EXPERIENCES OF INDIVIDUALS WITH HIGH SPINAL CORD INJURY USING SMART HOME TECHNOLOGY: AN INTERVIEW STUDY

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Pre-Dissertation Project Defense

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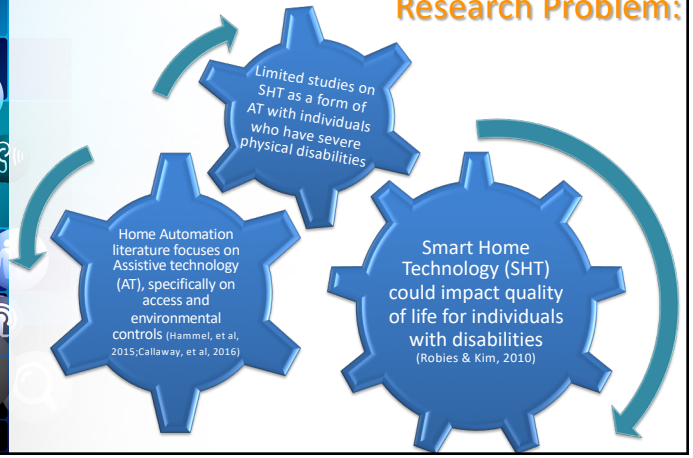
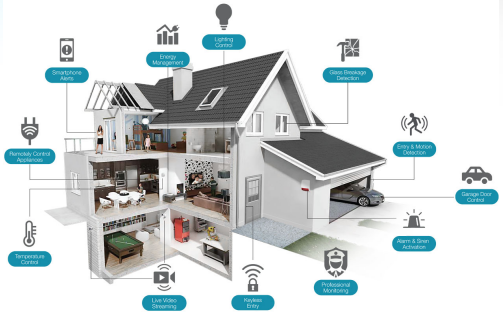
Research Problem:



Purpose:

- Experiences and perceptions of Super Users of Smart Home Technology
  - Deeper story of how Smart Home Technology has impacted their lives
  - Gain an understanding of interaction with Smart Home Technology

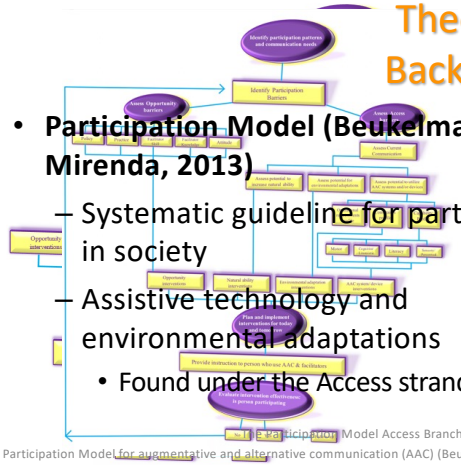
Smart Home Technology:



Smart Home Technology– the integration of home automation systems and services (Robies & Kim, 2010)

- Thermostats
- Smoke alarms
- Wireless speakers
- Security systems
- Lighting

Theoretical Background:



- **Participation Model (Beukelman & Mirenda, 2013)**
  - Systematic guideline for participation in society
  - Assistive technology and environmental adaptations
    - Found under the Access strand

The Participation Model Access Branch (Beukelman & Mirenda, 1988)

The Participation Model for augmentative and alternative communication (AAC) (Beukelman & Mirenda, 1988)

Theoretical Background:

- **Human Activity Assistive Technology (HAAT) Model (Cook & Hussey, 1995)**
  - Overlaps with the Participation model

The human activity assistive technology (HAAT) model and components (Cook & Hussey, 1995)

Research Questions

What skills and abilities are required of individuals with severe physical disabilities to use Smart Home Technology?

What elements of assistive technology (i.e., human-technology interface, activity output, processors and environmental interfaces) are supported by the SHT products being used by individuals with severe physical disabilities?

Central Questions:

What are the experiences of individuals with severe physical disabilities, resulting from a high spinal cord injury, who use Smart Home Technology (SHT)?

What are their perceptions on the impact of SHT on quality of life and increased independence?

How has SHT improved self-care, productivity and leisure activities for individuals with severe physical disabilities?

