deirdre walsh
amin ahmadi
dave monaghan

Insight DCU

Technology enabled behavioural change as a pathway towards better self-management of CVD

Horizon 2020, 10 partners, €4.9m, 44 months, 2015 – 2018

Coordinator - Kieran Moran

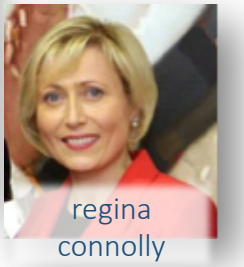
multidisciplinary research team


kiearn moran


catherine woods


niall moyna


noel mccaffrey


regina connolly


noel oconnor


dave monaghan


deirdre walsh

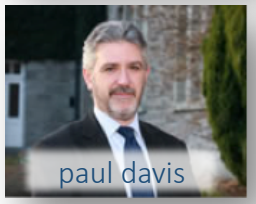

amin ahmadi


giulia migliorato


ed mitchell


freddie honohon


Zhenxing zhang


paul davis


aaron duane


francois destelle

experts in the fields of:

bio-mechanics

health & human performance

preventive medicines

medical exercise rehabilitation

behavioural change

computer science

engineering

inertial sensor analysis

computer games development

machine learning

business & health economics

motivations behind pathway

physical **inactivity** is responsible for:

- 5.2 million deaths (La Vecchia et al. 2012)
- 20% to 30% increased risk of all-cause mortality and Cardiovascular Disease events
- 21–25% of breast and colon cancers
- 27% of diabetes and
- 30% of Coronary Artery-heart Disease

physical **activity** alone

- reduces premature death by 24%
- protects from CVD risk factors and co-morbidities
- results in longer and better independent living
- decreased healthcare costs

(WHO 2011)

motivations behind pathway

Cardiac Rehabilitation (CR) - essential part of the contemporary management of CVD

Phase 1: in-hospital education,
Phase 2: outpatient education and support,
Phase 3: gradual increase in supervised Physical Activity (PA),
Phase 4: community-based CR, in which patients try to sustain long-term behaviour change typically with encouragement by CR staff.

The work being done in by HeartHealth specifically targets individuals at phase 4 CR.

Community Cardiac Rehabilitation Challenges

Uptake and adherence:

- severe lack of appropriate programmes (MedEx),
- travel time, scheduling issues,
- not tailored to their needs
- lack of peer mentoring,
- low self-efficacy associated with poor exercise technique, not “wanting to fail”, perceived poor ‘body image’ (not wanting to exercise with large groups of ‘strangers’),

motivations behind pathway

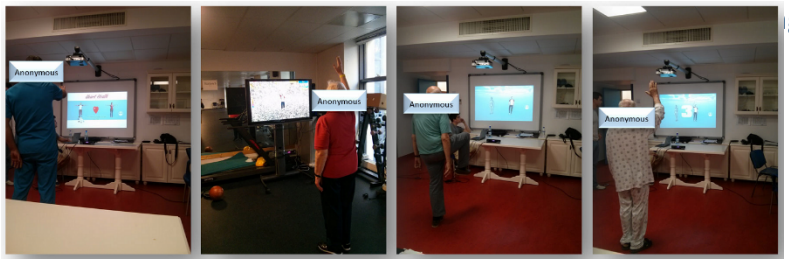
end users and mocap


Lots of Equipment for one data capture

motivations behind pathway

understand the end-user and design the pathway system solely with them in mind to bring about greater behavioural change

This image above shows a MedEx Cardiac Rehabilitation (CR) class taking place in DCU attended by over 400 Phase-4 CR patient visits a week



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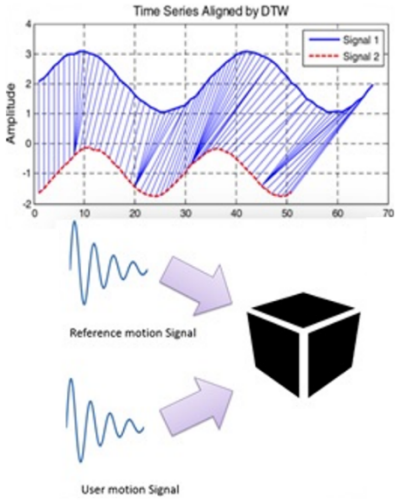
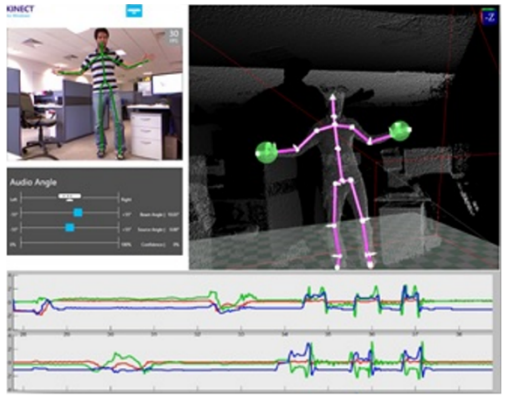
utilise low-cost and accurate motion capture

