Exploring learning heuristics for adopting new technology to assist with activities of daily living (ADL): Results of qualitative analysis using Nvivo 8 software

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Introduction

Background

On April 21, 2009 a focus group was held at the Orlando Health Rehabilitation Institute to explore the process by which persons with Traumatic Spinal Cord Injury (TSCI) learn new assistive technologies (AT) designed to assist with activities of daily living (ADL).

The focus group was conducted as part of the Robotic Manipulator (MANUS) for Improved Independent Function study led by Principal Investigators Dr. Aman Behal of the NanoScience Technology Center and the College of Engineering at the University of Central Florida (UCF), and Dr. David Portee of the Orlando Health Rehabilitation Institute. Dr. John Bricout of the UCF School of Social Work in the College of Health and Public Affairs (COHPA) joined this interdisciplinary effort as a research collaborator focused on integrating the social dimensions of the human-computer interaction in the MANUS project, beginning with a focus group aimed at exploring the learning heuristics of persons with TSCI. The focus group was facilitated by Drs. Aman Behal, John Bricout, and Dae-Jin Kim. Preliminary focus group data informed exit survey questions targeting future MANUS design and implementation improvements, while the full analysis contained in this report will be used both to inform future training protocols, and to guide follow-up focus groups.

The learning heuristics and social learning patterns of persons with TSCI, within the context of assistive technology adaptation, are complex. Both heuristics and social learning draw upon previous experiences and integrate new information using cognitive, motor, and social skills.

Participants

Focus group participants were purposefully recruited from the Orlando Health Rehabilitation Institute from the MANUS project, thus providing information on the learning heuristics of a subgroup of MANUS participants. The focus group included four participants with TSCI of varying ethnic backgrounds, ages, and levels of functional impairment. Two of the participants reported quadriplegic injury levels of C5-C6 complete. One participant reported a quadriplegic injury level of C5-C6 incomplete and one participant reported a quadriplegic injury level of C6-C7 complete. A large range was observed in participant onset of spinal injury, ranging from 4 to 33 years. Two participants reported having a quadriplegic status for four years while the other two reported 32 to 33 years. Sample representativeness is not a great concern in the current analysis, given the objective of the focus group was to gather initial information on this TSCI subpopulation's learning of AT as a means of furthering the design of an effective training program for the MANUS project.

Research Framework

Objective

The focus group and subsequent qualitative analysis were conducted to explore the process by which persons with Traumatic Spinal Cord Injury (TSCI) learn new assistive technologies (AT).

Sensitizing Concepts

Originally used by Blumer (1954), sensitizing concepts are constructs or organizing ideas that guide the qualitative researcher in their analysis (Holloway, 1997). The researchers utilized three main sensitizing concepts to guide research efforts: 1) Heuristics, 2) Technological

Adaptation, and 3) Social Learning through Networks. The heuristics of persons with TSCI was included as a sensitizing concept in order to examine ‘rules of thumb’ utilized in learning and adapting to new AT. In other words this analysis was interested in examining the technique persons with TSCI use to self educate. Technological adaptation was included to guide the researchers thinking about the tool and personal modification, completed as a means of integrating AT, undertaken by the person with TSCI. Social learning through networks was of specific interest to the analysis due to the probable use of social learning and networking in the heuristic process of persons with TSCI.

Thematic Questions

Several thematic questions were asked during focus group proceedings, stemming from the study framework and sensitizing concepts. The purpose of the questions was to gather information on the heuristics used by persons with TSCI, the adaptations utilized by persons with TSCI, and the social learning networks accessed by persons with TSCI.

Questions included:

1) When you are getting used to a new technology, how do you learn the ins and outs of use?
2) When you encounter a glitch, how do you problem solve it?
3) To whom or to what do you typically turn?
4) What are some things that make learning a new technology easier?
5) Thinking about the time and energy it takes to get the hang of a new technology, how long do you like to go at it before taking a break (level of discomfort and/or clock time)?
6) How have you adapted new assistive technology to best suit your needs?

Analysis Procedure

The focus group audio recording was transcribed by Josh Treadway, Research Assistant, Assistive Robotics Laboratory, UCF. To increase the reliability of the written transcription cleaning of the transcript was conducted by COHPA Public Affairs Ph.D. candidate Rebekah Hazlett prior to the process of coding. This initial step involved reviewing the focus group transcript and audio file.

This analysis utilized Nvivo version 8 software (QSR International, 2008). This research process involved developing and executing a coding process which was completed through topic coding. Topic coding, one of three main coding approaches used with Nvivo, assigns conceptual references within the text source to the categories to which they relate as determined by the researcher (QSR International, 2007). Coding in Nvivo is completed through the application of coding "nodes". Coding node exist in several forms. Tree nodes are used to code overarching concepts within the source with may have related ancillary concepts. Within the analysis related concepts branch off from tree nodes and are referred to as child nodes. Free nodes are independent codes which are unrelated to other concepts in the analysis. The use of free nodes allows the researcher to take a broad look at the data and then move towards specified and refined coding categories. Nvivo allows the researcher to transform free nodes into new or existing tree and child nodes when a relationships or redundancy is noted.

Preliminary Coding

Following a review of the transcript a preliminary coding sequence was created as guided by the sensitizing concepts and thematic questions. Table 1 provides a description of the preliminary coding sequence employed by the researcher. Please note that all codes are either tree or child nodes.