How is SHT impacting the physical, social, cultural and institutional contexts in which individuals with severe physical disabilities interact?

Method: Participants

- 9 Participants
  - All male
  - 1 withdrew from study
- 3 in person interviews, 5 online interviews

	Participants Age (Years)	Year Acquired Injury	Length of Injury (years)
Mean	42.25	2003.25	14.75
Standard Deviation	13.36	12.41	12.41
Range	26-62	1984-2016	2-34

Methods: Participants

Participant	Age	Spinal Cord Injury level	Year of Injury	Length of Injury (Years)	Location	Mini Mental Severity*	Use of Smart Home Technology (months)
Jorden	26	C3/C4 incomplete	2016	2	Grindstone, PA	No Cognitive Impairment	> 12 months
Spencer	30	C4	2008	10	Cantonment, FL	No Cognitive Impairment	> 12 months
Christopher	32	C4	2014	4	Orlando, FL	No Cognitive Impairment	> 12 months
Ryan	39	C4	1995	23	Coral Springs, FL	No Cognitive Impairment	> 12 months
Dave	40	C6	2011	7	Beaverton, OR	No Cognitive Impairment	> 12 months
Patrick	51	T1 w/weak right hand	1988	30	Dallas, GA	No Cognitive Impairment	> 12 months
Mark	58	C 5-C 6 incomplete	1984	34	Apollo, PA	Mild Cognitive Impairment	> 12 months
Joe	62	C4	2010	8	Powell, OH	Mild Cognitive Impairment	> 12 months
Scott	Withdrew from Study						

Methods: Procedure

(Rubin & Rubin, 2012; Kvale, 1996; Patton, 1990)

Method: Instruments

- Demographics & Screening Questionnaire
  - Used to collect information to determine whether individuals meet participant criteria
    - Information about individuals acquired disabilities
    - What Smart Home Technology they are using
    - How long they have used Smart Home Technology

Method: Instruments

- Level of Independence Scale
  - Formal measure of participants level of independence
  - Compared eight different activities of daily living for three levels of assistance

Adapted from the FIM measure (Keith, 1987) and the Katz Index of Independence (Brorsson, 1984)

Method: Instruments

- Comfort of Technology Use Scale/Questionnaire
  - Created to obtain rating of a participants comfort with three technology skills
  - Used a 6-scale rating system
    - Extremely comfortable (EC)
    - Moderately comfortable (MC)
    - Neutral comfort level (NCL)
    - Not applicable (NA)
    - Moderately uncomfortable (MUC)
    - Extremely uncomfortable (EUC)

Adapted from U. Schroeders and O. Wilhelm's Computer Usage questionnaire (2011) and S.W. Edison & G.L. Geissler's adapted scale Measuring Attitudes Toward General Technology (2003)

Method: Instruments

- Mini Mental State Examination
  - Cognitive assessment
    - Given to provide more perspective of participants profile
  - Three items were not administered and given an automatic score of zero due to physical requirements
    - "Take the paper in your right hand, fold it in half, and put it on the floor"
  - Participant scores
    - No cognitive impairment (n = 6)
    - Mild cognitive impairment (n = 2)

(Folstein, Folstein, McHugh, 1975)

Method: Instruments

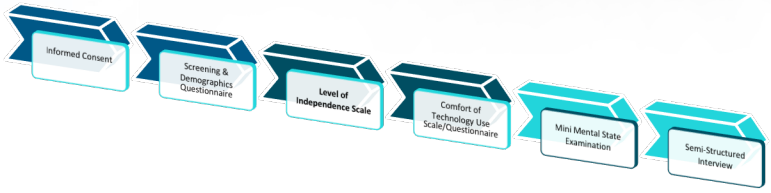
- Semi-Structured Interview
  - All interviews were done in participants homes
  - Video and audio recorded for data collection purposes
  - An overview of how the interview would be conducted was provided

(Rubin & Rubin, 2012; Kvale, 1996; Patton, 1990; Folstein, Folstein, McHugh, 1975)

Interview Script:

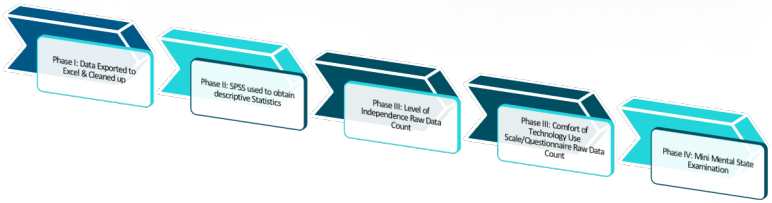
- Same script/flow of questions were used for both the online and in-person interviews
  - Questions to describe the participant
  - Questions to address the four components of the HAAT model
    - *Human Component*
    - *Activity Component*
    - *Assistive Technology Component*
    - *Context Component*
  - Participants were given $25.00 as compensation for their participation in the study

Methods: Procedure

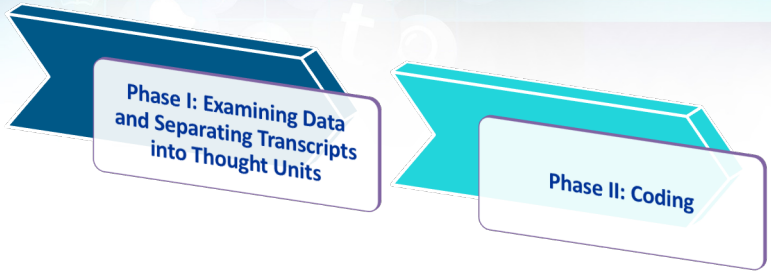


(Rubin & Rubin, 2012; Kvale, 1996; Patton, 1990)

Methods: Procedure



Methods: Qualitative Data Analysis



(Rubin & Rubin, 2012; Kvale, 1996; Patton, 1990)

Quantitative Results:

- The Level of Independence Scale
  - Pre-Injury
    - 8/8 participants reported complete independent with no assistance from a helper for all 8 activities of daily living
  - Post injury
    - 4/8 participants reported complete independence with no assistance for 4 activities of daily living

Level of Independence Results

Activity of Daily Living	PRIOR: Total Assistance with Helper	AFTER: Total Assistance with Helper	PRIOR: Modified Independence with NO helper	AFTER: Modified Independence with NO helper	PRIOR: Complete Independence with NO helper	AFTER: Complete Independence with NO helper
Turning on the Lights	0%	12.5%	0%	37.5%	100.0%	50.0%
Adjusting the Temperature	0%	25.0%	0%	25.0%	100.0%	50.0%
Turning on the Television	0%	25.0%	0%	25.0%	100.0%	50.0%
Listening to Music	0%	12.5%	0%	25.0%	100.0%	62.5%
Opening the Door	0%	25.0%	0%	25.0%	100.0%	50.0%
Running the Vacuum	0%	50.0%	0%	25.0%	100.0%	0%
Running the Washing Machine	0%	62.5%	0%	0%	100.0%	12.5%
Turning on the Oven	0%	62.5%	0%	0%	100.0%	25.0%

*Adapted from the FIM measure (Keith, 1987) and the Katz Index of Independence (Brorsson, 1984).

Quantitative Results:

- The Comfort Level of Technology Scale
- Prior to injury
  - 3/8 participants (32.5%) rated themselves “extremely comfortable,”
  - 4/8 rated themselves “not applicable” (50%)
  - 1/8 rated himself a “neutral comfort level” (12.5%)
- After their injury
  - 7/8 participants (78.5%) rated themselves “extremely comfortable”
  - 1/8rated himself “moderately comfortable” (12.5%) for updating voice-controlled speakers.

Comfort Level of Technology Scale: Updating

Participant	PRIOR: Updating software for computer systems	AFTER: Updating software for computer systems	PRIOR: Updating software for mobile technology (i.e., cell phones, tablets, etc.)	AFTER: Updating software for mobile technology (i.e., cell phones, tablets, etc.)	PRIOR: Updating software in voice-controlled speakers	AFTER: Updating software in voice-controlled speakers
Joseph	EC	EC	EC	EC	EC	EC
Mark	NA	EC	NA	EC	NA	EC
Jorden	N	MC	EC	EC	NA	MC
Ryan	NA	EC	NA	EC	NA	EC
Spencer	EC	EC	EC	EC	EC	EC
Christopher	EC	EC	EC	EC	EC	EC
Patrick	MC	EC	NA	EC	NA	EC
Dave	EC	EC	N	EC	N	EC

**EC = Extremely Comfortable; MC= Moderately Comfortable; N = Neutral NA = Not Applicable; MUC = Moderately uncomfortable; EUC = Extremely Uncomfortable;

***Adapted from U. Schroeders and O. Wilhelm's Computer Usage questionnaire (2011) and S.W. Edison & G.L. Geissler's adapted scale Measuring Attitudes Toward General Technology (2003).