replay data-capture at dcu that involved a state of the art Vicon mocap setup

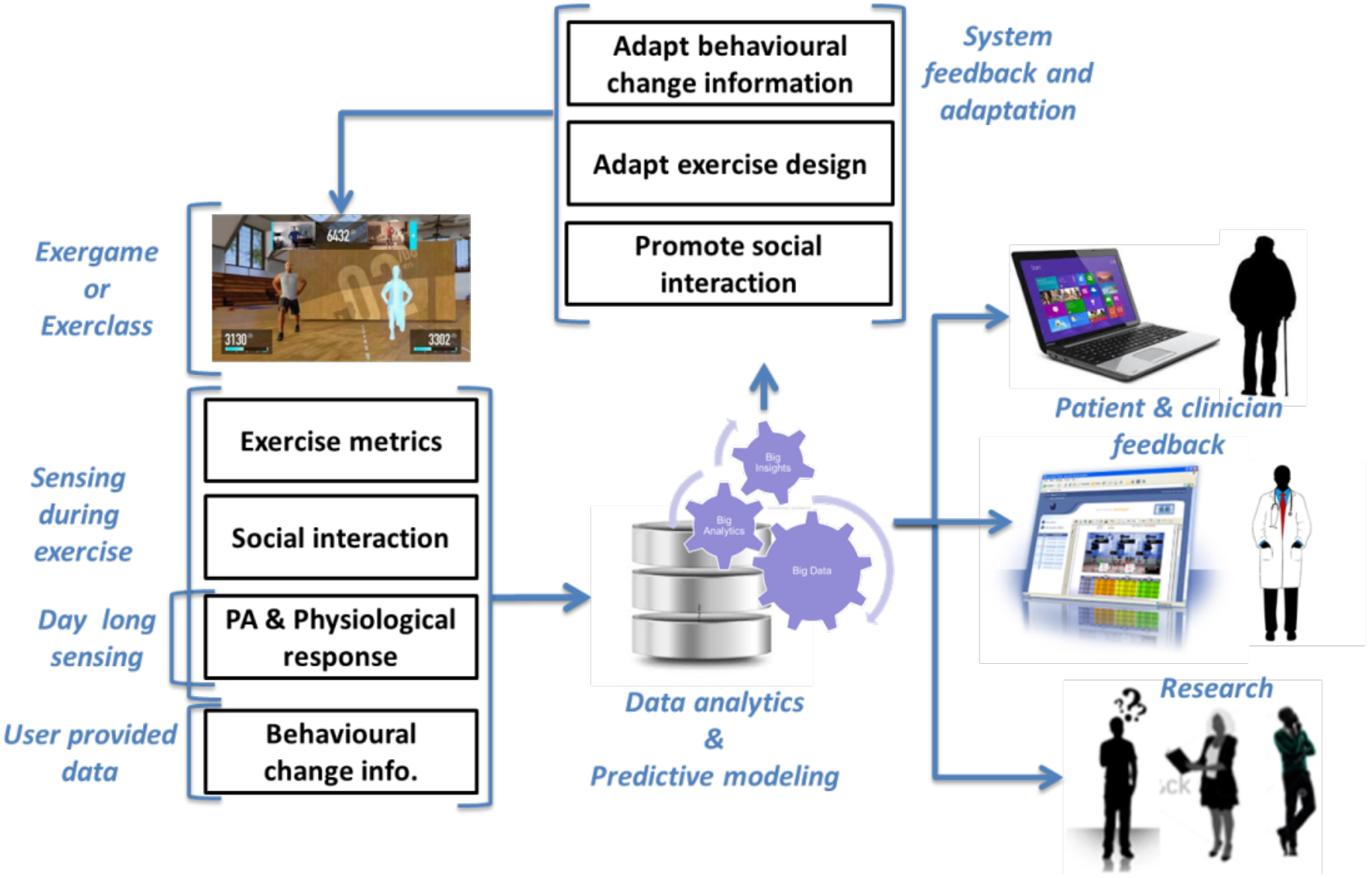
we have worked to create advanced algorithms that fuse data from both the KinectV2 and body worn accelerometers, using Vicon as a Ground truth, to create low-cost accurate Mo-Cap

our sensor fusion allows us to record skeletal information with a higher accuracy than either the kinectV2 or inertial sensors independently





motivations behind pathway



so what exactly do you want to do?

we want to use low-cost motion capture technologies coupled with computer gamification, patient information managements systems and effective behavioural change

to

develop a low-cost, home-based, self-selected, personally tailored, continually challenging and enjoyable, CVD exercise-based rehabilitation and monitoring platform

to

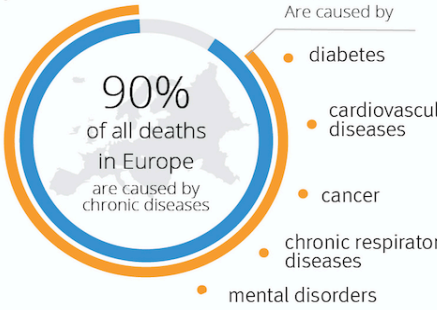
encourage patients to self-manage their CVD through exercise and physical activity

