Using a Telepresence Robot to Improve Self-Efficacy of People with Developmental Disabilities

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ABSTRACT
People with Developmental Disabilities (DD) often rely on other people to perform basic activities such as leaving the house and accessing public spaces. This problem, exaggerated by a decrease in community engagement, has been documented to decrease their sense of self-efficacy. Telepresence robots provide a unique opportunity for people with DD to access public spaces, particularly for those who are homebound or dependent on others for using transportation or buying exhibit tickets. This research evaluates the use of telepresence robots operated by people with DD in exploring a public exhibit. This study was in partnership with Hope Services, an organization that provides skill-improving activities for people with DD. Our analysis consisted of quantitative and qualitative methods using data from semi-structured pre- and post-interviews focusing on participants' sense of physical and social self-efficacy, and well-being. Our study revealed positive trends toward showing that using telepresence can contribute to wellbeing and physical and social self-efficacy. Therefore, we believe that there is some promise for using telepresence robots to tour an exploratory space for people with DD and that it can be a viable option for those who face accessibility limitations.

Keywords
Developmental disability, accessibility, mobility, physical self-efficacy, social self-efficacy, telepresence, social connectedness

INTRODUCTION
Developmental disabilities (DD) are chronic mental or physical impairments gained before adulthood. Due to these impairments, people with DD often depend on others to perform basic activities [4][11]. This difficulty along with a decrease in community engagement can decrease their sense of self-efficacy and independence [10][3]. There is not one particular technology for those with DD that can help one bypass cognitive hardships, dependence on a caregiver, and physical fatigue [3]. Telepresence provides the opportunity to bypass the cognitively difficult processes required to attend an exhibit space, such as buying tickets, or using public transportation [2]. There has been some related work in the use of telepresence for disabilities [1][8][12]. Public exploratory spaces are spaces open to the public such as art exhibits, museums, or libraries, which emphasize more self-guided movement. Telepresence could provide the opportunity to bypass the cognitively difficult processes required to attend these spaces, such as buying tickets or using public transportation [2]. Telepresence robots also eliminate the need for a caregiver to drive, and decrease possible fatigue. According to people with mobility impairments, they felt "empowered" by telepresence which alleviated mobility issues they faced when attending in person [6]. No prominent work has been done yet on accessible telepresence for more relaxed exploratory spaces, particularly with regards to self-efficacy and wellbeing for individuals with DD.

The purpose of this research is to investigate the impact of telepresence robots on participants' sense of presence, flow, wellbeing, and self-efficacy, and to determine whether telepresence is a helpful and viable option for individuals with DD to overcome challenges in participating in public exploratory spaces.

STUDY DESIGN
To investigate these effects, we examined both the difference in social and physical self-efficacy as well as wellbeing before and after people with DD used a Beam+ telepresence robot. Participants remotely operated a Beam+ to interact with the locals and view exhibits at the Seymour Marine Discovery Center, a local community-supported marine science education center.

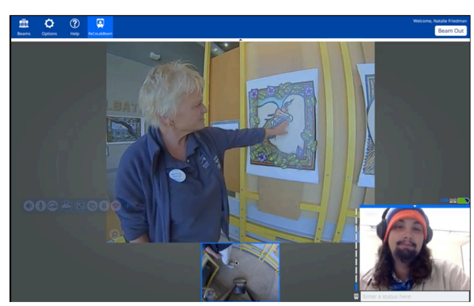

Figure 1. A participant operating the Beam+ software interface

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Participants
Six participants were recruited from Hope Services, a local organization that provides skill-improving activities for people with DD. Participants were age 23-43, primarily male (83%), and primarily white (50%; 17% Hispanic/ Latino; 33% Undisclosed). Participants had lower mobility (50%; medium 17%; high 33%) and mixed prior technology use (50% prior FPS video game use). Participants had the following disabilities: Autism, Klinefelter Syndrome, Mild Cognitive Disability, Unspecified Organic Brain Syndrome, Mild to Moderate Intellectual Disability, Inverted X Syndrome, Obsessive Compulsive Disorder, and Dandy Walker with Epilepsy.

Measures
Measures used included: NASA TLX (flow) [5], WHO Disability Assessment Schedule 2.0 (mobility) [13], Nowak & Biocca's scale (presence) [7], and Peto et al.'s scale (self-efficacy) [9].

Some questions were modified slightly to facilitate participant understanding, and underwent face validation from expert consultation with psychologists and disability specialists.

- "Did you feel rushed?"
  - Flow, adapted from NASA TLX scale [5]
- "Is it stressful for you to move around a crowded space?"
  -Physical self-efficacy, adapted from Peto et. al. [9]

Procedure
First, the researcher explained the consent process and provided a tutorial on how to operate the Beam+ followed by practice with an in-house Beam+. Participants were verbally given a pre-interview that measured demographics, wellbeing, and physical & social self-efficacy. The tour consisted of two exhibits led by a docent: an Albatross art exhibit and a Meet the Scientists exhibit. After the tour, participants were given a semi-structured post- interview that measured their current physical and social self-efficacy, wellbeing, flow and presence.

Figure 2. The back of Beam+ at the *Meet the Scientists* exhibit

RESULTS
We found high levels of presence and flow, as well as positive trends for wellbeing and physical and social self-efficacy.

Presence was measured at 1.71 (SD = 0.46) where 1 is considered low presence and 2 is considered high presence. Flow was measured at 1.13 (SD=0.43) where 1 is considered high flow and 2 is considered low flow. Wellbeing was measured using the question, "Tell me 3 words that tell me how you feel right now" before and after interacting with the Beam+. All individual words used are in the word clouds in Figure 3, scaled by frequency. Participants were high in anticipation (i.e., "excited" and "nervous") before using the telepresence robot, but shifted to be more uniformly "happy" afterwards. A sentiment analysis of the aggregated valence scores indicate a positive trend in wellbeing between the pre- (M=.7, SD=.09) and post-tour (M= .76, SD=.05) for this particular question; $t(5) = 2.45$, $p <.10$.

Figure 3. Pre- and post-interview wellbeing responses

We conducted paired-sample t-tests (two-tailed) comparing the pre- and post-measures of self-efficacy. We found a positive trend in physical self-efficacy between the pre- (M=2.3, SD=.5) and post-tour (M=2.7, SD=.4) interviews; $t(6) = 2.23$, $p <.10$ and a positive trend in social self-efficacy between the pre-tour (M=2.2, SD=.98) and post-tour (M=2.67, SD=.52) interviews; $t(6) = -2.24$, $p < .10$. However, because we only have six participants, we should view these results as trends rather than statistically significant. Qualitative findings support these trends. During the study, one participant mentioned, "I could do it every day. I liked moving around the whole room," which could indicate physical self-efficacy. Another said, "I want a robot to have arms and legs that can walk."

DISCUSSION AND FUTURE WORK
This study explores how use of a telepresence robot in an exploratory space would affect wellbeing and self-efficacy for individuals with DD. By studying people without independent transport, we aim to benefit and provide a basis of research for a wider population who can't drive independently. We found evidence for a positive affect on wellbeing as well as social and physical self-efficacy, showing telepresence could be an effective accessibility tool. Future studies could compare the effects of telepresence to either an in-person experience or to paper or digital versions of the exhibits in order to isolate the effects of telepresence on wellbeing. Another direction for future work could include a wider variety in exhibit spaces that focus the viewer's attention without contextualization. Finally, research could focus on individuals with lower body impairments to see if there is decreased fatigue and increased mobility in moving around public spaces.

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