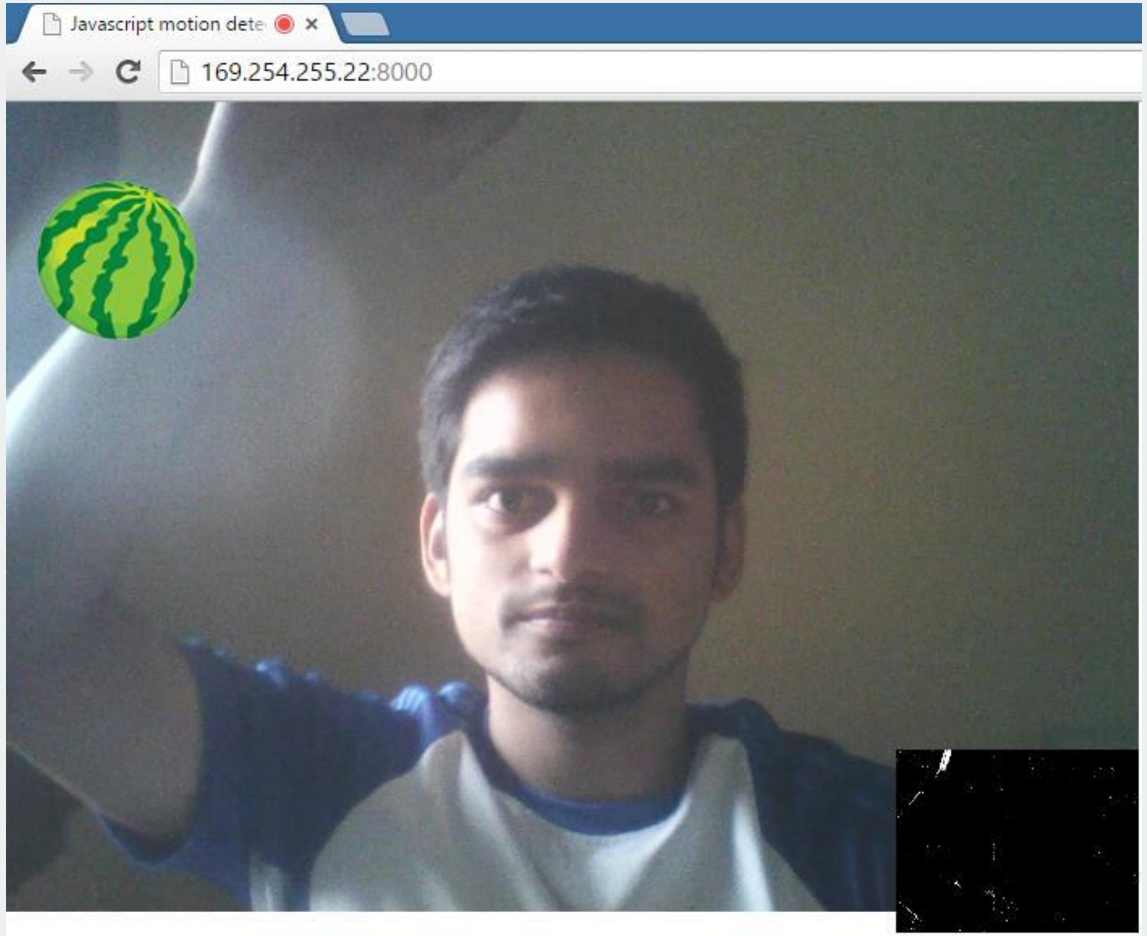
Motor skills rehabilitation through games

Guided by Prof. Girish Dalvi

Dileep M | 146330006

Motivation



Problem context

One in 6 people in the world suffer from neurological disorder.

Over 600 known neurological disorders.

Only 7% receive rehabilitation care.

Accessibility of facilities is low.

Lack of motivation, socio-economic and psychological problems.

Secondary research

Domain | Existing systems

Neurorehabilitation

Minimize any functional alterations.

Aimed to attain the highest level of independence.

Adapting a new way of living.

Rebuild self-esteem and confidence.

Help in community reintegration.

Therapies involved

Physiotherapy

Muscle strength, motor functions

Occupational Therapy

Activities of Daily Living (ADL)

