Development of ASSIST Checklist for Use of Smart Home Technology as Assistive Technology

Dan Ding\textsuperscript{1,2}, PhD, Lindsey Morris\textsuperscript{1,2}, OTD, OTR/L, Andrea Fairman\textsuperscript{1,3}, PhD, OTR/L, CPRP

\textsuperscript{1} Human Engineering Research Laboratories, Univ. of Pittsburgh
\textsuperscript{2} VA Pittsburgh Healthcare System
\textsuperscript{3} Department of Occupational Therapy, Slippery Rock University
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Learning Objectives

1. Identify two potential benefits of using a formal assessment tool in the provision of mainstream smart home technologies as assistive technology for persons with physical disabilities.

2. Identify mainstream smart home technologies that can be used to support at least 5 different daily activities which persons with physical disabilities may have difficulty completing independently.

3. Identify at least two key factors to advocate for provision of mainstream smart home technologies as assistive technology in the service delivery process to increase access for persons with disabilities.
Outline

• Background
• Overview of the ASSIST Project
• Rationale for the ASSIST Functional Performance Index (AFPI)
• AFPI Structure and Design
• AFPI Content Validity
• AFPI Test-Retest Reliability (Ongoing)
• AFPI Review for Comments/Suggestions
Mainstream Smart Home Technologies as AT

Pros
- Readily available
- Affordable
- Wide variety
- Customizable
- Smart

Cons
- Accessibility, usability, and integration with existing AT not considered
- No standard protocol and universal compatibility between products
- Wide variety
- No service delivery
ASSIST Project

- **Autonomy, Safety, and Social Integration via Smart Technologies (ASSIST)**
- To develop and evaluate ASSIST - a comprehensive technology-based intervention in people with physical disabilities residing in the community who are at risk of institutionalization.
ASSIST Service Delivery Model

ASSIST Development Guided By:
Human Activity Assistive Technology Model\(^1\) and Cognitive Orientation to Daily Occupational Performance (CO-OP)\(^2\)

Assessment
- Needs, Ability, Environment, Support system ...

Technology Selection
- Smart home hub, smart home devices, access methods

Implementation
- Installation, configuration, customization

Training
- “Goal-Plan-Do-Check” strategy, customized materials

Follow-up
- Problems from usage logging and user report
ASSIST Functional Performance Index

Purpose

1. Assessment: Identify occupational performance deficits that could be addressed using mainstream smart home technology as AT

2. Outcome Measure: Assess the impact of smart home technologies provided with AT services on the client’s functional performance

Key Features

- Client Centered
- Diverse Item Bank for Persons with Severe Physical Disabilities
- Consider Environmental & Personal Contextual Factors
Review of Existing Measures

- Functional Performance Assessments
  - Assessment of Life Habits (LIFE-H)\(^3,4\)
  - Spinal Cord Injury Function Index using AT (SCI-FI/AT)\(^5\)

- Home Modification / Accessibility Assessments\(^6\)
  - In-Home Occupational Performance Evaluation (I-HOPE)\(^7\)
  - Client-Clinician Assessment Protocol (C-CAP)\(^8\)
  - Comprehensive Assessment and Solution Process for Aging Residents (CASPAR)\(^9\)

- Assistive Technology Assessments
  - Individually Prioritized Problem Assessment (IPPA)\(^10\)
  - Matching Person and Technology (MPT) Assessment\(^11\)
Gaps in Existing Assessments/Outcomes

Lack of assessment/ outcome tools specific to delivery of AT for environmental control (ECU or Smart Home Tech)

- Variability in measurements used to assess the impact of AT use on functional performance and participation
- Variability specificity of task and activities in item bank
- Variability in how functional performance is measured
  - Measures used and sensitivity of rating scale
  - Self report vs. clinician rating
ASSIST FPI Development

1. Review Existing Assessments
2. Develop Draft
3. Content Validation
4. Pilot Testing
5. Test Re-test Reliability

= Revise

- Professional Study Interviews
- Client Study P1: Interviews
- Client Study P2: Testing
AT Outcome Measure Development