THE HYPER-CONNECTED PATIENT

New opportunities to manage and prevent chronic diseases

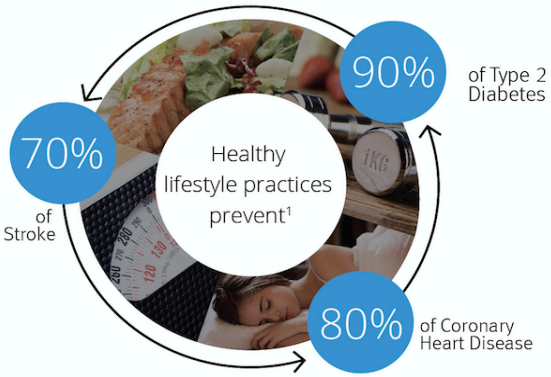
PREVENT CHRONIC DISEASES AND THEIR COMPLICATIONS

Europe has the highest burden of chronic diseases globally[1]



86% Are caused by

- diabetes
- cardiovascular diseases
- cancer
- chronic respiratory diseases
- mental disorders



PROMOTE HEALTH THROUGH IMPROVED PATIENT ENGAGEMENT

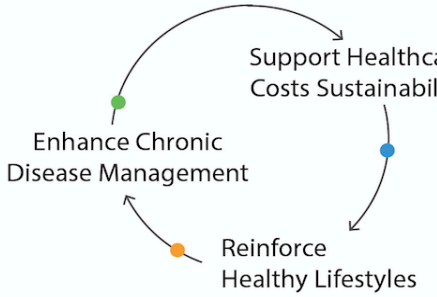
BY 2017

5 million

patients worldwide

are forecast to be using wearable technology and remote monitoring devices[2]

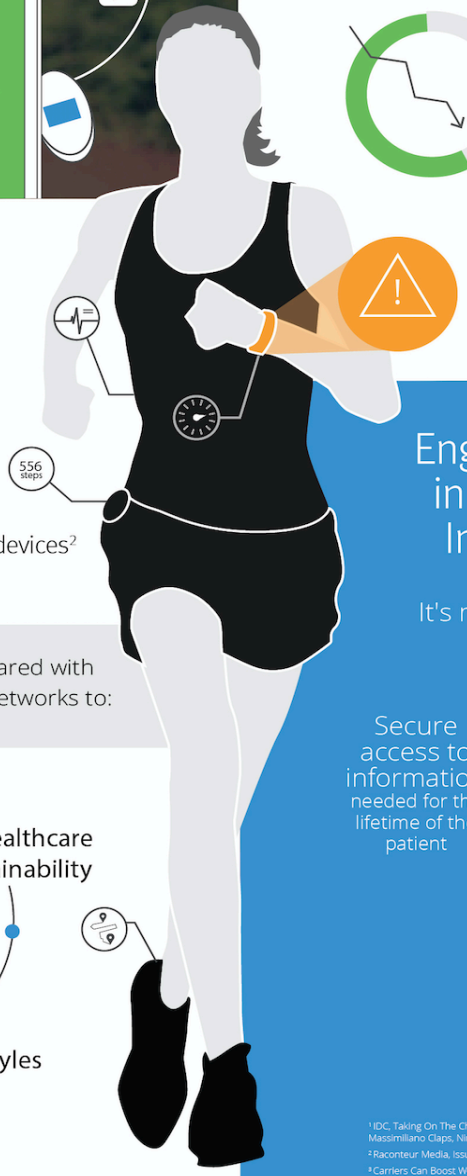
Patient generated data can be shared with healthcare providers and social networks to:



INSPIRE LONG-TERM CHANGE

Use financial incentives and behavior change programs to engage and motivate the patient.

57% willing to use a device if it would lead to lower health insurance premiums[3]



40.9% lost interest and stopped using devices when no behavioral change programs were used[4]

Engage the Patient in the Delivery of Integrated Care

It's more than just devices. It's about:

Secure access to information needed for the lifetime of the patient

A patient centered ecosystem relying on end-to-end information management

An interoperable, agile architecture that is sustainable as technology changes

[1] IDC, Taking On The Chronic Disease Burden In The Hyper-Connected Patient Era, Massimiliano Claps, Nino Giguashvili, Sept 2014

