeries are performed annually. RC tears can impede physical function, such as one's ability to perform activities of daily living (ADLs), and maintain functional independence. While studies have compared post-operative thoracohumeral (humerus relative to thorax) joint kinematics of various populations, there is no known research assessing upper extremity (UE) joint kinematics of ADLs pre- and post-operatively, which may provide insight on the rehabilitation process. The purpose of this study is to compare shoulder function and glenohumeral (GH) joint kinematics during a combing task before and after supraspinatus repair surgery.

Methods

Six adult subjects (63.5 ± 7.1 years) with a full-thickness, supraspinatus RC tear completed two sessions: 0-12 weeks before surgery and 9-12 weeks after surgery. The validated Simple Shoulder Test (SST) and the University of California-Los Angeles (UCLA) shoulder test were administered to assess perceived shoulder function. A 15-camera Vicon T-series motion analysis system (Oxford Metric Group, Oxford, UK) tracked 27 reflective markers on the upper extremities (UE) during 5 combing trials. A custom biomechanical model was used to calculate the GH joint angles (humerus relative to scapula) in the 3 anatomical planes. The Wilcoxon signed-ranks test compared pre-operative to post-operative sessions ($p < 0.05$) via IBM SPSS Statistics (IBM, Armonk, NY).

Results

There was a statistically significant decrease in GH joint external rotation range of motion pre-operatively (72.9° ± 26.9°) to post-operatively (46.3° ± 16.0°) ($p= 0.028$). This is due to the significant decrease in maximum external rotation angle from 83.8° ± 24.8° pre-operatively to 56.2° ± 18.6° post-operatively ($p = 0.028$). When combing the hair, less external rotation, while abducted, increases the subacromial space, thereby reducing the risk of shoulder impingement. Despite the group improvement of these metrics, 2 individuals were unable to independently complete the task post-operatively. There were no statistically significant differences for the SST and UCLA scores, yet for the question on the UCLA regarding satisfaction with the affected limb, five subjects reported an increase post-operatively.

Conclusion

We were able to successfully compare GH joint kinematics during hair combing and shoulder assessments before and after a RC repair surgery. Although patients may be able to perform ADLs independently before surgery, they may be using altered kinematics and compensation strategies due to injury and pain. A comparison of the pre-operative to post-operative performance may influence appropriate rehabilitation after surgery. Research is underway to investigate shoulder motion, pain, and function in a larger population with additional ADLs. Ultimately this work may aid occupational therapists in ADL interventions to improve rehabilitation outcomes and increase independence.

Acknowledgements

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Occupational Therapists Perspectives on the Potential Use of Performance Profiling in Occupational Therapy Practice

Michelle Perryman and Karen Morris, PhD
University of Cumbria – England

Introduction

Client centred practice is seen to be vital to the occupational therapy profession. However, there are ongoing challenges to promote our professional values and meet the expectations of services and organisations. There is still a significant shift needed from therapist led sessions to truly collaborative therapy (Sumsion 2006). As a result, the research introduced an alternative method in the form of Performance Profiling to occupational therapy. Performance Profiling is a natural application of Kelly's (1955) Personal Construct theory that is utilised within sporting psychology (Butler and Hardy 1992). The method offers a systematic approach to enhance the understanding of how athletes rate their physical, psychological and technical skill development to enable optimum performance. This supports collaboration to build ideal intervention based on the athlete's perception of need (Doyle & Parfitt 1997).

Methods/Design

The research utilised a social constructionist qualitative method which included a workshop introduction, interview or focus group. The participants were asked two questions 1. To share their thoughts about Performance Profiling and 2. Whether they thought it could support Occupational Therapy Practice. Nine expert occupational therapist from three counties participated. The data was thematically analysed.

Results and Discussion

Four major themes were found, theoretical perspectives, practice settings, promoting communication and education. There was an agreement that Performance Profiling had potential use of supporting occupational therapy practice by promoting effective communication with clients. However, further research is required to understand its contribution to the client therapist relationship. This research is a first of a grounded theory doctoral research to provide insight into the valuable communication within the therapy process.

Acknowledgements

We the authors would like to thank all the participants for giving their time and dedication to the research process. Our gratitude is extended to the University of Wisconsin -Milwaukee Occupational Science and Technology team for their continued support to ensure the next phase of the research maintains an international perspective. Special thanks to Dr. Ginny Stoffel and Dr. Jay Kapellusch for your mentorship.

Prior submissions:

This research has been presented at; The Royal College of Occupational Therapists- UK (2015) with developments presented at the; American Association of Occupational Therapists (2018).