Table 1: Preliminary Coding for Focus Group on Learning Heuristics

Related Sensitizing Concept (SC) or Thematic Question (TQ)	Tree Node (Parent Node)	Child Node Level A	Child Node Level B	Operationalization
SC 2 TQ 2 & 6	Adaptation			The participants' report of adaptation. Adaptation may be of self or the AT.
		Self-Adapt		The participants' report of adaptation of the self to the AT, including the personal and physical interaction of the person with TSCI with the tool.
		Tool-Adapt		The participants' report of a physical adaptation or modification of the tool by (or requested by) the person with TSCI.
SC 1 TQ 1, 4, & 6	Heuristic			The participants' report of any method that involves or serves to aid the learning of AT.
		Observation		The participants' report of watching a formal or informal demonstration of how to use the AT.
		Practice		The participants' report of applying knowledge gained from experience, Trial & Error, instruction, or advice as a means of learning the AT.
		Problem Solving		The participants' report of any means of solving a glitch or problem encountered with the AT.
		Seeking Advice or Feedback		The participants' report of seeking information sources outside of self and own experience.
			Client to Server	The participants' report of contacting the AT supplier or maker for information on AT.
			Online	The participants' report of accessing an online source for information on AT.
			Peer to Peer	The participants' report of contacting a TSCI peer for information on AT.
		Training		The participants' report of attending a formal or informal training on AT.
		Trial and Error		The participants' report of trial and error, persistence, just trying it without previous knowledge.
SC 3 TQ 1, 2, & 3	Social Learning			The participants' report of AT learning and interaction within the social environment.
		Community or Network		The participants' social environment.
			Face to Face	The participants' reported personal contacts (phone or in person).
			Online	The participants' reported contacts via online community and social networks.

Coding Iterations

Preliminary coding of the transcript source was completed using Nvivo software. Three coding iterations were completed in order to further refine the coding nodes as the data story emerged. Table 2 shows coding additions and alternations within the first iteration. The main change within the first iteration was the addition of free nodes as a means of broadly examining the data and addressing emergent themes. Please see Table 1 for the operationalization of previously defined codes.

Table 2: Coding Changes with Iteration-I.

Free Node Addition	Operationalization
Barriers and Challenges	The participants' report of barriers to the learning and successful integration of AT.
Interface needs	The participants' report of desires and needs in AT interface.
Awareness of AT	The participants' report or reference to types and forms of AT.
Emotions related to AT	The participants' report of emotions as related to AT use and learning.
Customizable	The participants' reported need of AT that is customized, personalized, or specific to individual needs and differences.
Training and learning needs	The participants' report of needs in trainings on AT use.
Pay it Forward	The participants' report of assisting others within the participant's social network.

Within the second coding iteration the social learning of participants was determined to exist within the context of established and emerging networks. The isolated distinction of face to face and online contacts was no longer sufficient. The addition of child nodes representing learning that occurred within established vs. emerging social networks allowed the researcher to more closely examine the social learning of the participant. Coding revealed redundancy within several of free nodes and resulting in the collapsing (merging) of free nodes into either another free node or tree (parent or child) node. Nodes that were eliminated entirely were AT Awareness, Emotions related to AT and Physical impairment, and Pay it Forward. Free nodes were further refined and merged into existing tree node hierarchies. Table 3 illustrates changes within the second coding iteration.

Table 3: Coding Changes with Iteration-II

Node	Node Type	Change Made	Operationalization
Community or Network	Child Node	This child node was maintained as a simple calculation of face to face vs. online contacts.	
Emerging network	Child Node		Reports of social learning within a network that is not fully established by clear relationships and roles. Social capital may be low but growing.
Established network	Child Node		Reports of social learning within a network which has clear peer and family relationships. Terms like parent, mother, father, sister, brother, peer, mentor, friend in conjunction with learning.
Barriers and Challenges	Free Node	This free node was merged into interface needs.	
Interface needs	Free Node	This free node was kept in the analysis, barrier and challenges was merged into this existing free node.	
Awareness of AT	Free Node	This free node was deleted from the analysis-unrelated to current study questions.	
Emotions related to AT	Free Node	Reports of emotional adaptation by the participants in response to AT were merge into the Adaptation tree node. This free node was deleted-unrelated to current study questions.	*Adaptation of Self (Child node of adaptation) will now include the emotional and behavioral adaptations undertaken by persons with TSCI.
Customizable	Free Node	This free node was merged into interface needs.	
Training and learning needs	Free Node	This free node was examined and kept in the analysis.	
Pay it Forward	Free Node	This free node was deleted from the analysis due to small number of references within current sample. As more focus groups occur it may be valuable to revisit this node.	

Within the third and final iteration coding categories were refined, which included further elimination of unnecessary or redundant nodes, the merging of similar nodes, and a further specification of themes. All existing nodes were transformed into tree and child nodes. Table 4 shows the final coding scheme.

Table 4: Final Coding Scheme

Tree/Parent Node	Child Node Level A	Child Node Level B	Child Node Level C	Operationalization
Heuristic				The participants' report of any method that involves or serves to aid the learning of AT.
	Observation			The participants' report of watching a formal or informal demonstration of how to use AT.
	Practice			The participants' report of taking knowledge gained from experience, Trial & Error, instruction, or advice and then applying this in sequence to master the AT.
	Problem Solving			The participants' report of means of solving a glitch or problem encountered with the AT.
		Adaptation		The participants' report of adaptation by the person with TSCI. Adaptation may be of self or the AT.
			Self-Adapt	The participants' report of adaptation of the self to the AT, including personal, physical, emotional, and behavioral interaction of the person with TSCI with the AT.
			Tool-Adapt	The participants' report of a physical adaptation or modification of the AT by (or requested by) the person with TSCI.
		Seek Information		The participants' report of seeking information sources outside of self and own experience.
			Client to Supplier	The participants' report of contacting the AT supplier or maker for information on AT.
			Online	The participants' report of accessing an online source for information on AT.
			Peer to Peer	The participants' report of contacting a TSCI peer for information on AT.
		Trial and Error		The participants' report of trial and error, persistence, just trying it without previous knowledge.
Interface				Reported desires and needs in AT interface.
	Accessibility to Repair			The level of ease to access parts and knowledgeable labor should AT break or fail.
	Accuracy			The AT's ability to successfully perform the specific tasks asked of it.
	Affordability			Low to moderate cost of AT.
	Customizable			The AT's ability to be modified to the specific user.
	Reliability			The person with TSCI's ability to count on the AT to consistently perform the tasks asked of it without malfunction or breakdown.
	Responsiveness			The AT's ability to self-learn about the user.
	Simplicity			The AT's simplicity in terms of machinery and user instructions. Can the person with TSCI clearly and easily explain how to use the AT to a non-TSCI person?
	Speed			How quickly the AT device takes to accomplish its task.