Psychological

Cognitive and social dimensions

Language therapy

Articulation, fluency, oral feeding

Neurophysiotherapy

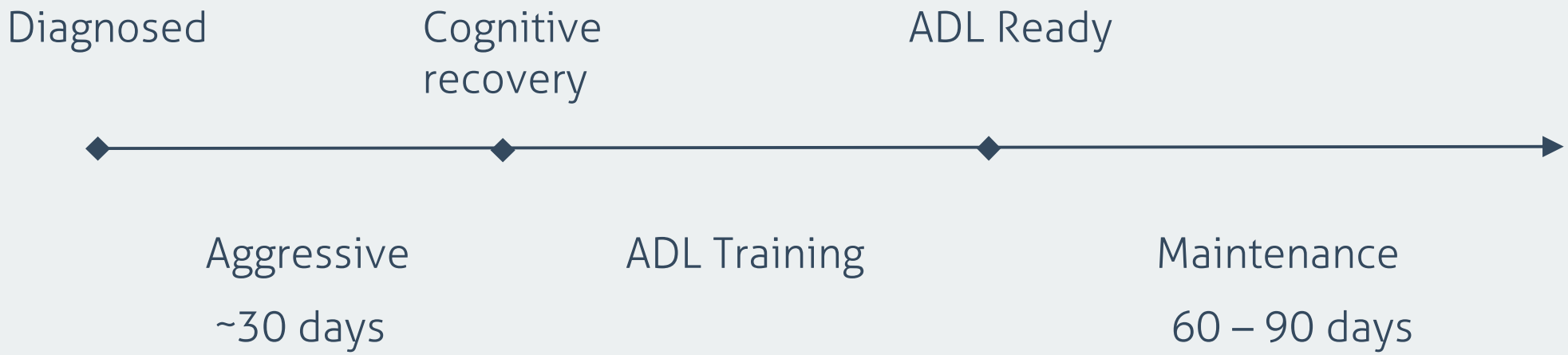
Neuromuscular retraining

Balance retraining

Gait analysis

Activities of Daily Living

Timeline of rehabilitation



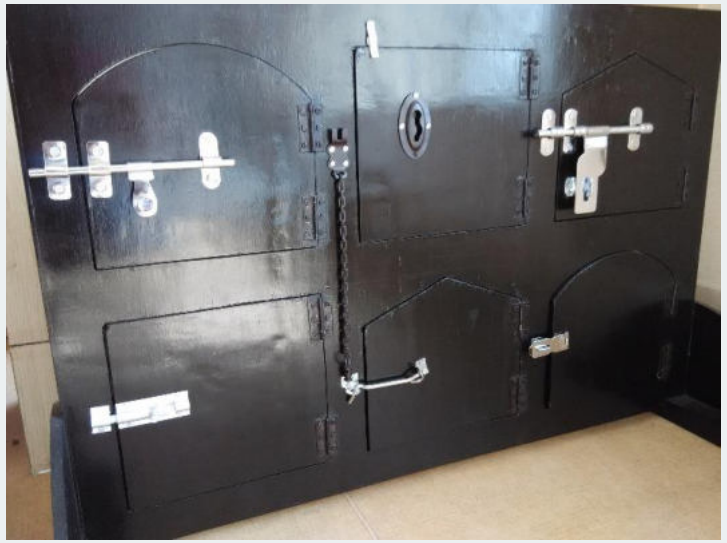
Current methods

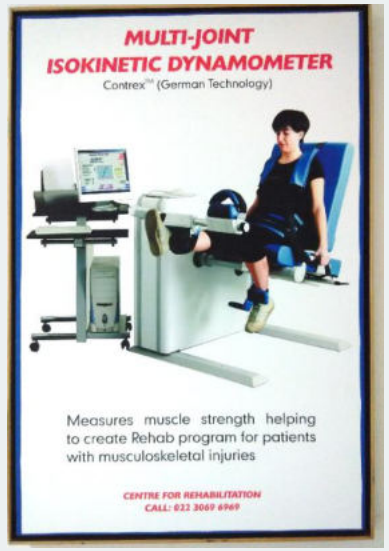
Task oriented exercises

Using external attachments or equipment

Box and block test
Source: Reha-Stim

Insights





Lack of motivation

Facilities or equipment not accessible

Demands heavy supervision

Game therapy

Task oriented games

Real life scenarios

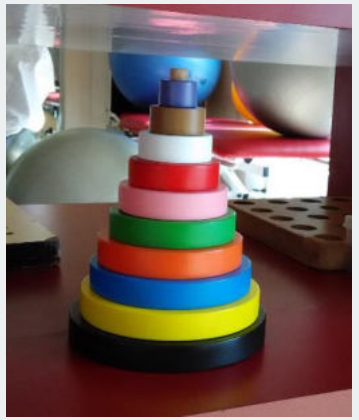
Provoking cognitive abilities

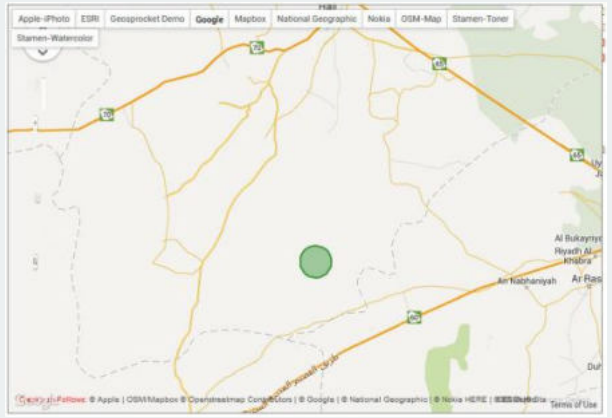
Accuracy and reflex test

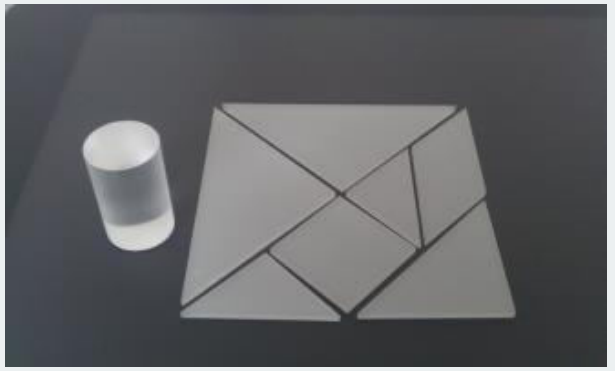
Mimic on-screen actions

Commercial products

Wii Rehab – Nintentdo Wii Sports







Primary research

Primary research

Approach

Semi-structured interview

Participants

4 Hospitals visited

7 Neuro-Physiotherapists

6 Patients

Insights

Rehabilitation plan depends on the individual.

Visual judgement for assessment.

Minor improvements fail to get noticed.

Discontinue due to lose of faith.

Care-takers and family plays an important role.

Not aware of facilities like GAMA, Isokinetic exercises, game therapy etc.

Insights

Participants are more aligned to exercises that are aided by equipment.

They also prefer to change environment to fight depression.

Home-based therapies involve instruction manuals and periodical feedback session (15 days to 6 weeks).

Counselling and positive feedback to motivate participants.

Project objectives

Project objectives

To design and develop a platform by which rehabilitation of motor skills can be made engaging through games with minimum error and supervision.

Which will -

Motivate the participants to continue the rehabilitation process.

- Making exercises engaging and rewarding.
- Feedback for even the slightest improvement.