**Domain Definition**
- Identify behaviors and traits being measured

**Content Validation**
- Assess items by clarity/importance and revise as needed to finalize version for pilot testing

**One to One Administration**
- Test with a few individuals to check for clarity of wording, directions, rating scales/qualifiers, activities, and cultural relevance → revise as needed

**Field Testing & Analyses**
- Test with larger group, item analyses (factor analyses of subscales, item difficulty/variability), preliminary reliability testing

**Revisions**
- Based on analysis of field testing

**Measure Validation**
- Complete psychometric testing, reliability and validity needed to be considered a valid assessment
Final Item Bank includes 54 items within 5 Domains

- Environmental Control
- ADLs
- IADLs
- Communication and Social Participation
- Leisure

Existing smart home technology that may support a client’s performance has been identified for all activities in the item bank.
ASSIST Functional Performance Index

Outcome Rating Scales and Qualifiers

- Client rating of their **activity performance**
  - Type and amount of assistance amount used to complete task
- Client rating of **difficulty** experienced completing the task
- Client rating of **satisfaction** with activity performance

- Clinician rating of **activity performance**
  - Based on level of assistance provided and safety concerns observed when client performs the task

Combination of self-report and clinician rating to support client centered assessment and intervention model
ASSIST Functional Performance Index

Administration

• **Method:** Computer based via REDCap
• **Time:** 45-60 minutes
• **Process:**

1. Clinician reviews instructions with client
2. Client answers questions to rate their activity performance, difficulty, and satisfaction for each item
3. Review results together, then client selects the top 10 items they want to focus on improving their participation and ranks them highest to lowest priority
4. Clinician assess client's performance for the selected activities and rates their performance based on amount of assistance provided and safety risks observed
5. Clinician reviews and discusses the results with the client and uses shared decision making to select 3-5 items to focus on addressing
### ASSIST Functional Performance Index Draft 1

Follow the next three steps and check the appropriate boxes which best describe your current ability to complete each task below.

<table>
<thead>
<tr>
<th>Task</th>
<th>Need a Box</th>
<th>Complete Physical Assistance (CPA)</th>
<th>FLSA</th>
<th>GMLA</th>
<th>CGSA</th>
<th>RLSA</th>
<th>GLSA</th>
<th>Clinical Physical Assistance</th>
<th>Notes/Tips/Comments</th>
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</thead>
<tbody>
<tr>
<td>Home Access</td>
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<td>Garage Access</td>
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<td>Open and close garage door</td>
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<td>Handling visitors (e.g., attendants)</td>
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<td>Answer doorbell</td>
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<td>Let visitors into the building</td>
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<td>Let visitors into the apartment/house</td>
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<td>Inside door access</td>
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<td>Open/closed hinged door</td>
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<td>Open/closed pocket door</td>
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<td>Turn off/on ceiling lights</td>
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<td>Turn on/off lamps</td>
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<td>Turn on/off outdoor lights</td>
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<td>Turn on/off and adjust thermostat</td>
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<td>Turn on/off and adjust ceiling fan</td>
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<td>Turn on/off and adjust floor/ceiling fan</td>
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<td>Window Control</td>
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<td>Lock/unlock windows</td>
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<td>Open/close windows</td>
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<td>Adjust window treatment</td>
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<td>Rest and Sleep</td>
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<td>Sit up/lay down in bed</td>
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<td>Reposition in bed</td>
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<td>Use of tech and/or apps to support quality of sleep</td>
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</table>

**CLINICAL PERFORMANCE ASSESSMENT**

<table>
<thead>
<tr>
<th>Safety/Behavior</th>
<th>Very satisfied</th>
<th>Satisfied</th>
<th>Neutral</th>
<th>Disatisfied</th>
<th>Very dissatisfied</th>
</tr>
</thead>
</table>

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<table>
<thead>
<tr>
<th>ADL</th>
<th>Items</th>
<th>Notes/Tips/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathing</td>
<td>Turn on/off shower head</td>
<td>Adjust/determine appropriate water temperature</td>
</tr>
<tr>
<td>Grooming</td>
<td>Wash body with soap only</td>
<td>Adjust/determine appropriate water temperature</td>
</tr>
<tr>
<td>Toiletting</td>
<td>Get toothpaste or hand soap out of container</td>
<td>Wash personal care</td>
</tr>
</tbody>
</table>