Tree/Parent Node	Child Node Level A	Child Node Level B	Child Node Level C	Operationalization
Social Learning				The participants' report of AT learning and interaction within the social environment.
	Contact via Established Community or Network			Reports of social learning within a network which has clear peer and family relationships. Terms like parent, mother, father, sister, brother, peer, mentor, friend in conjunction with learning.
		Face to Face		Personal contacts reported by the person with TSCI (phone or in person).
		Online		Online community and social network references by the person with TSCI
	Contact via Emerging Community or Network			Reports of social learning within a network that is not fully established by clear relationships and roles. Social capital may be low but growing.
		Face to Face		Personal contacts reported by the person with TSCI (phone or in person).
		Online		Online community and social network references by the person with TSCI
Training Preferences				The training preferences as reported by the participants.
	Demonstrate			Formal or informal demonstration of AT use.
	Verbal			Verbal instruction
	Visual			Visual aids such as charts, diagrams, pictures.

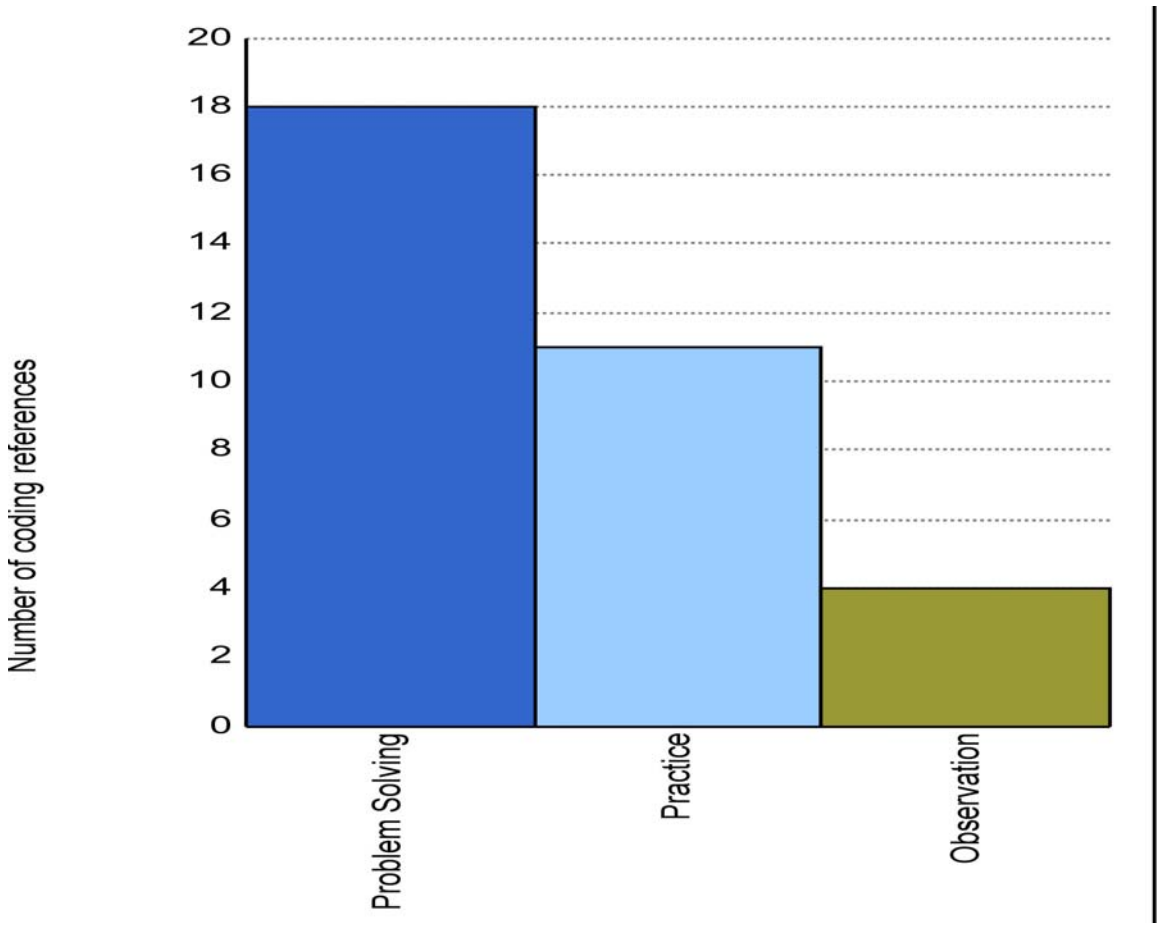
Results

Four tree nodes were retained in the analysis representing both the sensitizing concepts and thematic questions.