Comfort Level of Technology Scale: Backing Up & Troubleshooting

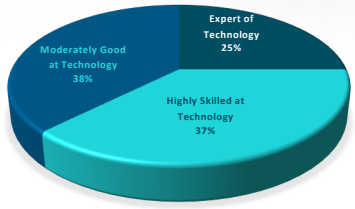
Participant	PRIOR: Backing up Devices	AFTER: Backing up Devices	PRIOR: Trouble-shooting software issues	AFTER: Trouble-shooting software issues	PRIOR: Trouble-shooting hardware issues	AFTER: Trouble-shooting hardware issues
Joseph	EC	EC	EC	EC	EC	MUC
Mark	NA	EC	NA	EC	EUC	EC
Jorden	MC	MC	MUC	MUC	MC	MUC
Ryan	NA	EC	NA	EC	NA	EC
Spencer	EC	EC	EC	EC	MC	MUC
Christopher	EC	EC	*	EC	EC	EUC
Patrick	MC	EC	MC	EC	MUC	MC
Dave	EC	EC	EC	EC	EC	EC

*Participant typed in Comfortable.

**EC = Extremely Comfortable; MC= Moderately Comfortable; N = Neutral NA = Not Applicable; MUC = Moderately uncomfortable; EUC = Extremely Uncomfortable;

***Adapted from U. Schroeders and O. Wilhelm's Computer Usage questionnaire (2011) and S.W. Edison & G.L. Geissler's adapted scale Measuring Attitudes Toward General Technology (2003).

Comfort Level of Technology Scale



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Participants self-rating of their level of technology

*One participant indicated *Highly Skilled* for modern technology (i.e., computers and mobile technology devices)

Qualitative Results:

- Main themes:
  - *Participant History* (570 thought units)
  - *Benefits of Smart Home Technology* (158 thought units)
  - *Challenges of Smart Home Technology* (185 thought units)
  - *Future Directions and Products* (85 thought units)
  - *Social Support* (136 thought units)
  - *Other Thoughts* (153 thought units)

Qualitative Results:

- Four major themes related to the 4 components of the HAAT model
  - *Benefits of Smart Home*
  - *Challenges of Smart Home Technology*
  - *Future Directions and Products*
  - *Social Support.*

Counts and Percentages

Major Theme		Human Component	Activity Component	Assistive Technology Component	Context Component
Benefits of Smart Home Technology	Count	59/158	30/158	62/158	59/158
	Percentage	37.34%	18.99%	39.24%	37.34%
Challenges of Smart Home Technology	Count	16/185	3/185	120/185	59/185
	Percentage	8.65%	1.62%	64.86%	37.34%
Future Directions and Products	Count	6/85	0/85	67/85	12/85
	Percentage	7.06%	0%	78.82%	14.12%
Social Support	Count	15/136	0/136	0/136	121/136
	Percentage	11.03%	0%	0%	88.97%

Human Component:

- All 8 Participants mentioned a *Benefit of Smart Home Technology*
- *7* out of 8 participants mentioned the *Challenges of Smart Home Technology*
- *1* participant mentioned the *Future Directions and Products*
- *1* participant mentioned the *Social Support*

Human Component

Participant	Benefits of Smart Home Technology	Challenges of Smart Home Technology	Future Directions and Products	Social Support
Jorden	x			
Spencer	x	x		
Christopher	x	x		
Ryan	x	x		
Dave	x	x		
Patrick	x	x		
Mark	x	x		
Joe	x	x	x	x

Human Component

"I guess uh I just laugh cause when we were kids right you had to call your smart uncle and now you have Google." -Patrick