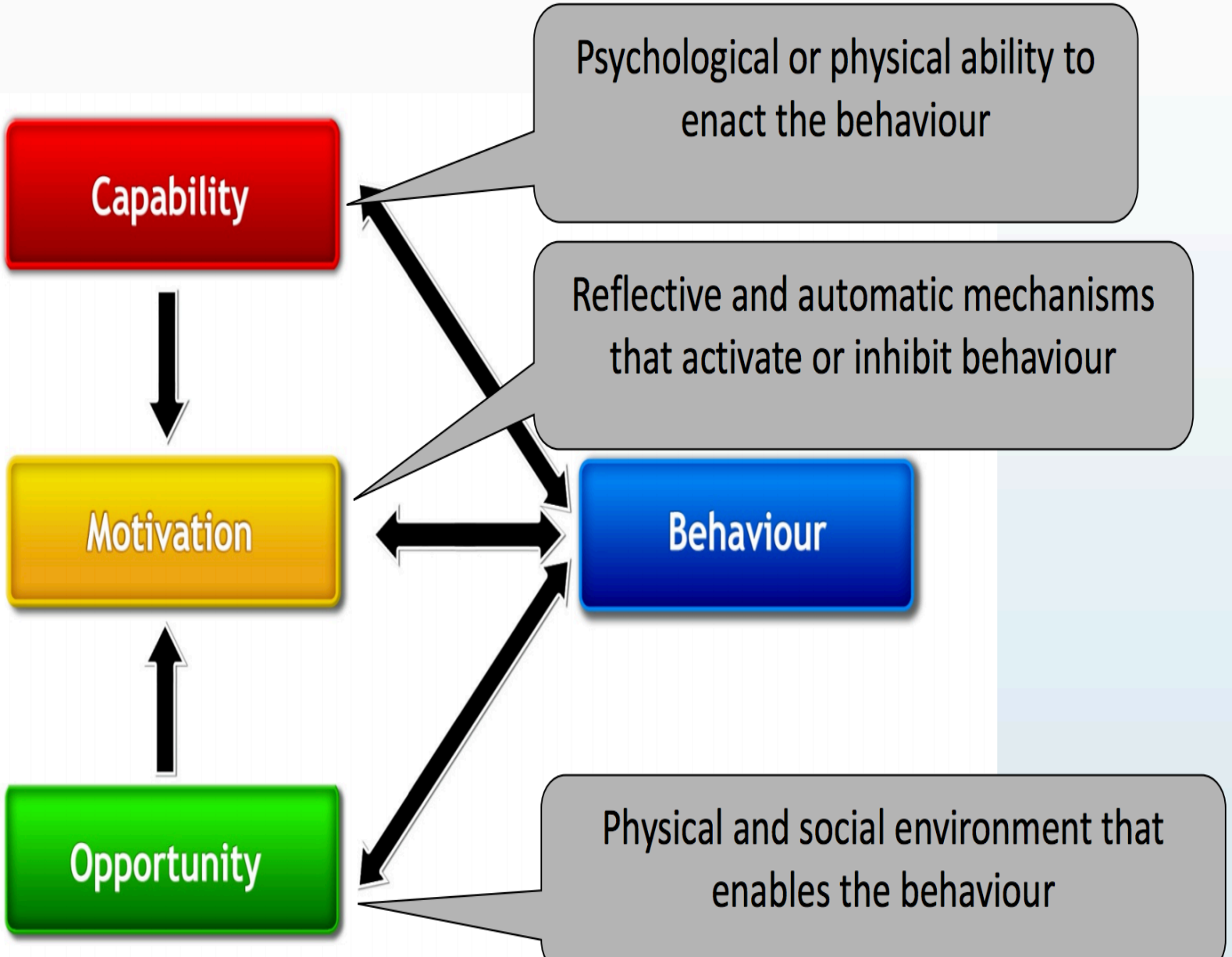
[2] Raconteur Media, Issue #0277, 25/09/14

[3] Carriers Can Boost Wearable Health Adoption - BenefitsPro, Dan Cook, Oct 2014

[4] IDC Health Insights "Perspective: The Consumer Experience — Why Consumers Stop Using Fitness Trackers", June 2014".