Heuristics

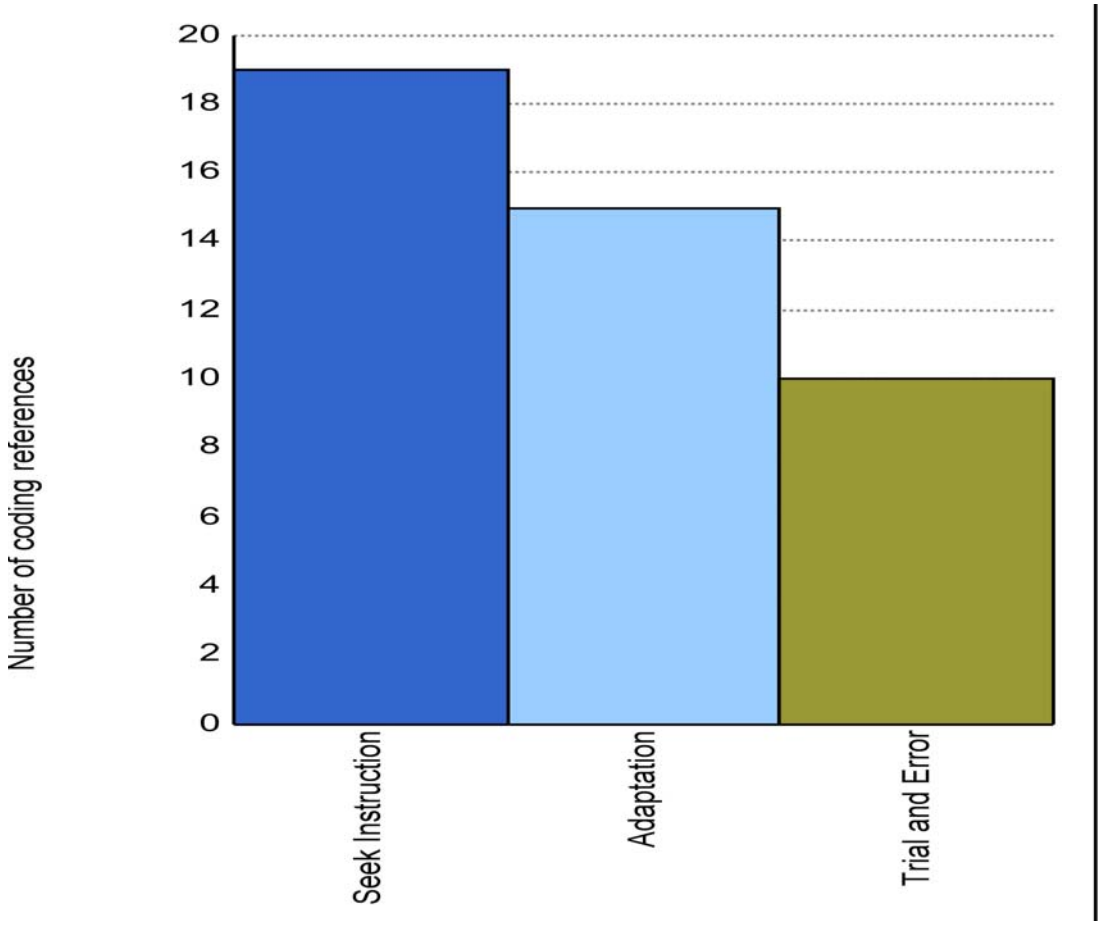
Topic based analysis, as previously defined, revealed that in the current focus group the participants used three main heuristic methods. Nvivo analysis resulted in 37 separate coding references by participants to some form of heuristic type. Figure 1 shows the three main types of heuristic, as shown by the Nvivo analysis process. Problem-solving involves tacit knowledge on the part of the participant, possibly resulting from individual experience. The participants made eleven discrete references to practice indicating that building upon previous experience or knowledge of AT is common to this group. Finally, observation was used by participants to integrate AT at a smaller frequency (N=4).

Figure 1: Three Main Heuristic Types



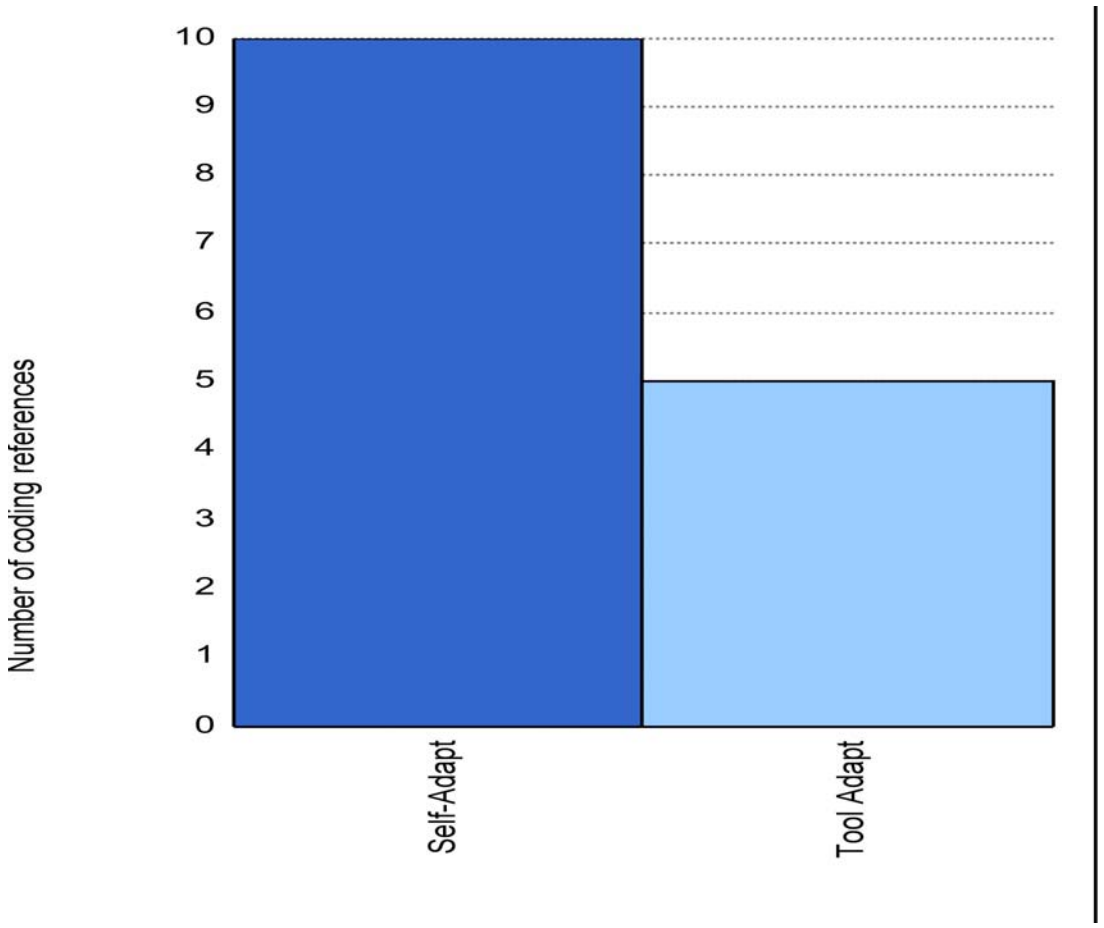
Problem-solving resulted in the highest number of discrete references. Coding of problem solving techniques revealed that persons with TSCI to use multiple means of identifying the problem, identifying potential solutions, and acting upon these potentials, as seen in Figure 2. Three main methods of problem solving by participants emerged and included: adaptation, seeking instruction, and trial and error. Trial and error received ten discrete references with responses like “that is the biggest thing, trial and error”.