Project objectives

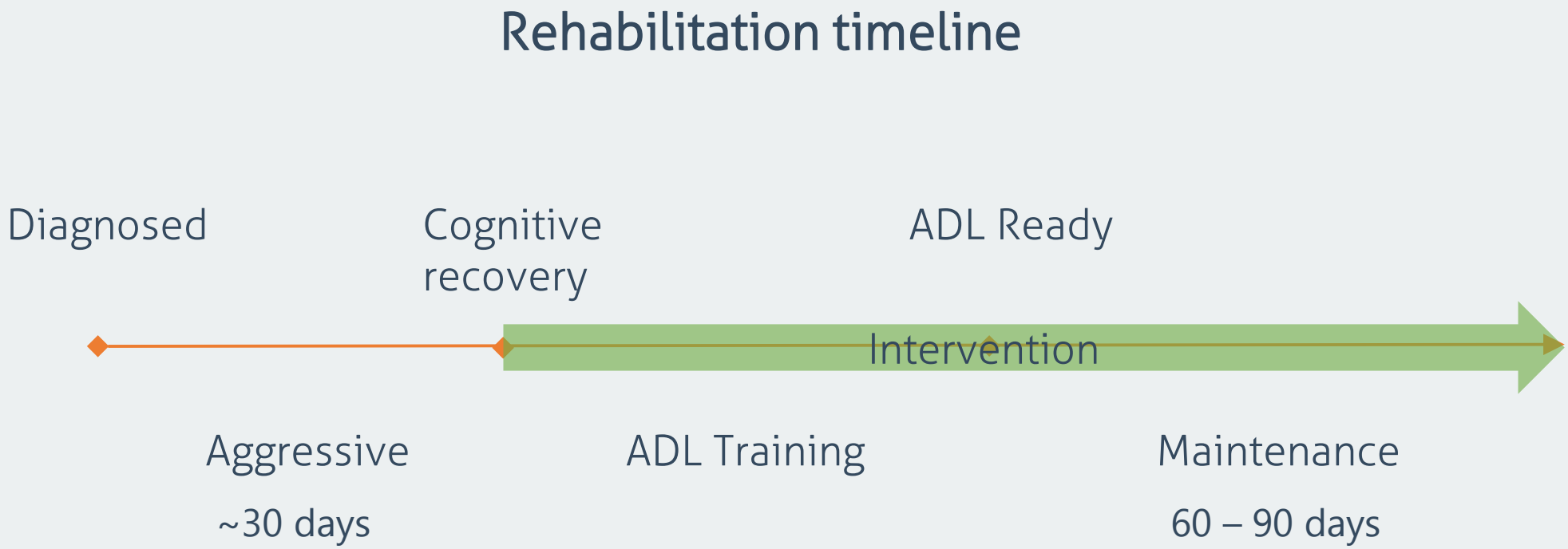
Help them build confidence and aid in community reintegration.

- Familiarize with Activities of Daily Living (ADL) to benefit in real life scenarios.

Enable access to neuro-rehabilitation process to a larger community.

- Affordable and simple systems.

Where to intervene?



Physiotherapy for the upper limb

Priority of rehabilitation

Thumb Fingers Wrist Elbow Shoulder

Why wrist?

High priority in rehabilitation timeline

Lack of equipment

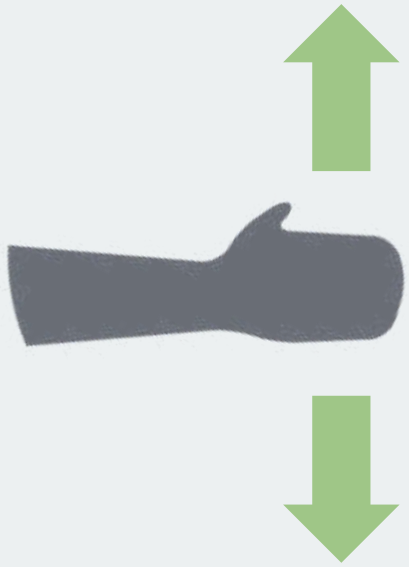
ADL activities like –

- Eating
- Combing
- Wearing shirt
- Drinking water from glass etc.

Wrist

Exercises for wrist

Radial deviation



Ulnar deviation

Extension

Flexion

Supination

Pronation

Variance include - against and parallel to gravity plane and involving resistance

Concepts

Physical Vs. Digital

Not adaptive

Limited feedback and assessment

Lack of variety in gameplay

Useful only at particular stages

No error compensation

Minnesota Manual Dexterity Test

Grooved Pegboard Test

Box and Block Test

Design ideas

Early prototype

Goals

Acceptance of game as a medium

Handling the hardware

Data collection and representations

Initial concept - game

Paper plane

Infinite runner

Self learning

Gradual increase in difficulty

Extension/flexion & pronation/supination

Range of motion & session length

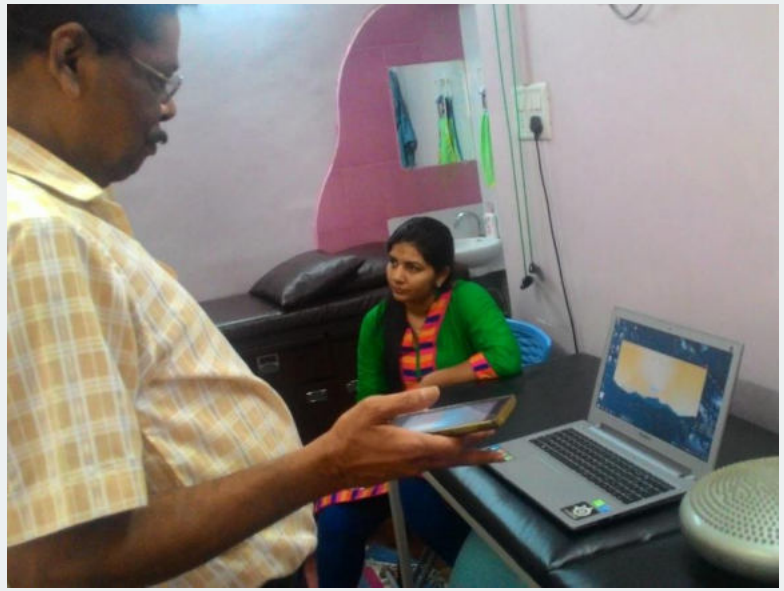
Insights

Are able to handle mobile phone as controller

"Mein game kyu khelu?"