EMC²

COM-B: A simple model to understand behaviour…

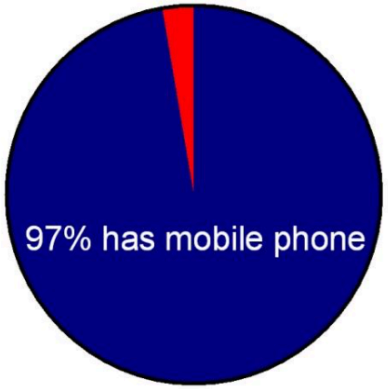


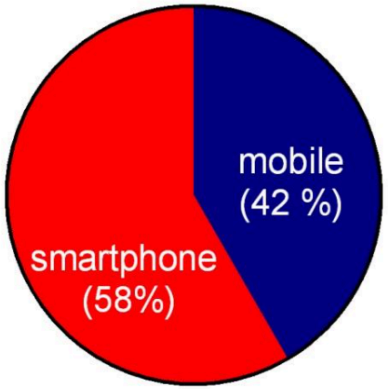

•Technology Usage Questionnaire
•End-user Interviews

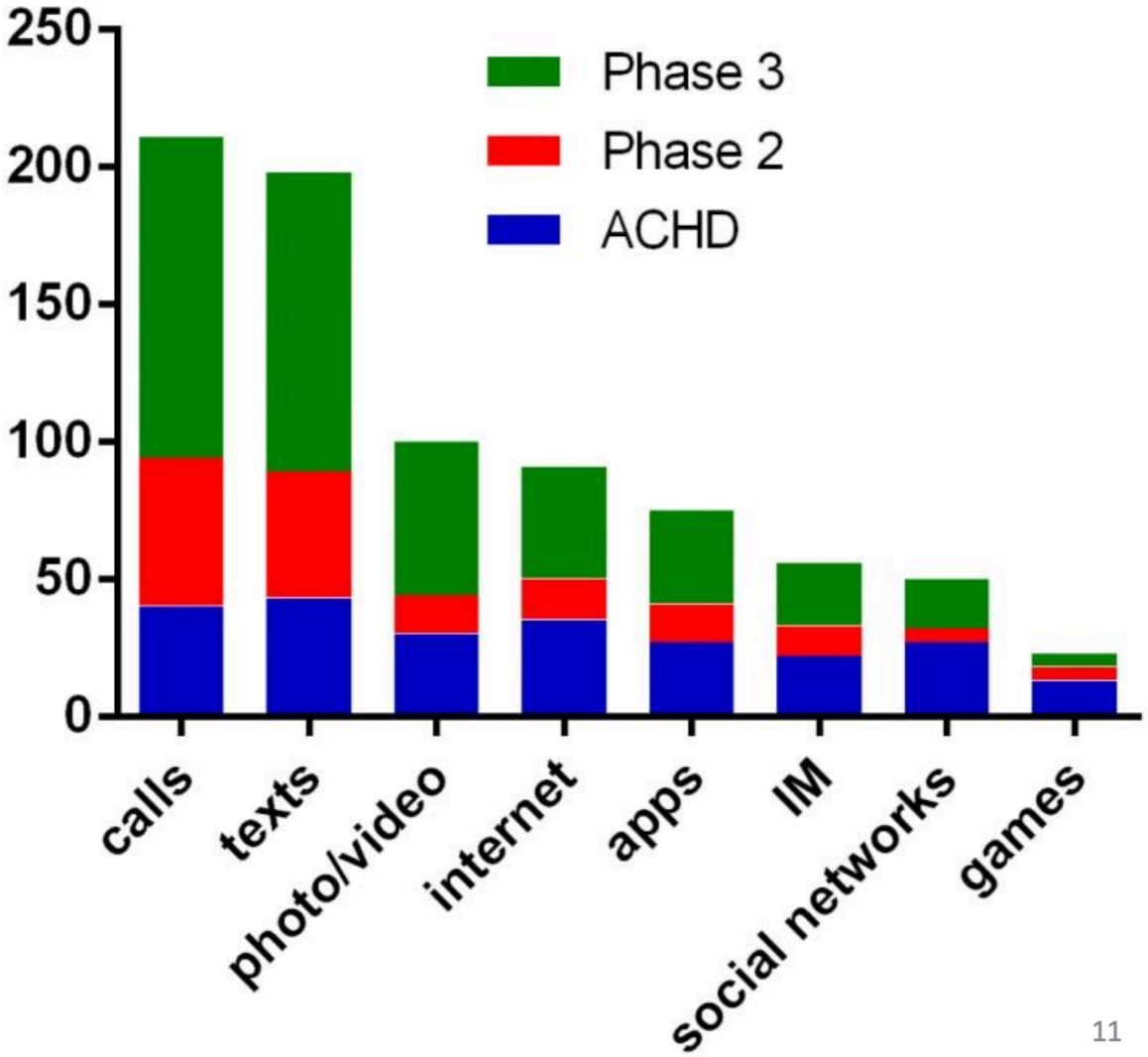
Results

- 298 respondents
  - 70 Heartsmart Dublin
  - 129 Harpa Leuven
  - 56 hospital based CR Leuven
  - 43 congenital heart disease consultation Leuven