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**Financial Management**

| BR/TX | Banking and Budgeting | Compose pressure relief as your doctor recommends |

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**Health Management**

| SB/TX | Managing and taking medications | Management of healthcare supplies (ordering, tracking) |

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**Communication and Social Participation**

<table>
<thead>
<tr>
<th>SB/TX</th>
<th>Make a voice call</th>
<th>Send/read text messages</th>
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<tbody>
<tr>
<td></td>
<td>Make a video call</td>
<td>Post/social media networks</td>
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</tbody>
</table>

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**Other Device Use**

| SB/TX | Locate information on the internet | Download and use apps on a mobile device to complete daily activities |
Content Validation

Provider Study Interviews

- Activities providers currently use smart home tech to support client performance
- Review of ASSIT FPI
  - Relevance of task in item bank
  - Relevance of outcomes measures
  - Understandability of instructions and assessment tool form
  - Administration format
  - Any additional feedback

Client Study Interviews

- Activities clients currently have difficulty completing and/or receive assistance from caregiver to complete (paid or unpaid)
- Activities clients use smart home tech to support their performance
Provider Study

Qualitative study conducted to:
- Understand the service delivery methods used by professionals from different disciplines when using mainstream smart home technologies as AT
- Collect feedback on version 1 of the ASSIST Functional Performance Index (AFPI)

Practice Settings
- 6 Home health or community-based services
- 5 Inpatient rehabilitation
- 4 Outpatient rehabilitation
- 6 Independent business
- 1 School

Demographics
15 Participants

Professional Backgrounds
- 8 OT
- 2 SLP
- 1 PT
- 1 RE
- 7 ATP
- 2 Technology Specialist
- 5 Certified Aging-in-Place Specialist
- 2 State AT Program Directors
- 1 Independent Living Specialist

Semi-Structured Interviews
- Individual or focus group of 2-3 providers

Transcription

Thematic Analysis (TA)
- 3 researchers TA separately
- Group discussion & review to identify major & sub-themes
Provider Study Interviews
Support Need for Smart Home
AT Outcome Measure

Theme: Informal service delivery process – Lack of formal outcome and assessment measures

- Despite different roles and professions, professionals tend to start with a similar process which includes considerations of client goals and abilities.
- Only 2 out of 15 professionals used some custom surveys for outcome evaluation.

PT: “We don’t really have any formal way of determining the effectiveness of it. It’s more informal that I try and reach back out to the client two, three, four weeks after to see if it’s working, see if they like it … And honestly, I think that’s one area that we could improve on.”

ATP: “I’ve created a kind of questionnaire that I just go through.”

Tech Specialist “… obviously the challenge is people that don’t know what they don’t know.”

OT: “We would have kind of a process that we would follow. We tried searching for an evaluation that sort of met the needs and we never really found one. My client need sets are so highly variable that I’ve not had a standardized assessment that I bring into it.”

OT: “This was something that we had a challenge taking on in at our organization and we were really trying to find ways to measure these outcomes. And you know, I think some of our outcomes were based on individual experiences and anecdotal in nature. So we implemented kind of data collection using the goal attainment scaling to try to capture outcomes of groups of individuals.”
Provider Study Interviews

Current Smart Home Tech Use in Services

Smart Home Devices Providers Most Commonly Used with Clients
- Smart Doorbell
- Smart Speaker
- Smart Thermostat
- Smart Light Bulb
- Smart Door Lock
- Smart Switch

Additional Smart Home Devices Used with Clients
- Smart Vacuum
- Smart Microwave
- Smart Blinds
- Smart Tech for Medication Management
- Smart Faucets
- Smart Shower
Comprehensive tool to support the assessment process and measure outcomes

"I really liked the different types of parameters and how you're collecting data. I like that it's a self report on performance. I like that you have the satisfaction piece in there too...that satisfaction piece is such an important part... And then I like that there's the clinical observation aspect as well, because that may not always be consistent with how an individual reports their own function."