Representation of feedback and challenges in a relatable format for participants

Therapists need specifics and holistic details for assessment



Insights

Parameters useful for the therapist – Range of motion, resistance, number of sessions

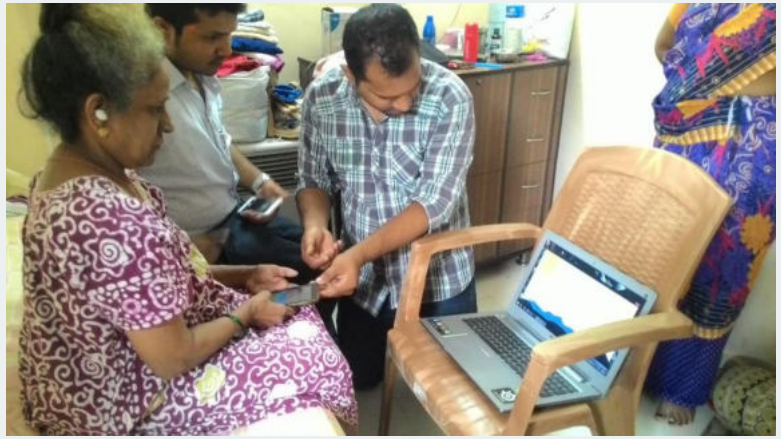
Gameplay –

Customize for single exercise

ADL challenges (feedback)

Personalize for each patient

Contrasting and familiar visual elements



Game ideas

Gameplay mechanics incorporating therapy

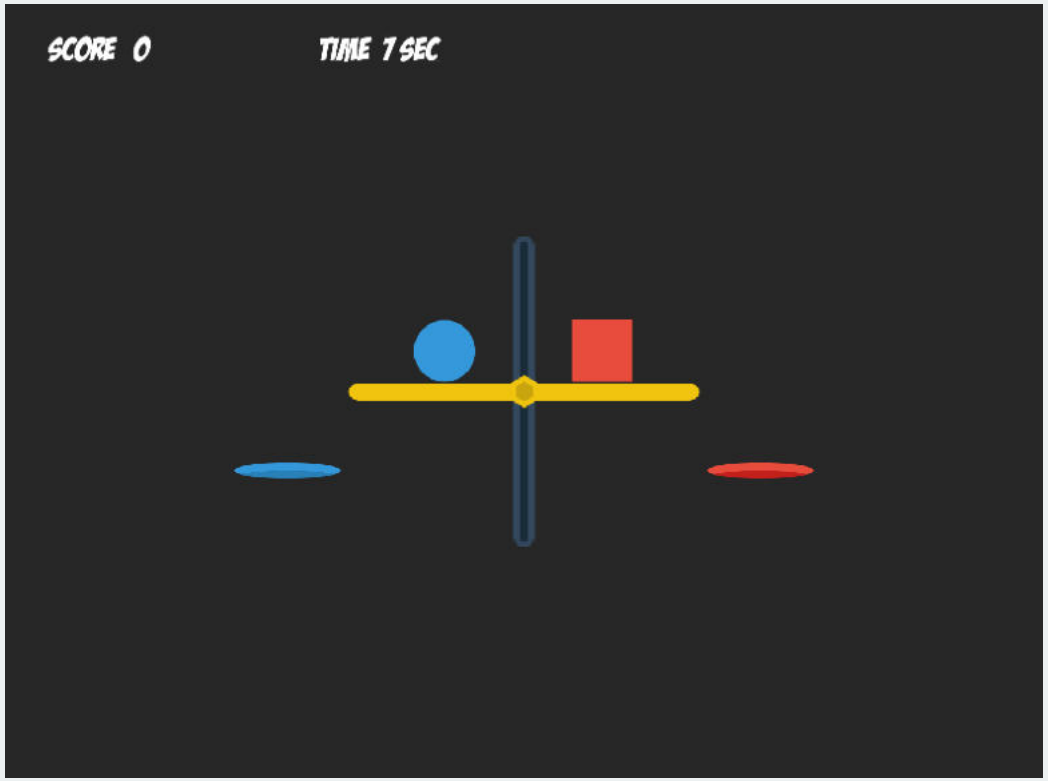
Shapes

Abstract theme

Focus on movement control

Survival mode gameplay

Pronation-supination exercise



Fly high

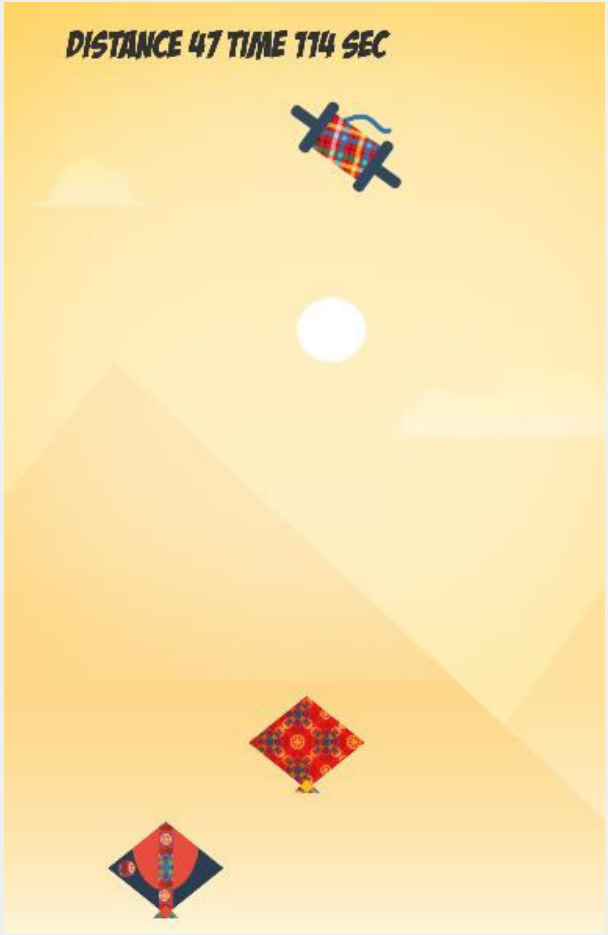
Contextual theme

Focus on repetition of exercises

Survival mode gameplay

Pronation-supination and

flexion-extension



Fort defense

Contextual theme

Focus on improving hand-eye coordination

Survival mode gameplay

Pilot evaluation

Goals

Evaluating the prototypes on **psychological absorption, flow, immersion and presence** factors to measure engagement levels. To evaluate their focus on therapy.