"Yeah the only thing I do not have now um actually my house got flooded like 4 years ago so all the…we had a flood over here and um so all my stuff got destroyed." -Spencer

"The costs of the switch far exceed of the- of the savings you'll get." -Joe

"I've always been kinda a techie so I kind of well actually I had it before my accident at our oth- at our previous house." -Joe

Activity Component:

- 7 out of 8 Participants mentioned a *Benefit of Smart Home Technology*
- *2* out of 8 participants mentioned the *Challenges of Smart Home Technology*
- *0* participants mentioned the *Future Directions and Products*
- *0* participant mentioned the *Social Support*

Activity Component:

Participant	Benefits of Smart Home Technology	Challenges of Smart Home Technology	Future Directions and Products	Social Support
Jorden				
Spencer	x	x		
Christopher	x			
Ryan	x	x		
Dave	x			
Patrick	x			
Mark	x			
Joe	x			

Activity Component

"…but with the, with the Apple Watch on my wrist I uh, get feedback through it. Uh, Same thing with driving, it (Apple Watch) vibrates before every, every turn coming up so I know that um, I don't have to always have you know the Siri assistant um, you know shouting orders at me, I can kind of leave stuff muted and the music on and still be able to uh navigate, so…." - Dave

"…especially like here living in Florida during the summer I got the ceiling thing [fan] going on and the AC going on and if the AC is off and I turn the ceiling fan off and then I try to get her [Alexa] to turn the ceiling fan on…" - Ryan

Assistive Technology Component:

- 6 out of 8 Participants mentioned a *Benefit of Smart Home Technology*
- *8* out of 8 participants mentioned the *Challenges of Smart Home Technology*
- *8* out of 8 participants mentioned the *Future Directions and Products*
- *0* participant mentioned the *Social Support*

Assistive Technology Component:

Participants	Benefits of Smart Home Technology	Challenges of Smart Home Technology	Future Directions and Products	Social Support
Jorden		x	x	
Spencer	x	x	x	
Christopher	x	x	x	
Ryan	x	x	x	
Dave		x	x	
Patrick	x	x	x	
Mark	x	x	x	
Joe	x	x	x	

Assistive Technology Component

"Yeah. Uh some of it still works off of uh Bluetooth, which is directly uh communicates between your smart phone and your device." - Mark

"So what do I need to do, if I really was a YouTube person and I wanted to speak to it (YouTube), I'd have to go buy a Google assistant with a screen and watch YouTube. I think that's a bit ridiculous but then like Amazon won't sell Google stuff and won't sell Apple stuff it would be great, but you know it's all about making dividends. And who can be the number one billionaire every quarter." -Ryan

"Um I guess you know instead of being able to a have to put a google home or Alexa in the room if those could be built right into the TV or something like…I mean they are building everything else in the TV why not that." -Patrick

Context Component:

- 3 out of 8 Participants mentioned a *Benefit of Smart Home Technology*
- *8* out of 8 participants mentioned the *Challenges of Smart Home Technology*
- *2* out of 8 participants mentioned the *Future Directions and Products*
- *8* participant mentioned the *Social Support*

Context Component:

Participants	Benefits of Smart Home Technology	Challenges of Smart Home Technology	Future Directions and Products	Social Support
Jorden		x		x
Spencer	x	x		x
Christopher		x		x
Ryan	x	x	x	x
Dave		x		x
Patrick	x	x		x
Mark		x		x
Joe		x	x	x

Context Component

"...and you know since I work out of the house I don't drive the truck every day, so if we're gonna take off and go to my daughter's home on the other side of Atlanta it's nice to look in there and go oop how much gas is left in the truck or you know so that part is very cool."
- Patrick

"So I have to have someone um, you know reset it and reconnect it for me."
-Jorden

"I mean there- there I mean, obviously there's a- there should be a field for consultants that specialize in all the adaption there's a lot of those, but smart home adaptions I mean there's a lot of you know... and a grab bar, uh yeah you can find those {individuals who install adapted equipment} all over Columbus or Ohio, but go out and find a smart home consultant- Then you could hire to bring into your home, I don't know, I think it'd be hard to find." -Joe