"I like that you look at what they perceive as their ability to do it for task mastery, and then contrast that and compare that with the clinician's observation."

"The fact that you account for you know, hey, they're doing this, but they're unsafe while they're doing it. That is taking into account one component of it that some measures don't even consider. So, I just wanted to say that I appreciate that a lot."

"It makes sense to me like how it's, how it's laid out and just reading through, like, I can think of like clients, like examples of where many of these different things were applicable in different situations. So, I think it makes sense that it's all captured here."

"It's a pretty comprehensive tool... I think it looks like a great tool to organize your approach when selecting smart technology for an individual."

"I like it though it kind of covers everything that you could see us covering in a home assessment, and just kind of going through the list of things. Yeah I like that it’s really comprehensive. It balances the patient’s their perception, their satisfaction and actual clinical assessment of performance, so it does balance that well."
**Suggested Changes**

- Use laymen's terms for the qualifiers on difficulty and assistance rating scales
- Consolidate home access tasks in item bank
- Consider an adaptive administration format and/or computerized
- Add supervision or verbal cues option to clinician rating scale

### Rating Scale Changes

<table>
<thead>
<tr>
<th>Minimal</th>
<th>→</th>
<th>A Little</th>
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<tbody>
<tr>
<td>Moderate</td>
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<td>Some</td>
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<tr>
<td>Maximal</td>
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<td>A Lot</td>
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### Item Bank Consolidation

<table>
<thead>
<tr>
<th>Environmental Control</th>
<th>Home Entry</th>
<th>Garage Entry</th>
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</thead>
<tbody>
<tr>
<td>Opening and Closing the Main Exterior Door</td>
<td>Opening and Closing the Main Exterior Door</td>
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<tr>
<td>Locking and Unlocking the Main Exterior Door</td>
<td>Opening and Closing the Garage Door</td>
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<tr>
<td>Handling Visitors</td>
<td>Answering the Doorbell</td>
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<tr>
<td>Letting Visitors In Your Home</td>
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<tr>
<td>Lighting Control</td>
<td>Turning On, Off, and/or Dimming the Lights in All Areas of Your Home (Interior/Exterior) That You Want/Need to Control the Lighting</td>
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<tr>
<td>Temperature Control</td>
<td>Controlling the Thermostat to Turn Heating/Cooling On, Off, or Adjust the Temperature</td>
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<tr>
<td>Turning On, Off, and/or Adjusting the Speed of Ceiling or Plug-in Fan(s)</td>
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<tr>
<td>Window Control</td>
<td>Opening and Closing the Windows</td>
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<tr>
<td>Opening, Closing, and/or Adjusting Window Treatments (Curtains or Blinds)</td>
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</table>
Client Study

Mixed-Methods study conducted to:
- Assess content validity of ASSIST Functional Performance Index item bank to ensure the task are
- Assess Test re-test reliability

3-6 sessions conducted via Zoom

Demographics

15 Participants

Ages: 24-76 years old
Gender: 10 female, 5 males

Severe Physical Disabilities
- Cerebral Palsy
- Multiple Sclerosis
- Spinal Cord Injury
- Arthrogryposis
- Multiplex Congenita
- Ehlers Danlos
- Congenital Myasthenic syndrome
- Fibromyalgia

Participants

- Live in residential setting
- Receive home & community-based services waiver
- 33% Live alone and 66% Live with caregiver, parent, spouse or roommate

Semi-Structured Individual Interviews
- Interviews Transcribed
- Thematic Analysis 3 reviewers
- TA used to revise item bank

Pilot Testing
- 4 participants
- Complete test 2x 3-7 days apart, interviews after each

Test Re-Test Reliability Testing
- 15 participants
- Complete test 2x, 3-7 days apart
Client Study

Session 1: Interview

• Semi structured interviews to understand participants
  ▪ Current activity performance and assistance needed or currently utilized
  ▪ Caregiver supports and their impact on activity performance
  ▪ Experience using mainstream smart technologies (smartphones, tablets, computers, and smart home devices)

• Thematic Analysis
  ▪ 3 researchers complete TA separately followed by group discussion and review to identify major & sub-themes

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# Client Study Interviews

## Major Themes

1. Activities that require human assistance
2. Challenges that may be addressed with smart technologies
3. Wide range of current tech usage
4. Influence of comfort & experience
5. Instructions and technical support
6. Concern for cost – impacting access
7. Implications of home environment
8. Influence of Caregivers
9. Value independence
10. Safety & Security

### THEME 1:

**THEME 1:** “The smart plugs are tricky, but interesting and something that could be plugged and unplugged easily, you know? And that might be something that I could use. Like I said, it can’t be a permanent thing because I do rent.”

