LOW-COST VIRTUAL REHABILITATION GAMES: HOUSE OF QUALITY TO MEET PATIENT EXPECTATIONS

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Introduction

- Stroke is the 3rd leading cause of death in US
- Each year, more than 700,000 people suffer from a stroke
- Stroke survivors' ADL* is significantly impaired
- Stroke survivors can recover with rehabilitation even more than one year after the incidence

Virtual Rehabilitation System

- VRS* (e.g., rehabilitation games) that patients can use at home may have potential to prolong the treatment duration and thus enhance RECOVERY
- Motivation, Repetition and Feedback are essential key elements for rehabilitation system
- VRS can provide Motivation, Repetition and Feedback
- It is important to know patients' expectation about game



Objective

 To identify stroke survivors' expectations regarding VR games for rehabilitation

 To evaluate two newly developed low-cost rehabilitation games according to the patients' expectation



Subjects

Age	Sex	Years	Туре	UE* Fugl–Meyer	Function
75	F	2.5	Ischemic	66	Minor limitations in her shoulder and elbow
41	F	10	Hemorrhagic	65	Almost completely recovered
71	М	5.5	Ischemic	19	Very poor voluntary movement in UE*

All subjects had experiences with Wii game All subjects were currently using computer at least 30 min per week

Protocol

A single session with 4 parts (up to 30 min for each part)



Patients' General Expectation for VRS

- Total 28 questions with multiple choices (1-5)
- Involvement of therapists during VRS
- Type of games (sports, puzzle, car racing, archery, ADL)
- Type of movements (unilateral, bilateral, hand only, whole upper extremity)
- Willingness to use VRS at home
- About game (easy to install, interesting, challenging, fancy graphics, adaptive, etc)

Focus Groun

Discussion

Example of Questionnaire (Likert Scale)

1. How important is it for any rules and goals of the game to be easy to understand?



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Game Development



- Puzzle game
 - C++, P5 glove

- Archery game
 Blender, Python, C++, P5
 - glove, Kinect



Evaluation of Games



- Total 26 questions with multiple choices
- Usable of the game at home
- Easy to set up the hardware and start the game
- Clear and easy to play
- Challenging and motivating
- Adaptive

Focus Group



- After game evaluation, all patients gathered together
- All patients were asked to freely discuss what they have thought about VRS, how they liked or disliked the games, their suggestions about games, etc

Data Analysis: House of Quality



Result: Patients' Expectation



	Criteria	Mean	
	Easy to install	5.0	
	Interesting	5.0	
	Challenging	5.0	
	Easy to use	4.7	
	Clinical assessment	4.7	
	Adaptation	4.3	
	Proven clinical effect	4.0	
	Progression score	3.7	
	Graphics quality	3.3	
	Variety	3.3	

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Result: Game Evaluation

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Criteria	Puzzle game	Archery game
Easy to install	3	3
Easy to understand	4	4
Graphics quality	3	4
Progression score	2	4
Interesting	3	4
Challenging	3	4
Adaptation	2	3
Mean	2.9	3.7

Result: House of Quality



Result: Focus Group

- One patient expressed frustration since he could not put on the P5 Glove due to his low function
- Patients had hard time to play puzzle game due to calibration issue
- Playing archery game was enjoyable due to responsive interaction between patients and game
- One patient really enjoyed the archery game since he used to practice it before he got stroke

Discussion: Patients' Expectation

- Preferred both the hand and arm involved (uni- or bilateral) ⇒ multi-joint or multi-limb coordination needs to be considered
- Willing to play VRS game 1-5 times per week, 20 60 min at a time
- Preferred price range of VRS game for purchase: \$20-\$100
- Preference of game: ease to install and use, motivating, proven clinical effects for rehab than fancy 3D graphics or game varieties

Discussion: Game Evaluation

- Device reliability, device precision and proven clinical effects are the most important factors to be considered for further game development
- Adaptability of games depending on patient's functional capability is important
- Providing instruction manuals to understand motion capture volume and device calibration is necessary

Take Home Messages

- The choice of the lowest possible motion capture devices (P5 Glove, Kinect) is feasible for VRS at home
- Ease to install and play game, interesting and motivating game, proven clinical effects, device precision and reliability are important factors
- Fancy 3D graphics and game realism are not critical
- Low cost (\leq \$100) VRS is preferred



Thank You

Questions?