Figure 2: Problem Solving Techniques



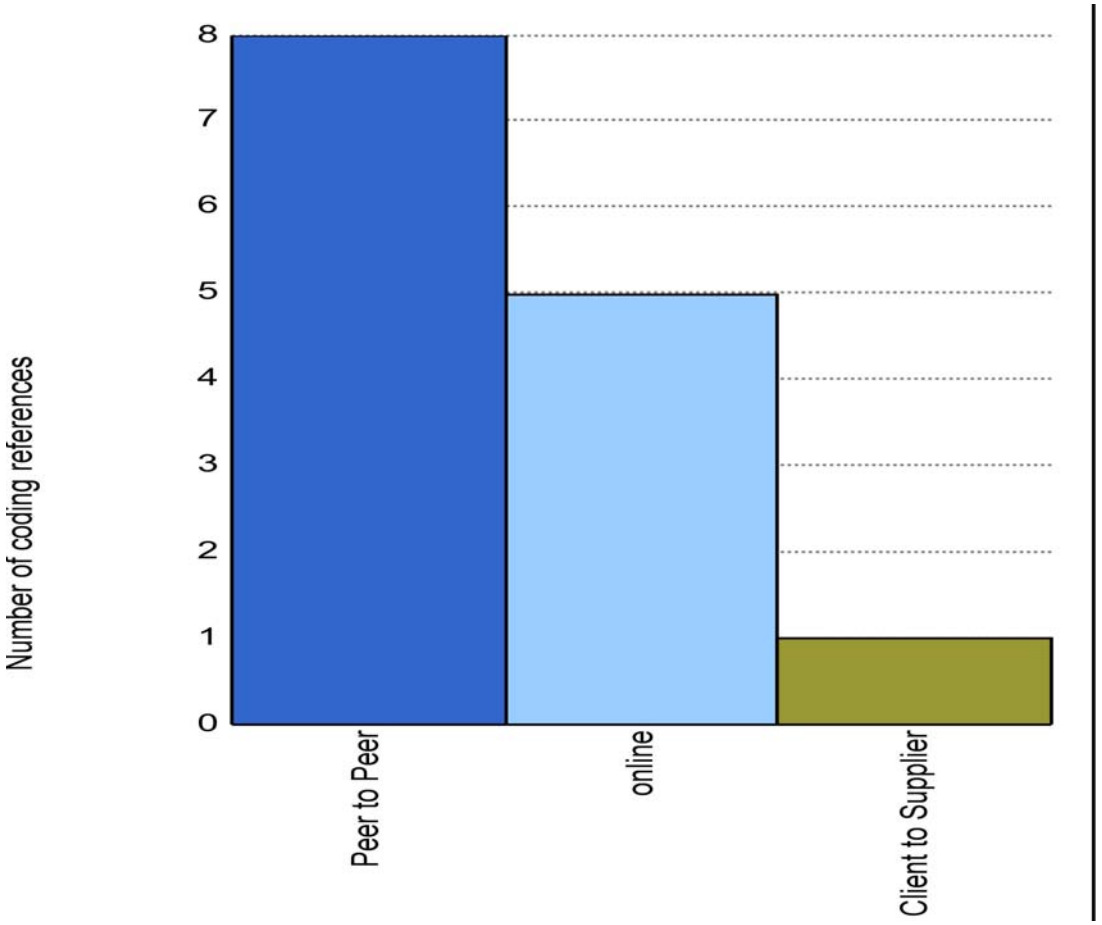
One participant reported that adapting an AT device through modification allowed him to successfully use the AT, stating that you "make it work a little bit differently and modify, find a way that we can work it". Another participant referenced his use of adaptation of self by noting "If I'm doing something around my house and I am having problems about dealing with whatever I am doing sometimes I will be so aggravated. I will leave it alone. I do something else, rest, or chill out, then I go back once I calm down to try it again." Participants made a greater number of references to adapting the self than adapting a tool, as seen in Figure 3.

Figure 3: Adaptation



Participants' use of the problem-solving technique of seeking instruction or information fell into three main categories, as shown in figure 4. Participants turn to peers, online, and to a lesser extent the maker or supplier of the AT as means of problem-solving. As one participant reported "we go on line, we do some research too", and another, "That is the best way when you do not know, I call up my buddy and if he knows a bit and I not know, hey how do you do this. We contact each other."