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Healthy Transitions from the NICU to Home: A Pilot Study of the SMILE Curriculum

Emily Evans, Mara Herdrich, Kari Morse, Anna Sheikh, Emily Wallenhorst, Kris Barnekow, PhD, OTR/L
University of Wisconsin-Milwaukee
Department of Occupational Science & Technology

Background

Preterm birth accounts for ten percent of the Neonatal Intensive Care Unit (NICU) hospitalizations in the U.S. (March of Dimes, 2017). The SMILE Curriculum was developed to foster caregiver self-efficacy and strengthen the parent-infant relationship in caregivers of preterm infants that were hospitalized in the NICU (Erickson, 2010). It was originally developed as a facilitator guide that focused on parent-infant play interactions, to be administered in a group inpatient setting to parents only. However, recent literature warranted revisions to the curriculum to be delivered on a parent-infant dyadic basis within the natural home environment of the parents, as well as to include a more comprehensive overview of co-occupations including ADLs.

Methods

The MSOT 2017 Cohort research team began revising the SMILE Curriculum under the advisement of Dr. Kris Barnekow. The team conducted a literature review to identify revisions that would enhance the effectiveness of the original curriculum. The team revised each of the 5 SMILE modules and added parent handouts and further community resources that could be utilized by the parents.

Data

Upon completion of the revised protocol, expert feedback was sought from Dr. Gail Poskey, who specializes in NICU care and treatment. Dr. Poskey closely reviewed the revised SMILE Curriculum Protocol for potential revisions that would enhance the credibility.

Revision Results

Dr. Poskey recommended several revisions to the MSOT 2017 Cohort's SMILE Curriculum Protocol. Subsequently, the MSOT 2017 Cohort implemented these revisions within the individual/dyadic curriculum.

Conclusion

The SMILE Curriculum was revised to provide increased support to parents during their infant's transition from the NICU to home. Moving forward, researchers aim to collect more funding, obtain IRB approval, recruit participants, and implement the revised protocol.

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Using Photovoice to Understand the Meaning of Social Participation as it Impacts Transitions for Student Veterans

Caitlin Dobson, MS, OTR/L, and Virginia Stoffel, PhD, OT, FAOTA
UW-Milwaukee

Introduction

Student Veterans face a variety of social pressures that make the transition from military personnel to civilian student challenging. Social participation, an important occupational role that can hold meaning and is linked to health and well-being, is relevant to occupational therapy. Veterans report that social relationships are a critical challenge in their transition process (Plach & Haertlein Sells, 2013).

Social participation is also important to mental health, and social support has been shown to positively affect post-traumatic stress disorder, depression, traumatic brain injuries, substance use disorders, and suicide risk, all common conditions in this population (Kalpakjian, Lam, Toussaint & Hansen Merbitz, 2004; Pietrzak, et al, 2009; Southwick, Vythilingham, & Charney, 2005).

Methods/Design

Photovoice, an approach to qualitative research that embraces participatory action research (PAR) methods, was used to examine social participation in the context of participants' experiences in the university setting. The study piloted a modified short-format for sessions, reducing participants' time from 10.5-14 hours over 7 days (Tomar & Stoffel, 2014) to 6 hours over 2 days. Participants took photos and wrote narratives about their lived experience of campus social life as they re-entered civilian student life. Data from the Photovoice pieces and the group discussion around the stories viewed as important to participants in understanding the phenomenon of social participation in transition were recorded.

Results

Seven male Veterans, ages 22-30, generated a total of 15 photovoice pieces over 11.5 hours of recorded discussions. Analysis began by thorough examination of both the photovoice pieces and the transcripts. Statements that conveyed a participant's attitude about social participation in the transition process were extracted, and statements with similar meaning were clustered together to form themes.

Table 1. Phenomenological Themes

Themes	Subthemes
Camaraderie	Comfort, Shared Experiences, Accepting Adversity
Alienation	Age and Maturity, Social Expectations, Perceived Negative Attitude Towards Veterans, Unapproachability, Returning to Civilian Life with Disturbing Experiences
Identifying Challenges	Independent Living Without Guidance, Loss of Value in Academic Life, Perceptions of Safety, Conceptualizing How to Begin a New Future in the University, Procedural Challenges in the University
Rising to the Challenge	Accepting New Responsibilities and Roles, Envisioning Change to Help Other Veterans and Students
Diversity and Military and Veteran Students	Diversity and the Campus Military and Veteran Resource Center (MAVRC), Diversity and Civilians vs Military

Figure 1. Only a Part of the Picture Photovoice Piece

Only a Part of the Picture

As a veteran I feel like sometimes that's all some people see. That hollow "Thank you for your service" is the general response from people discovering a veteran among them. I don't want to be admired, feared or pitied. I would rather be just a regular person first and a veteran second. Not the other way around. I know that the military changed me. I have yet to meet a person who was not changed by the military. But the military does not define me, instead I draw on those experiences as I navigate through life. I live in the present, not the past. If you see me as only a veteran, you only see a reflection of the past.

Photograph and narrative by Josh Collier

Figure 2. Moto Shirt Photovoice Piece

Moto Shirt

I see familiarity here. The PT shirt shows me a person with a common interest or who's been to the same places I have—it's somebody I can talk to about where I've been. This was an old unit that I used to work with in the Marines.