### THEME 2:

**THEME 2:** “That is an issue. I can’t reach the thermostat for the heat. Oh, I can’t reach the light switch...And the control for my heat I can’t reach that well...Yeah. And in fact, in January I was trying to reach my heat and I was standing up and on my bed and I fell and I broke my collarbone.”

### THEME 3:

**THEME 3:** “And that happens a lot. Last time somebody wasn’t around, um... I had a caregiver who was in the hospital last week. And a period of time when a backup couldn’t get here for a couple of hours. And I had to go to the bathroom. Well eventually nature took its course. Which meant that when somebody did show up, they had to put an extra 45 minutes into their shift to clean up the consequence...And that doesn’t – it’s not good for my health. It’s not good for my dignity. Um... certainly not good for my stress level.”

### THEME 4:

**THEME 4:** “Well, I loved it (ring doorbell) because I was able to see who was at the door. And I was able to see who was at coming up the ramp.”

### THEME 5:

**THEME 5:** “...you know, when it comes to my phone I would rather just go to the store and ask a person, how should I handle this, you know? ...I’m too broad when I ask for information. And I have to spend maybe minutes or, or hours, not hours but a long time searching for one little thing ... I’m not always aware of how to narrow my search down.”

### THEME 6:

**THEME 6:** “I was just gonna say that currently lights are the only thing I have set up. Partially cause of cost. Cause even the lightbulbs alone, per bulb, are pretty expensive compared to the average lightbulb.”

### THEME 7:

**THEME 7:** “The smart plugs are tricky, but interesting and something that could be plugged and unplugged easily, you know? And that might be something that I could use. Like I said, it can’t be a permanent thing because I do rent.”

### THEME 8:

**THEME 8:** “And that happens a lot. Last time somebody wasn’t around, um... I had a caregiver who was in the hospital last week. And a period of time when a backup couldn’t get here for a couple of hours. And I had to go to the bathroom. Well eventually nature took its course. Which meant that when somebody did show up, they had to put an extra 45 minutes into their shift to clean up the consequence...And that doesn’t – it’s not good for my health. It’s not good for my dignity. Um... certainly not good for my stress level.”

### THEME 9:

**THEME 9:** “The water temperature. Oh, cause sometimes like whenever the aid steps out the room sometimes the water ends up getting hotter. And then we go back to get it colder. Like, trying to find the middle. I wish I could find the middle. I had caregivers that just put the cold water, only turned it a little bit and it would be too cold, or it gets burnt. Cold and hot. That’s it. For me that’s hard.”

### THEME 10:

**THEME 10:** “Yeah, and I hear a lot about you have to be careful what you say because it records what you say....I don’t know if that’s true. Like she has asked me to learn my name, and I said... I decline it all the time because I’m afraid... you know. I don’t know, maybe I’m overcautious or what but...Right. And I’m just very wary of those kinds of things so I decline it all the time.”

### THEME 11:

**THEME 11:** “I was just gonna say that currently lights are the only thing I have set up. Partially cause of cost. Cause even the lightbulbs alone, per bulb, are pretty expensive compared to the average lightbulb.”
Over 90% of the tasks included our item bank were mentioned as tasks clients currently require assistance to complete, have difficulty completing, or currently use smart home technology to complete the task.