Figure 4: Seek Instruction/Information

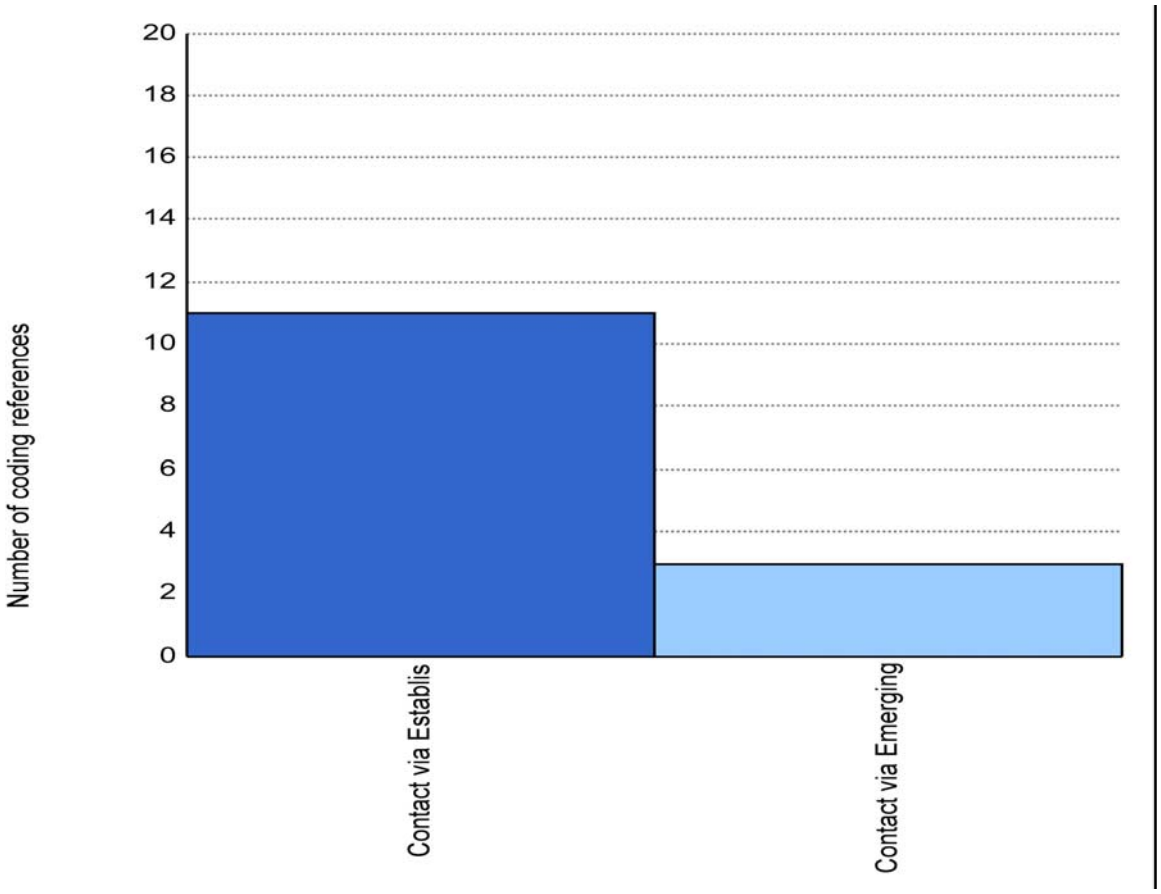


Social Learning/Network

Of additional interest to this analysis is the exploration of the social learning process. In this analysis this involved understanding the context of social networks through which persons with TSCI learn new AT.

Coding results revealed a greater number of references to contacts to and within established social networks as opposed to emerging networks as previously defined. This is seen in Figure 5.

Figure 5: Emerging vs. Established Network



Face to face contact within established networks is common in the participants' learning interactions, while in emerging networks all contacts are online contacts. Given the nature of emerging online and virtual social networks this group finding is not surprising. Figure 6 shows contacts within established networks. Figure 7 shows contacts within emerging networks.

Figure 6: Established Social Network Contacts

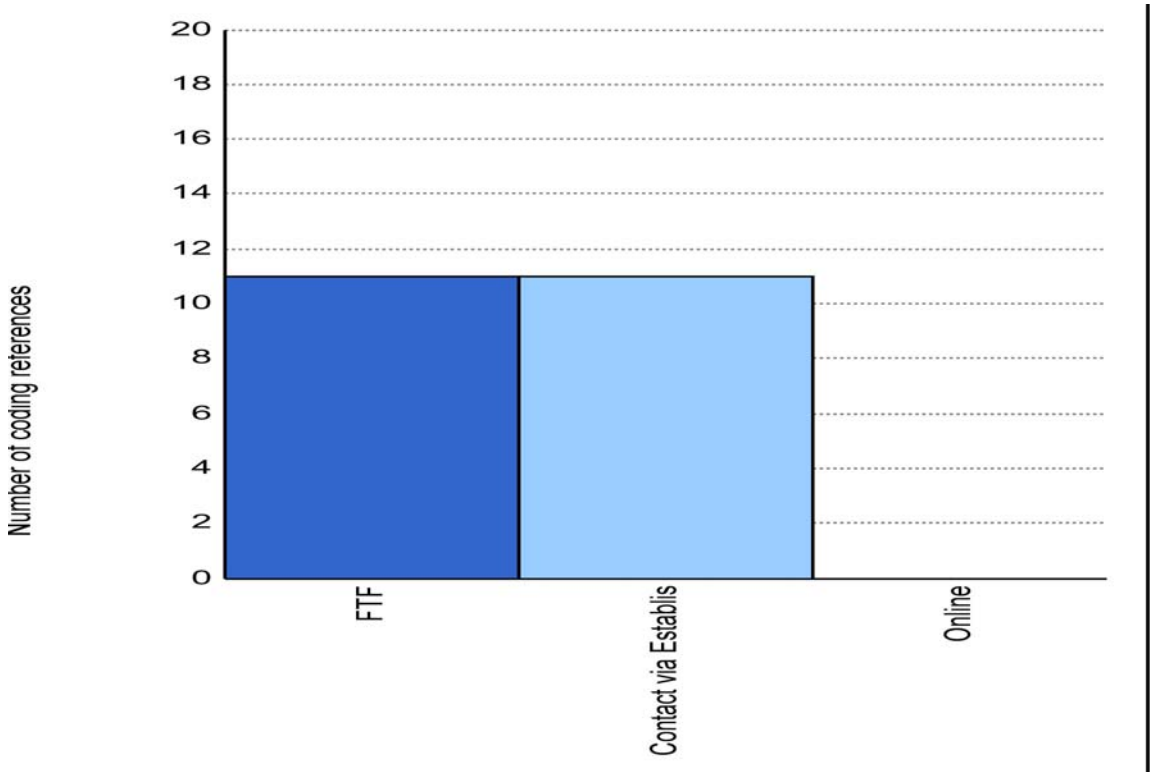
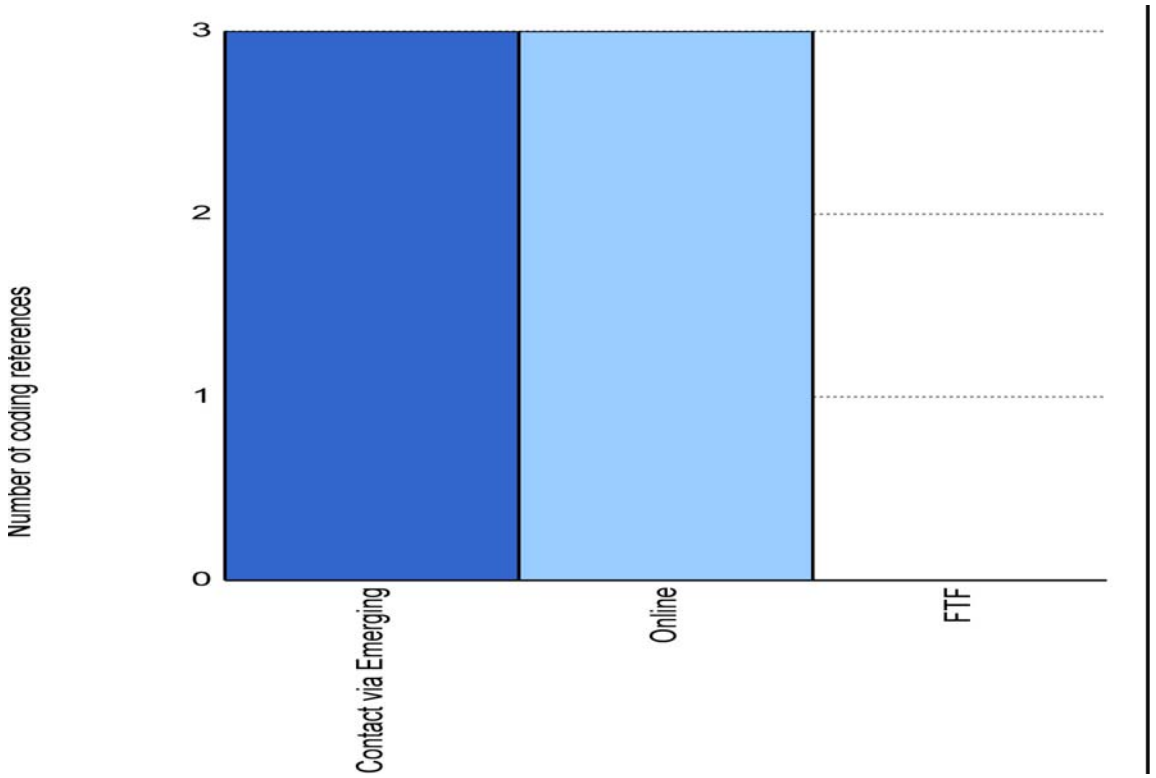