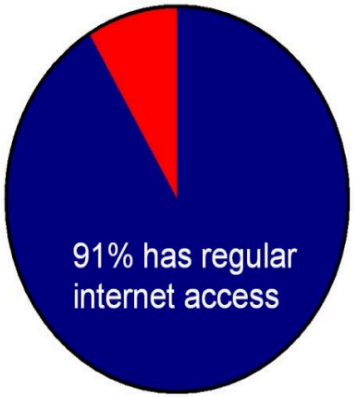
Mobile phone use

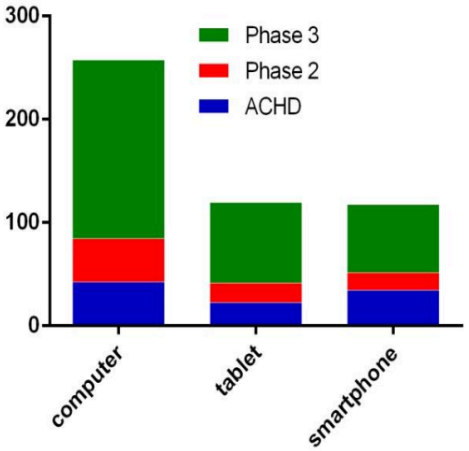


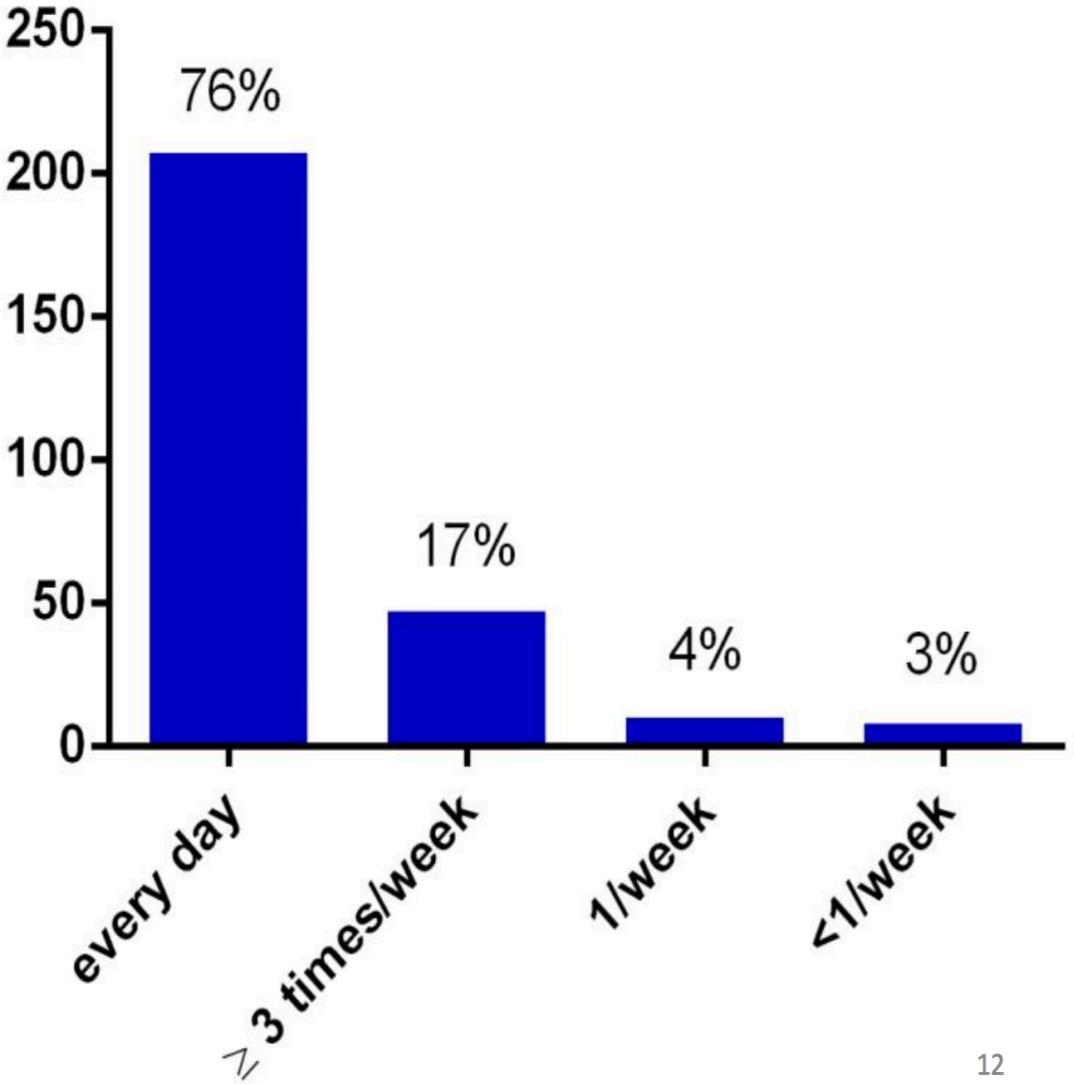




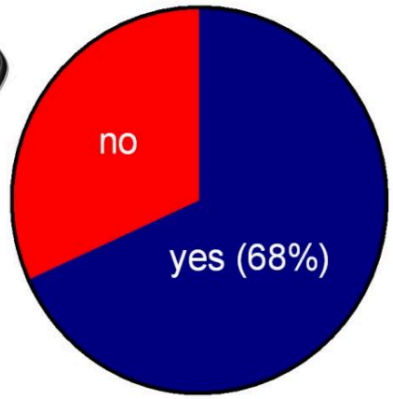
Internet use