Protocol

Play the game for 10 minutes.

Fill the self-reported questionnaire.

Take a break for 5 minutes.

Repeat the steps with the other two games.

Pilot evaluation

Traps

General talk with others in the room, to test the presence level of the participant.

- No specific details to remember
- Specific details to remember (like numbers, names etc.)

Talk to the participant about anything except the game.

Insights

Quantitative evaluation on the three games did not reveal any significant difference.

Priority in therapy

Strength > Sensitivity > coordination

Intuitiveness

Kites > Shapes > Fort defense

Empathy

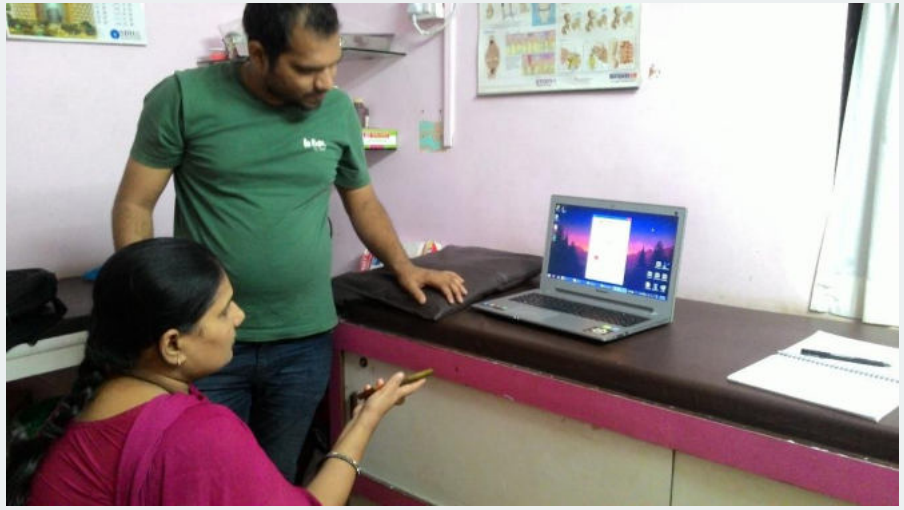
Fort defense > Kites > Shapes

Insights

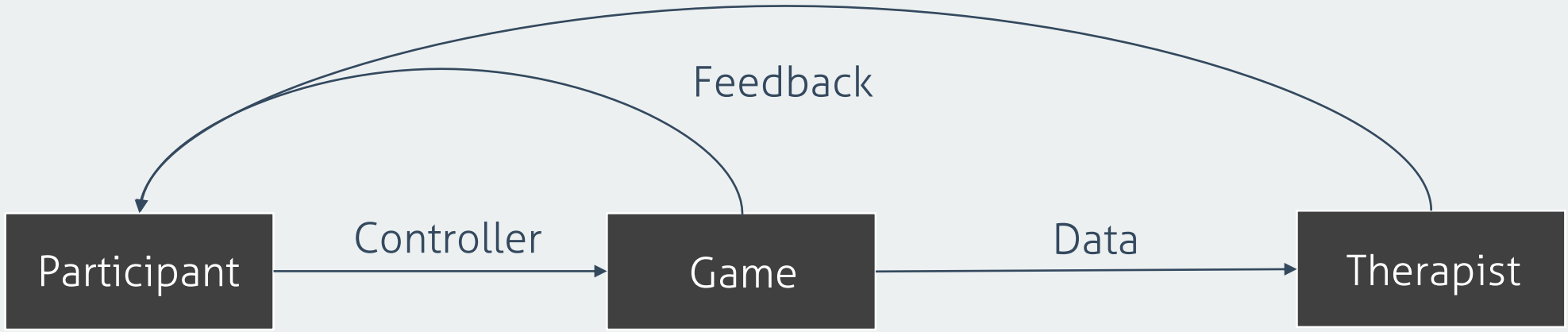
Feedback is critical to motivate and build confidence.

In meaningful format for the participant as well as therapist.

To assess progress – therapist and participants.



Overview



ROM
Sessions

Participant
Progress

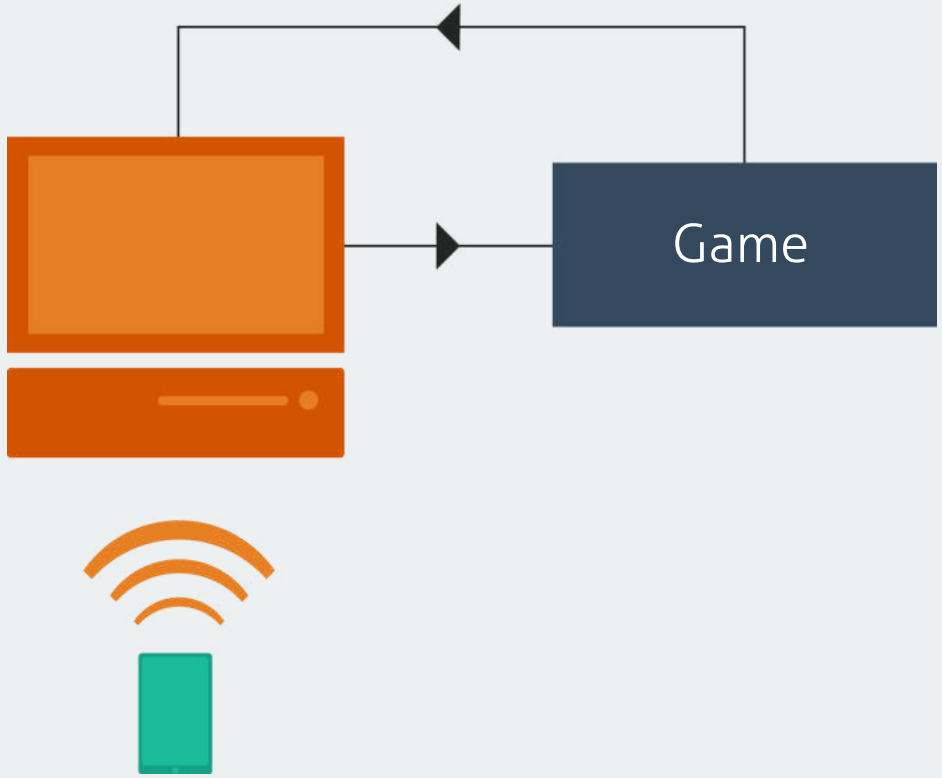
Final concept

Final concept

Modular platform.