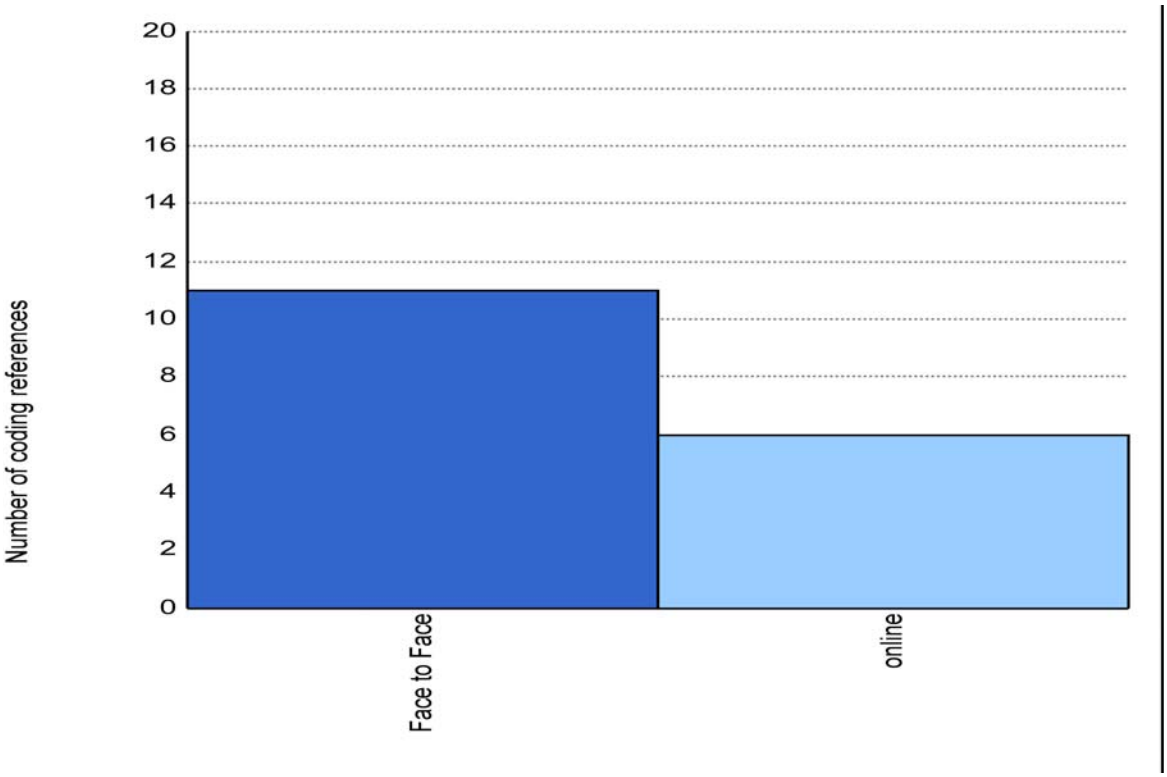
Figure 7: Emerging Social Network Contacts



One participant recounted how a certain online source was discovered through an established network stating, “In support group meetings. We interact with each other a lot.” Another participant reported a solution he arrived at through the help of his family member, “People in your family, you’d be surprised sometimes they go and do something and how did you do that? I went to the bar and I get home the first time. Someone rip me off for 200 bucks how did they do that? I told them my wallet was in my back pocket get it out and pay for the drinks, I don’t know how much they took out. Mother would go take the back pockets off and set. See that’s how you…you try it and have a problem with it.”