Now that I'm out, I look out more for USMC emblems or patches so I can find someone to connect with about how life is going, school, stuff like that. If I see similar shirts, the grunt-style shirts, 5.11 gear, warrior bands, moto packs, M-frames or Oakley sunglasses in general – you see that and they tend to be military personnel, or law enforcement at least. Seeing these things gives me a feeling of comfort, like I'm at home at base around my friends and people I know and respect. It's nice to see people who have a similar understanding as me, understand how the world works and that everything's not really handed out and nothing's really free—especially among all these college students that are far out there, who have an image of how the world should be but don't realize how impractical it is.

It's relatively easy to see people who are wearing these things, but there's an awkward interaction bumping into people to say, "Hey I was in, were you in?" It's nice to get away from that awkward interaction by walking into MAVRC, knowing everyone is somehow related. It's too bad that so many people don't know about it or use it as much. Some people know it's here but they don't really understand the use of MAVRC or how it can help you through the day. I call it "the safe space away from safe spaces," because you don't have to have a filter and it's okay to be that way.

Photograph and narrative by Cody Brault

Discussion/Conclusion

Social and professional expectations established by military rank structure create challenges in social participation for those transitioning to civilian life. Student Veterans feel stigmatized for their experiences and beliefs, and feel excluded from their new social domains by individuals who do not understand military culture. Issues of mental health can compound these social difficulties.

Higher education institutions and the OT community should incorporate a holistic approach to guiding student Veterans and helping them integrate into the university's diverse community. Recommendations include: improving knowledge of university resources to entering students, improving military cultural knowledge to educators, improving military benefits knowledge for financial aid staff, encouraging organization of multi-cultural events on campus (including military/Veteran culture), applying Veterans acquired leadership skills, and strengthening Veterans' peer support system.

Further research should strive for a more diverse sample (including women), and examine social participation related to substance use, intimacy, and "anti-military" interactions with civilians.

Acknowledgements

Sincere thanks to the student Veterans who participated and shared their lived experiences in an open and compassionate manner, whose mission was to contribute to building an open and inclusive university community.

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Using Participatory Action Research to Uncover the Impact Photovoice has on Informing, Creating Opportunities, and Connecting Students by Exposing Focus Groups to Photovoice Pieces Depicting the Transition from Military to Civilian Student Life

Hearyun Cho, Danny Kang, Colleen Mcadams, Amanda Murphy, Ben Petersen and Ginny Stoffel, PhD, OT, FAOTA
UW-Milwaukee

Introduction

This study continued the research of Carol Haertlein Sells and Heidi Plach, and the photovoice research conducted by Nikhil Tomar, Caitlin Dobson and Virginia Stoffel who aimed to improve the transition for Veterans as they return to civilian life as students [1,2,3]. The purpose of this study was to use participatory action research, a qualitative research methodology where participants and researchers work together to achieve positive changes to benefit society and meet the needs of a particular group, to inform and generate feedback regarding photovoice as an effective methodology for conveying the student veteran experience [4]. The goal was for focus group input to provide insight towards making positive changes at the university and community level to improve student Veteran transition.

Methods

Two focus group sessions, one consisting of 10 occupational therapy practitioners and the other consisting of four members of the Veteran Advisory Council to the Chancellor (VACC), were held for approximately 90 minutes each and began with a brief introduction of qualitative research, participatory action research, focus group research, and Photovoice methodology. Following the collection of informed consent and demographic information, a 34 slide photovoice exhibit comprised of three previous projects were read aloud and shared with the participants [1,2,3]. Upon cessation of the display, ground rules for the focus group discussion were presented, and audio recording began as the first questions asked to the participants. Three main questions included: What are your initial reactions to seeing the photovoice display? Who might benefit from seeing this display? What do you think needs to happen (i.e. programs, services, supports)? During the focus group, notable information such as nonverbal cues were documented. Transcription of both focus group sessions were completed followed by thematic analysis first conducted individually by each of the five researchers, and then collaboratively as a team. This process was completed among and between both focus groups. Main themes among both groups were organized, defined, and supported using examples from both populations.

Results

Main Themes	Summary of Theme
Awareness of experience and culture	Overall change in perception of Veteran life
Identity conflict	Veteran identity vs. civilian identity
Variable Veteran experience	Acknowledge Veterans as individuals first
Building connections with non-Veterans	Determine a sense of belonging on campus
Difficulties reintegrating	Transition from structure to lack of discipline
Uncomfortable/strong emotions	Participants feel unqualified to give opinions
Gaining new perspectives	Generating solutions to improve transition
Lack of accessibility of resources	Combine resources to one known space

Discussion/Conclusion

Remaining consistent with the work done by previous researchers [1,2,3], photovoice was demonstrated to be an effective methodology for understanding the student Veteran transition experience. Those who participated in the focus groups all expressed a heightened appreciation for this population and generated supporting ideas on how to improve the transition moving forward such as combining all resources to a single, visible space and increasing social events between Veteran and non-Veteran students.

Acknowledgment
We would like to sincerely thank the researchers before us who began the projects to help improve the student Veteran transition. Also, a very special thanks to all the student Veterans who took their time to create and share photovoice to participate in advancing this mission.

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