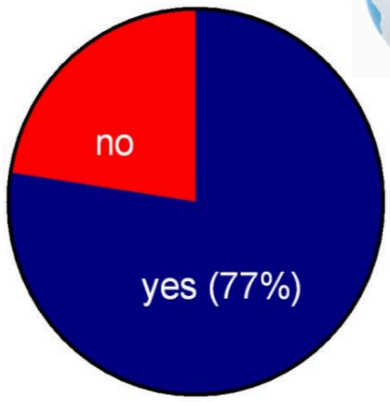


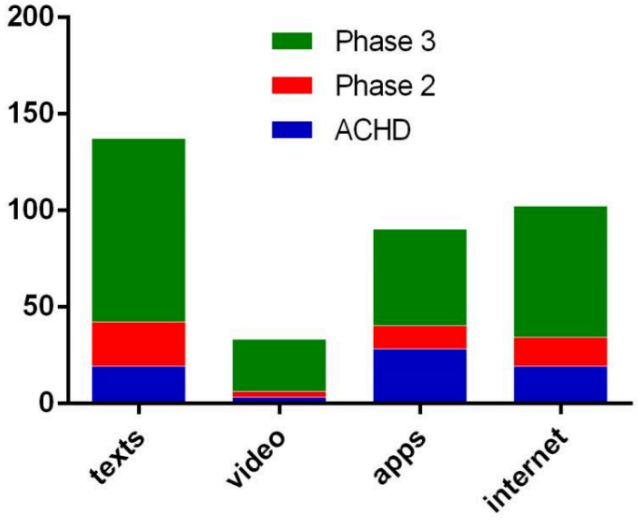


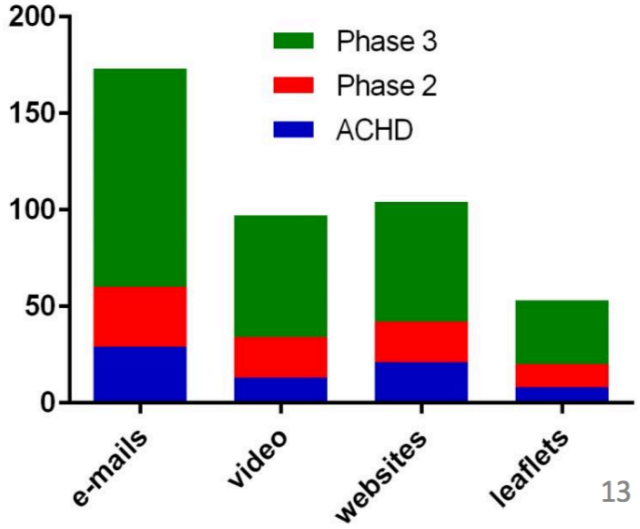


Interested in receiving CR support via mobile phone/internet?