To compare the number of contacts made by the participants through online vs. face to face means, nodes were merged to determine a number of textual references to both in either heuristic methods or social learning methods. Results are shown in figure 8.

Figure 8: Online vs. Face to Face

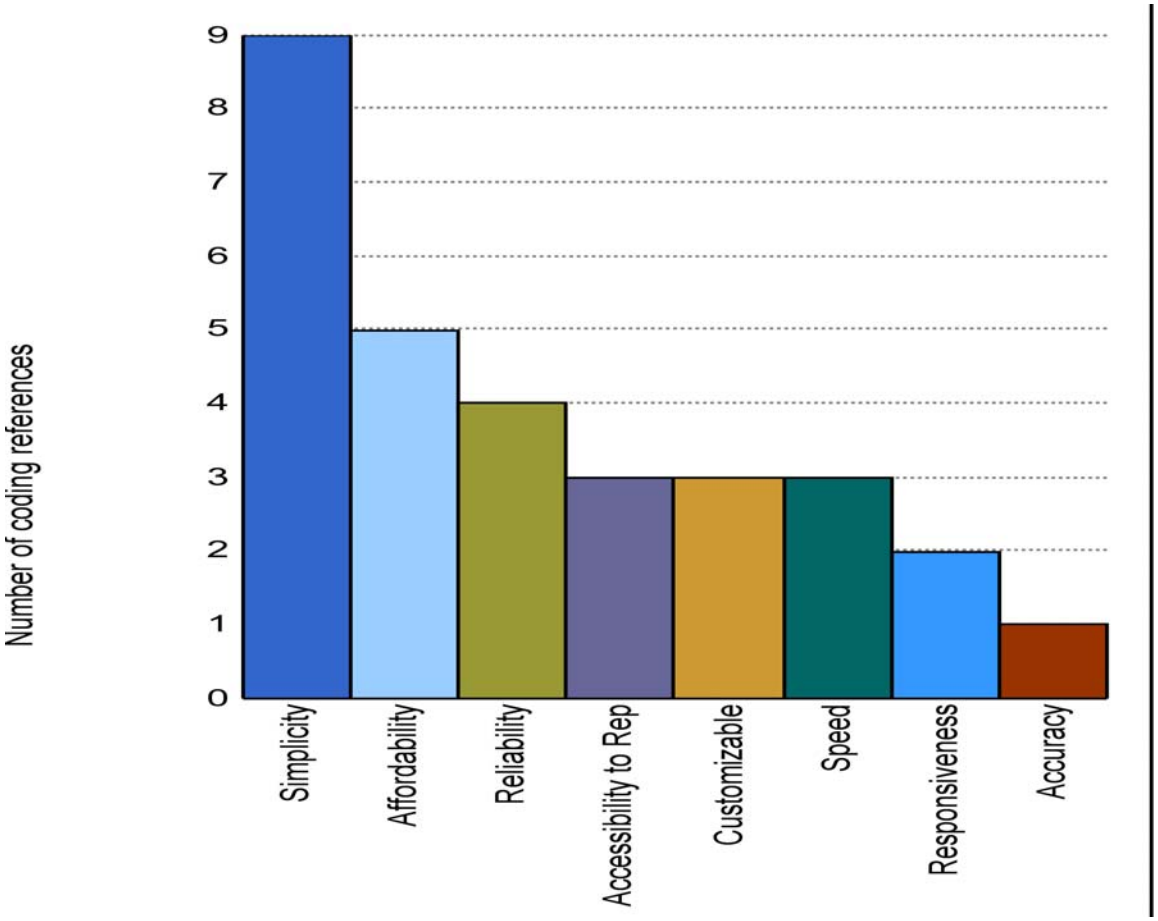


*Note face to face results excludes participant contact of the supplier as this only received on reference within the transcript and is not relevant to social learning networks.

Implications for Interface and Training

This analysis provided information on the interface and training preferences of the participants which may in turn assist the researchers to increase the usability of the robotic arm (user interface) and develop an effective training program. The coding process revealed eight patterns to participants' interface preferences. These responses are seen in figure 9. Participants made the most reference to the desire for simplicity and affordability. Other important interface elements were reliability, accessibility to repairs, customizability, and speed.

Figure 9: Interface Preferences



Five specific references were made by participants regarding training preferences. These included verbal instruction, demonstration, and the use of visual aids. It is recommended that this question be further explored in subsequent focus groups.

Limitations

A central limitation to the current analysis is the small number of both participants and focus group sessions. As more focus groups occur participants' responses will be added, as separate sources, to the analysis to address this restraint. Though representativeness of the sample was not of great concern in this current analysis a lack of representativeness of the overall TSCI population is recognized and paired with the low number of participants limits generalizability. Fern (2001) suggestions ensuring that the focus group sample is "representative of the relevant population of the respondents" (Fern, 2001, pp 125) to increase generalizabilty. Social influence can not be overlooked in a focus group of this size. A key concern regarding social influence is that of normative influence which refers to the influence exerted upon participants' responses as they compare themselves to others within the group (Fern).

Summary

Using Nvivo 8 software, analysis of an preliminary focus group which included participants with TSCI was conducted to identify the process by which the participants learn and adapt to AT through heuristics and social networks. Participants report using a variety of heuristic techniques including: observing others; practicing; and problem solving techniques such as tool and self adaptation, seeking instruction, and trial and error. The social networks in which participants interact to learn new AT and problem solve concerns related to AT are primarily well established and are face to face contacts. The interface preferences of participants yielded diverse and rich results. The most important interface elements for participants were

simplicity and affordability. The initial results of training preferences yielded few responses and should be revisited in future focus groups. Results point to several key concepts that begin to inform the researchers on the process through which persons with TSCI learn new AT and problem solve using heuristic techniques and social networks. Future focus groups with this population will further inform the current research plan.

References

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