Components

- System and controller
- Game
- Feedback system



Demo

Users

Types of users

Stroke survivors

Neurological / Orthopediatric patients

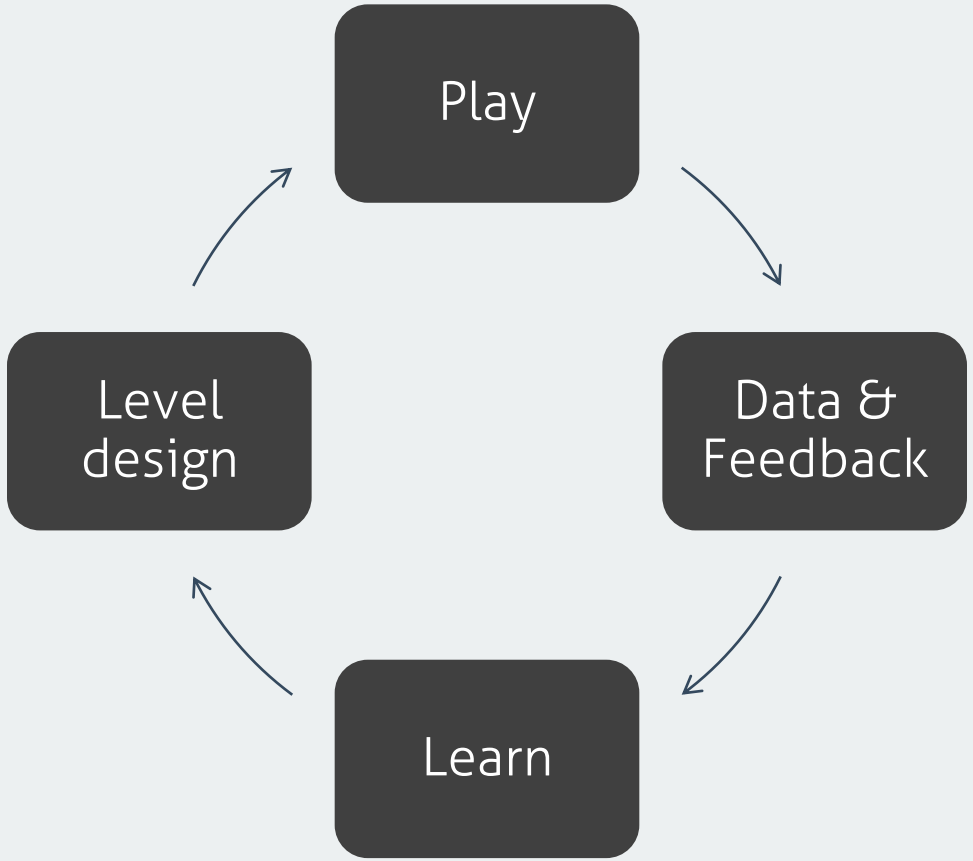
Doctors

Stages of rehabilitation

After cognitive recovery

Home based therapy / Maintenance stage

Core game loop



Feedback system

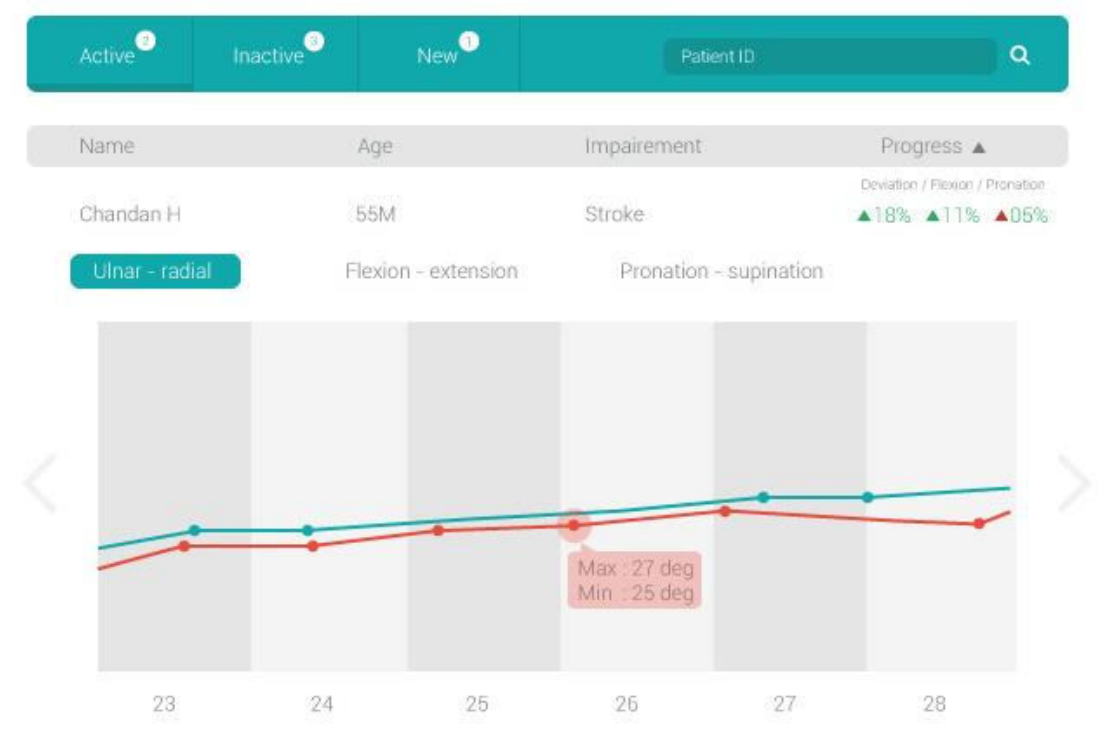
Therapist

Web portal

Remote patient data

Range of Motion progress

Session frequency



Wrist program

Dr. Rahul Reddy Logout

Patient ID: R15111523

Sharath C
55 Male
Malad(W)
+91 98 84 53 2100

Diagnosis
Stroke - Hemiparesis

Date of join
October 15, 2015

View full report | Add detail

Active 2 | Inactive 3 | New 1 | Patient ID

▲ Improving ▲ Not improving Deviation / Flexion / Pronation

Name	Age	Impairement	Progress ▲
Sharath C	42M	Stroke	▲18% ▲11% ▲05%
Raju Ram	45M	Trauma	▲07% ▲08% ▲03%