**Common Tasks Users Received Assistance with or Have Difficulty Completing**

- Environmental Control Tasks
- Vacuuming & Mopping
- ADLs

**Most Common Tasks Clients Currently Use Smart Home Tech to Complete**

- Smart Speaker
- Smart Tech for TV Control
- Smart Light Bulb

**Task Removed from Item Bank**

- Open/Close Interior Doors
- Cut grass/ Maintain Lawn
- Clear snow from sidewalks in winter months

**Task Added to the Item Bank**

- Charging phone, tablet and/or computer
Client Study

Pilot Testing

- 4 participants
- Completed ASSIST Functional Performance Index twice, 3-7 days apart
- Completed via REDCap
- Clinician provided instructions on completing the assessment and was present throughout to assist as needed

Step 1

Entering and Exiting Your Home

Do you have difficulty or require assistance entering and exiting your home from the main exterior door?

(Check all that apply)
* must provide value

- Yes, with locking and unlocking the main exterior door
- Yes, with opening and closing the main exterior door
- Yes, with home entry tasks that are not listed above
- No, I do not have difficulty or require assistance with home entry

Step 2

Which answer best describes your current ability to lock and unlock the main exterior door of your home?

* must provide value

- I require complete physical assistance
- I require a lot of physical assistance
- I require a little physical assistance
- I do not require physical assistance but have a lot of difficulty completing this task on my own
- I do not require physical assistance but have a little difficulty completing this task on my own

Do you currently use any assistive technology/device(s) to lock and unlock the main exterior door of your home?

* must provide value

- Yes
- No

Which answer best describes your current level of satisfaction with your ability to lock and unlock the main exterior door of your home?

* must provide value

- Very Satisfied
- Satisfied
- Dissatisfied
- Very Dissatisfied
Client Study Pilot Testing

Changes Based on Results and Client Feedback

Problems

• Demonstrated difficulty rating level of assistance or difficulty associated with task performance
  • Suggested adding percentages to help quantify a little and a lot of on rating scales
• Confusion regarding what context the participant should be rating their performance
• Confusion if assistive technology use included mainstream technology
• Item Bank Clarity Concerns
  • Self-management
  • Lighting Control
  • Completing Shopping Trip
  • Sleep

Revisions

• Restructure question format and sequence
• Improve clarity of instructions
  • Revised rating scale explanations and added qualifiers
  • Performance is to be rated based on how the client most commonly performs the task
  • Use of Technology is complete a task includes AT and mainstream technology devices
• Expandable help buttons added under question prompts to view explanations of rating scales as needed
• Item Bank Revisions
  • Defined self management and provided examples tasks
  • Added to cue to consider all areas of home
  • Split shopping into 2 task: online & shopping in a store
  • Sleep Task removed
Updated ASSIST Functional Performance Index
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<th>Assistance Type Selected</th>
<th>Level of Difficulty Selected</th>
<th>SCORE</th>
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<tr>
<td>Not Completed</td>
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<td>Complete human assistance</td>
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<tr>
<td>with or without non-human assistance</td>
<td>+ some difficulty</td>
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<td>+ a little difficulty</td>
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<td>with or without non-human assistance</td>
<td>+ some difficulty</td>
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<td>+ a little difficulty</td>
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<td></td>
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<tr>
<td>Some human assistance</td>
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</tr>
<tr>
<td>with or without non-human assistance</td>
<td>+ some difficulty</td>
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<td>+ a little difficulty</td>
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<tr>
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<tr>
<td>OR</td>
<td>+ some difficulty</td>
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<tr>
<td>No assistance</td>
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</tr>
<tr>
<td></td>
<td>+ no difficulty</td>
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</table>
Use of the ASSIST Functional Performance Index to support Assessment Process for using Smart Home Tech as AT

Understand Clients Baseline Functional Performance

Identify tasks which existing smart home technologies may improve functional performance

Supplemental ASSIST Environmental Characteristics Evaluation Checklist (in development)
Next Research Steps

In Progress

- Test re-test reliability testing
  - Intra-class correlation (ICC) coefficient of at least 0.75.

Planned

- ASSIST Pilot study
  - Use of ASSIST Functional Performance Index to support assessment and measure intervention outcomes

Future Directions

- Further psychometric testing with larger sample size
Questions?

Contact Us

https://assistdrrp.pitt.edu

dad5@pitt.edu
llm65@pitt.edu
References