"Uh, the first time when, when I was in rehab at Children's Institute. Kate was my Speech therapist and then I had uh, oh geeze, um. [Kate brought in Smart Home Technology?] Yeah, she, she did? (Kate) Her and um, she had an intern that worked with her at the time."
-Jorden

Participant Main Theme

- Four areas under *Participant History*
  - Accessing Smart Home Technology
  - Funding technology
  - Employment
  - Environments participants are using Smart Home Technology

Participant Main Theme: Access

- Accessing Smart Home Technology
  - All 8 participants are using their voice
  - 6 out of 8 participants are using direct selection

Participant Main Theme: Funding

- Funding technology
  - 7 out of 8 participants are independently funding
  - 1 out of 8 are utilizing State funding

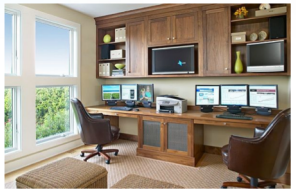
Participant Main Theme: Employment

- Employment
  - Prior to Injury:
    - All 8 were employed
  - After Injury:
    - 4 out of 8 participants are currently employed part-time
    - 5 out of 8 participants volunteer

Participant Main Theme: Employment

"And In fact I just went through an issues with the new job that I just got for an at home call service, where they had all of the accessibility features locked, so I had to go through HR and through there accom, uh accessible accommodation, reasonable accommodation department and I had been back and forth with them, they ended up pulling me from the program and I told them I didn't want to be pulled from the program I wanted to work, I just need to be able to access their systems if they would just let me use my systems (Smart Home Technology and assistive technology adaptations), I'd be fine. I have speech recognition, I have drag {dragon}, like I ,I have all of that, but they wouldn't let me use their systems because of their security features, which is understandable. So then after it was all done and said, they switched me to another program where I could bring my own computer, but had I had some of that adapted technology, like uh the adaptive USB mouse that plugs directly in, cause right now what I use is my wheelchair." -Chris

Participant Main Theme: Environment



- Environments participants are using Smart Home Technology
  - All 8 participants are using Smart Home Technology in the Home
  - 2 out of 8 participants indicated they they work out of their home
  - 1 out of 8 participants indicated they work out of an office and a home office

Participant Main Theme

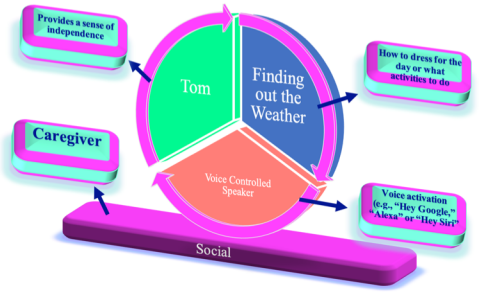
Participant	Interface Access of Smart Home Technology			Funding of Smart Home Technology		Employment			Environment Using Smart Home Technology In	
	Voice Control	Direct Selection	Switch Access	Independently	State funding	Previously Employed	Currently Employed	Volunteering	Home	Work
Jorden	X		X	X		X			X	
Spencer	X		X		X	X	X	X	X	X *
Christopher	X	X		X		X	X	X	X	*
Ryan	X	X		X		X		X	X	
Dave	X	X		X		X		X	X	
Patrick	X	X		X		X	X		X	
Mark	X	X		X		X		X	X	
Joe	X	X		X		X	X		X	*

Note. X indicates that the participant made a statement related to the given theme during the semi-structured interview, X* indicates work out of office and home office and * indicates participants stated they work out of their home.

Discussion: Theory

- Smart Home Technology aligns with the HAAT Model
  - Allows SLPs to feature matching a piece of Smart Home Technology for an individual
  - Benefits and Challenges of Smart Home Technology fell into all 4 components
  - Activities and Assistive technology have the potential to be better represented as technology advances

Smart Home Technology & HAAT Model



Example of the HAAT model completed for an individual (Cook & Hussey, 1995)

Discussion: Benefits

- Benefits of Smart Home Technology
  - Universal Design
    - Increases an individuals quality of life
    - Provides normalcy back to an individual

Discussion: Benefits (Activities)

- Variety of activities completed by Smart Home Technology
  - 1 Participant was responsible for vacuuming, a benefit to his wife
  - 1 participant uses Smart Home Technology to regulate watering his lawn