Shobhana M	38M	Stroke	▲09% ▲05% ▲02%
Shajahan R	35M	Stroke	▲02% ▲07% ▲04%
Kiran V	44M	Stroke	▲21% ▲13% ▲35%
Senthil P	52M	Trauma	▲27% ▲40% ▲52%

Re Motor skills rehabilitation platftorm

Wrist program

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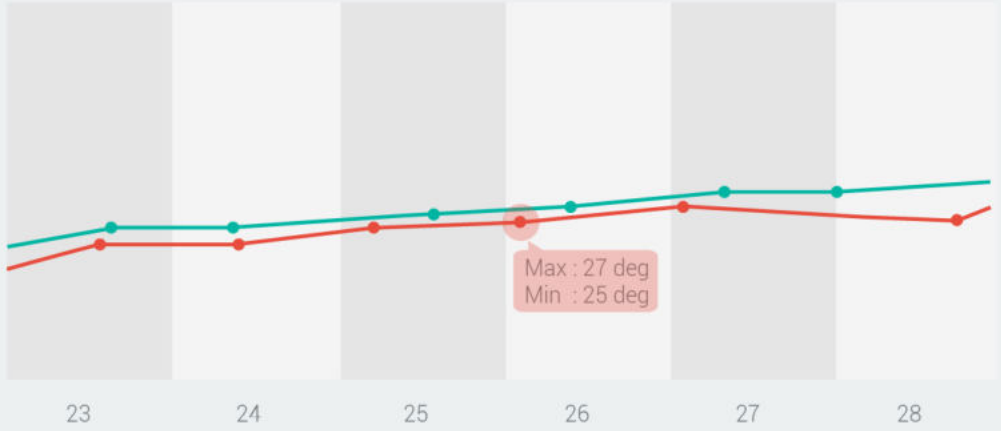
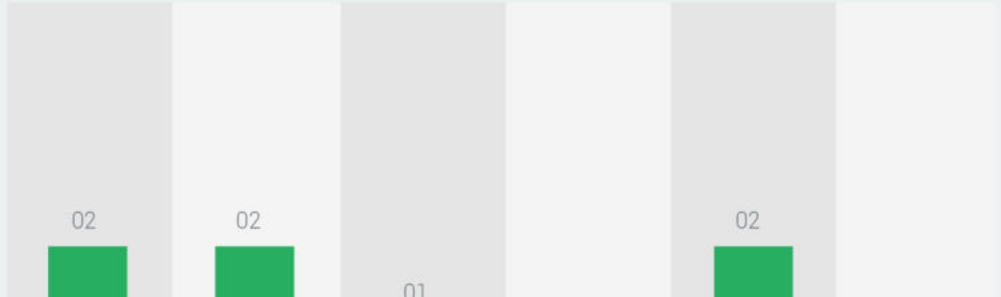
Name	Age	Impairement	Progress ▲
Sharath C	42M	Stroke	▲18% ▲11% ▲05%

Ulnar - radial | Flexion - extension | Pronation - supination



Number of sessions - Ocober 2015



Dr. Rahul Reddy Logout

Patient ID: R15111523

Chandan H
55 Male
Malad(W)
+91 98 84 53 2100

Diagnosis
Stroke - Hemiparesis

Date of join
October 15, 2015

View full report | Add detail

Active 2 | Inactive 3 | New 1 | Patient ID

Improving | Not improving | Deviation / Flexion / Pronation

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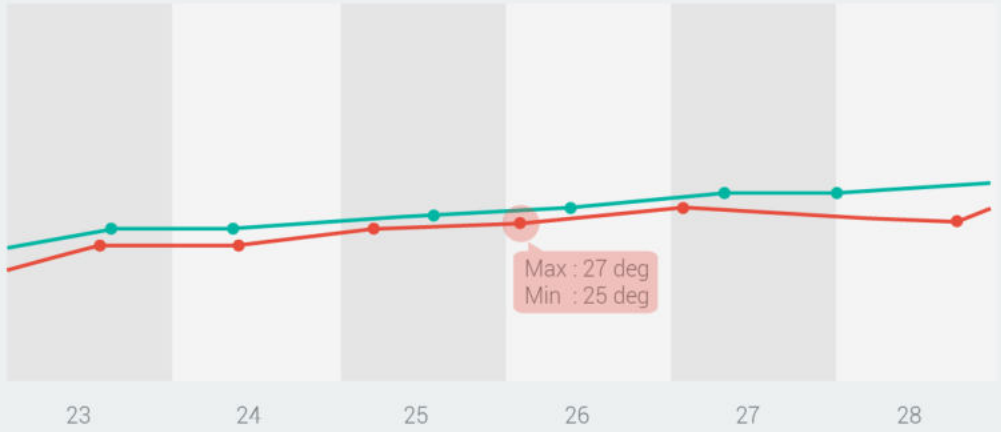