Discussion: Challenges

- Product cycle of Smart Home Technology
  - Short
  - New generations come out and may or may not be compatible with previous models
  - Serious challenge financially
  - Participants expressed the technology was already outdated or didn't work as intended

Discussion: Challenges

- Lack of Manufacturer Connectivity
  - Limitations between products
    - Accessing YouTube via Amazon Products
  - Study revealed that individuals with disabilities want to apply for positions at these companies to advance the accessibility features better

Discussion: Social

- Social Connectedness
  - Some participants interact with their artificial intelligent assistant like they would friends
    - 1 participant indicated his AI swore at him
  - Participants are expanding their knowledge base in a conversational way by querying a digital assistant
    - 2 participants provided feedback on the trivia feature and jokes

Discussion: Social

- Social Connectedness
  - Use of Amazon Dot to venture into the community
    - 1 participant discussed putting a Dot on his wheelchair and connecting to neighbors WIFI
    - Allowing individuals to interact more with their neighbors

AAC Implications

- Potential for Individuals with severe communication disorders
  - Social connectedness
    - increase communication opportunities
  - A sense of purpose
  - Allow them to be productive
  - Maximize their leisure skills
  - Empower them

AAC Implications

- Challenges for SLPs
  - Support with setup
  - Troubleshooting when technology doesn't work
  - Smart Home Technology potentially allows for Returning to work
  - Is this our Role?
  - Billing?
  - Funding?

Limitations

- Majority of Participants were from the east coast
- Funding information is determined by each state of residency
- Limitation of funding for all in-person interviews
- Study was done with Successful Users of Smart Home Technology
- Level of Technology Scale bias

Future Research

- Smart Home Technology & Speech Generating Devices
  - Signal to noise ratio
  - Volume levels
  - Male vs. female synthesized voices
  - English vs. British synthesized voices
- Intervention of Smart Home Technology with individuals who use SGDs
- Interprofessional Practice Study
  - Whose Role is it?
  - Exploring the grey areas

Conclusion:

Smart Home Technology has challenges; however, the benefits, future direction and social support outweigh the challenges when individuals with disabilities gain normalcy and quality of life.

Conclusion:

References:

- Beukelman, D. R. & Mirenda, P. (2013). *Augmentative & Alternative Communication Supporting Children and Adults with Complex Communication Needs, 4th ed.* Baltimore: Paul H. Brookes Publishing Co.
- Callaway, L., Tregloan, K., Williams, G., & Clark, R. (2016). Evaluating Access and Mobility within a New Model of Supported Housing for People with Neurotrauma: A Pilot Study. *Brain Impairment,* 17(1), 64-76. doi:10.1017/BrImp.2016.7
- Cook, A.M. & Hussey, S.M. (1995). *Assistive Technologies: Principles and Practice, 1st ed.* St. Louis: Mosby, Elsevier Inc.
- Cook, A.M. & Polgar, J.M. (2015). *Assistive Technologies: Principles and Practice, 4th ed.* St. Louis: Mosby, Elsevier Inc.
- Hammel, J., Magasi, S., Heinemann, A., Gray, D. B., Stark, S., Kisala, P., & ... Hahn, E. A. (2015). Original research: Environmental Barriers and Supports to Everyday Participation: A Qualitative Insider Perspective from People with Disabilities. *Archives of Physical Medicine and Rehabilitation*, 96578-588. doi:10.1016/j.apmr.2014.12.008

References:

- Kvale, S. (1996). Interviews: An introduction to qualitative research interviewing. Thousand Oaks, CA: SAGE Publications.
- National Spinal Cord Injury Statistical Center, Facts and Figures at a Glance. Birmingham, AL: University of Alabama at Birmingham, 2017.
- Patton, M.Q. (1990). Qualitative evaluation and research methods. Thousand Oaks, CA: SAGE Publication.
- Robies, R., & Kim, T. (2010). Applications, systems and methods in smart home technology: A review. *International Journal of Advanced Sciences and Technology*, 15, 37-48.
- Rubin, H.J. & Rubin, I.S. (2012). *Qualitative Interviewing: The art of hearing data*. (3rd edition). Thousand Oaks, CA. Sage Publications Inc.