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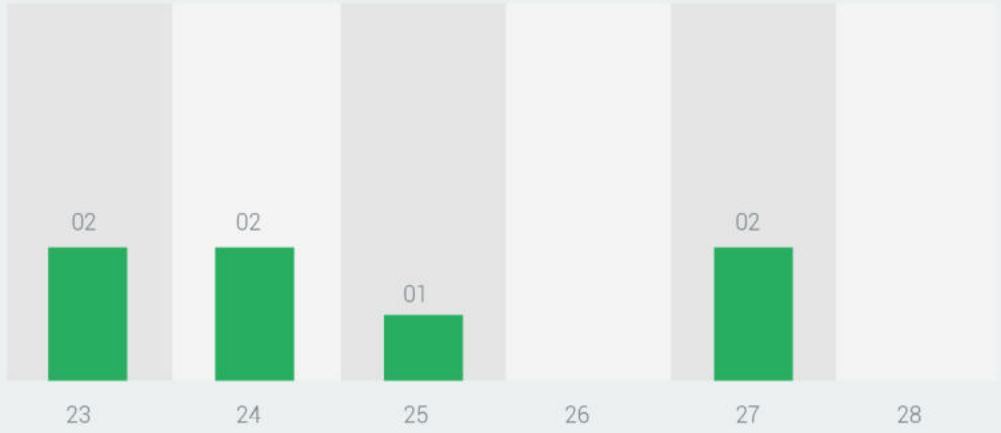


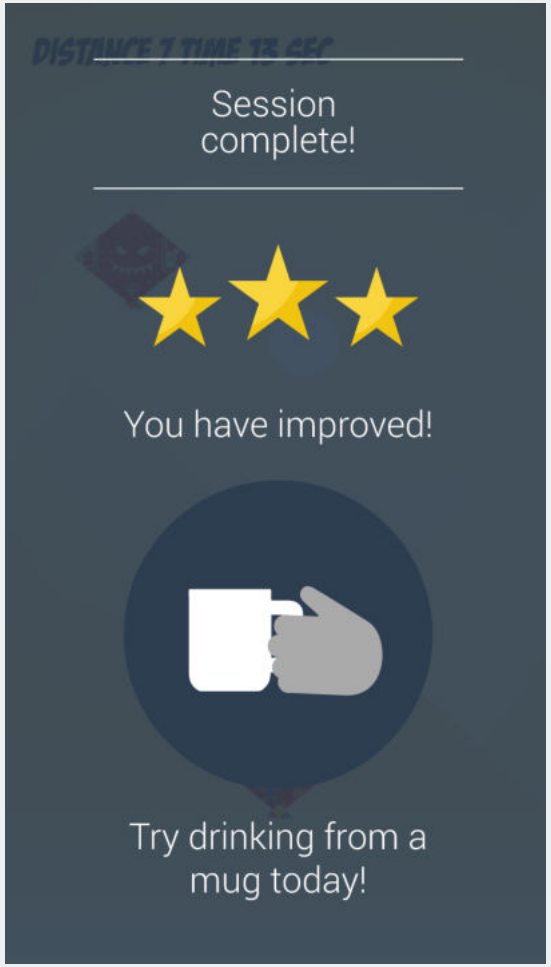
Feedback system

Participant

Game facts for motivation

Activities of Daily living challenges

Progress in a meaningful manner



ADL Challenges

ADL Challenges

Brushing

Have food with hands

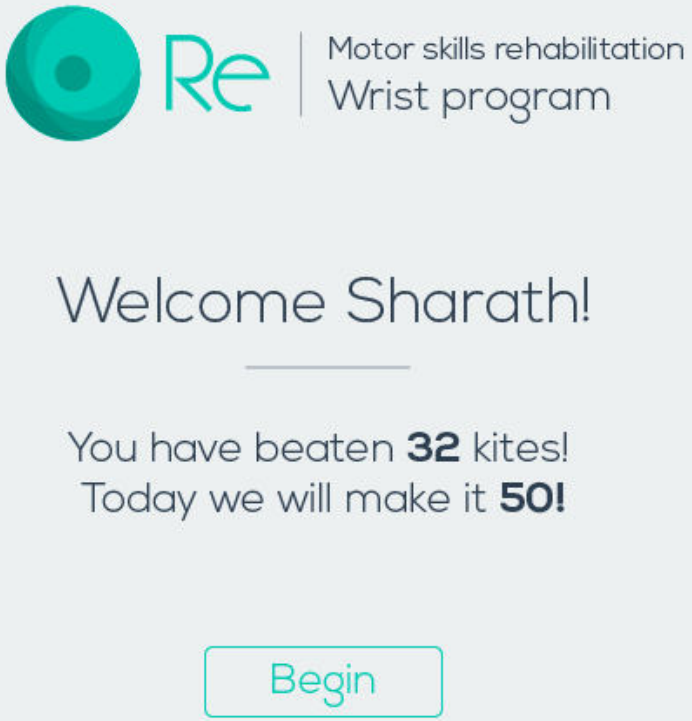
Comb your hair

Wear shirt by yourself

Pouring water into glass from another glass

Increase in complexity

Game facts for motivation



User journey

Patient

Hospital

Residence /
Common place

Game

Feedback

Evaluation

Goal

Evaluating the game against the traditional methods of motor skills rehabilitation exercise routines based on **psychological absorption, flow, immersion and presence.**

Protocol

Play the game and do the exercise for a period equal to the participant's current therapy session length.

Fill in the self-report survey for the game

Evaluation

Traps

General talk with others in the room, to test the presence level of the participant.

- No specific details to remember
- Specific details to remember (like numbers, names etc.)

Talk to the participant about anything except the game.

Insights

High absorption, presence and flow in the game than traditional exercise.

Localizing the game reduces entry barrier. *"This is the first time I am flying a kite".*

Doing exercises seemed automatic through games.

Insights

Supervision needed was minimal.

High absorption level helped in relieving tension in participants.

Conclusion

Serious games are more effective than traditional methods of treatment.

Localizing gameplay reduces entry barrier for the players.

Personalization of games helps to meet individual's goals and better retention.

Mapping daily activities to game mechanics benefits the player in real life scenarios.

Localization reduces the affect of gender and age preferences on gameplay.

Learnings

Conceptual learning

Localizing and personalization of games.

How to design serious games.

Data visualization depending upon the user.

What is a minimum viable prototype for games and how to play test them.

Future work

Multi-language support for better localization.

Evaluate preferences in serious games for different genders.

Increase the accessibility by creating DIY resources.

Custom therapies – game customizations.

Acknowledgement

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Thank you.