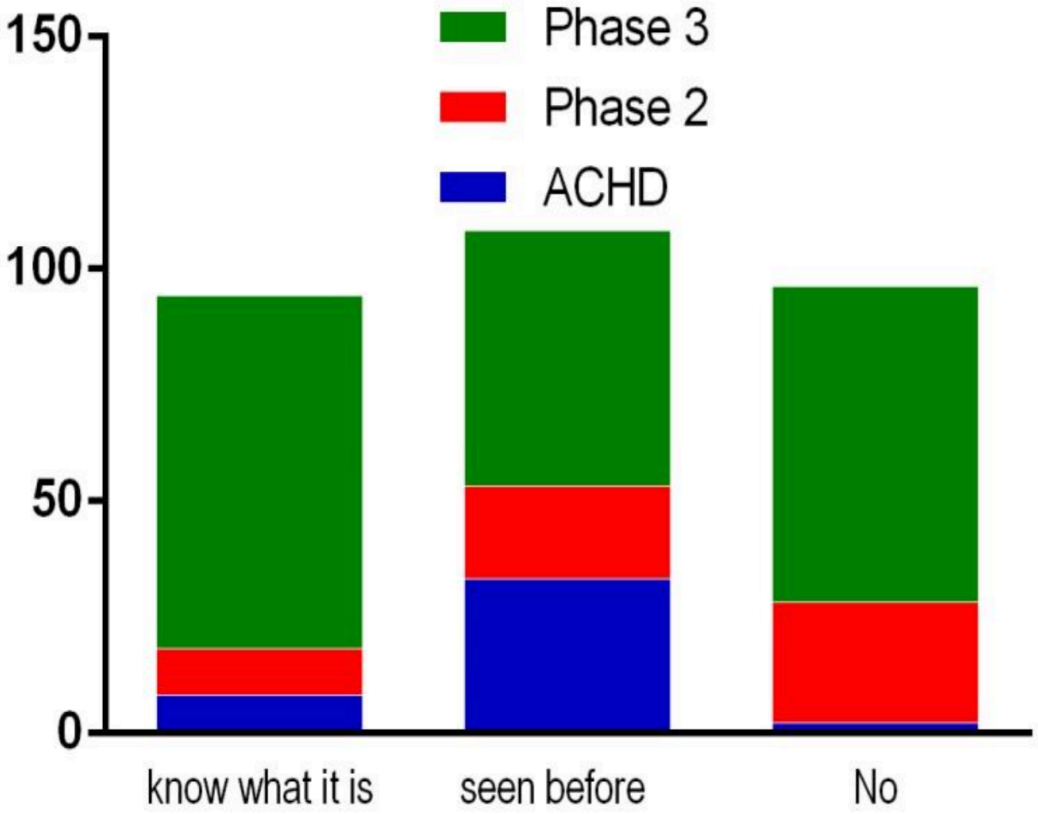


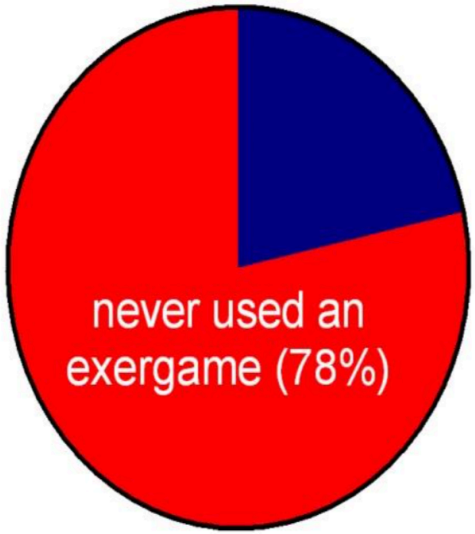




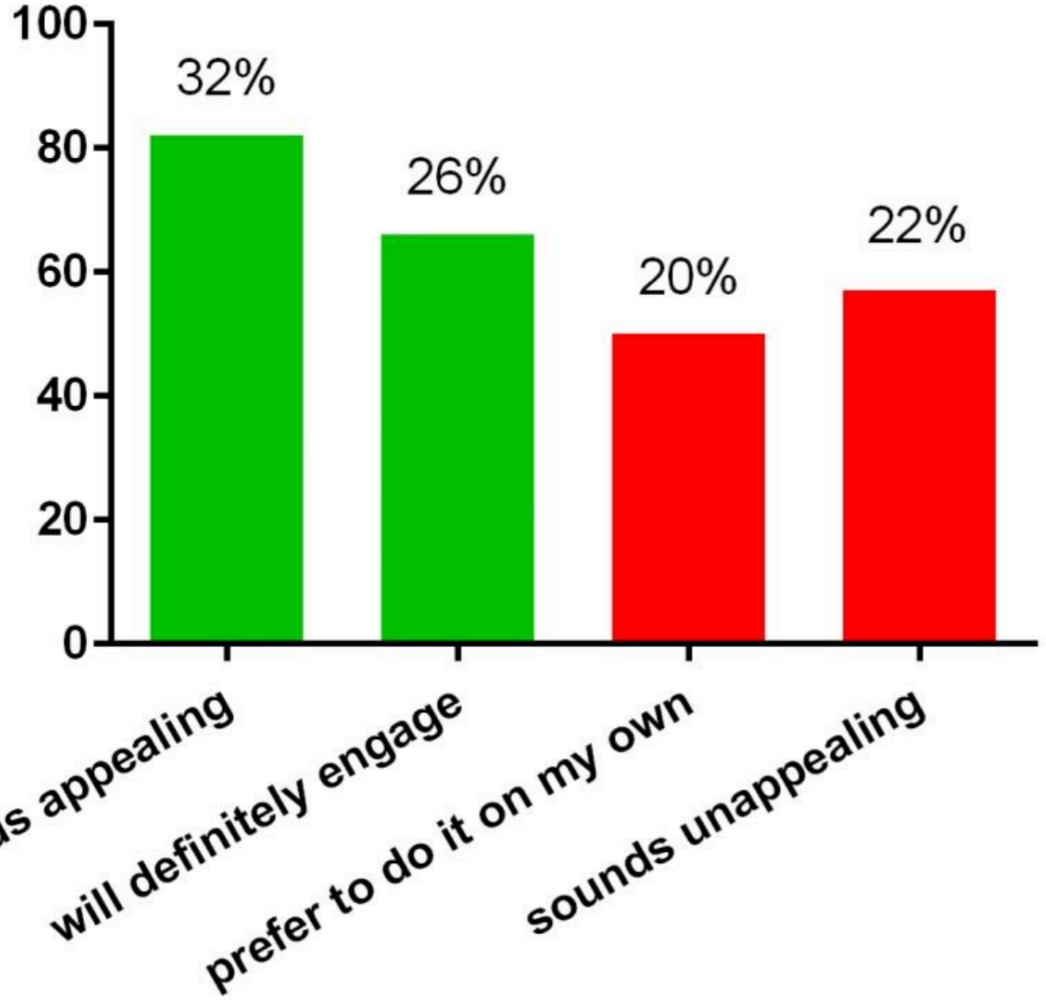


Are you aware of computer based physical activity games?



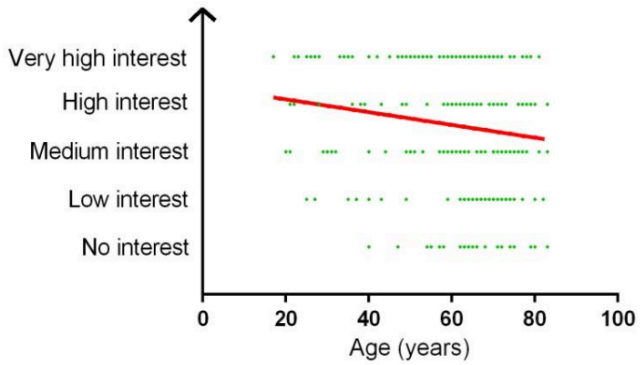


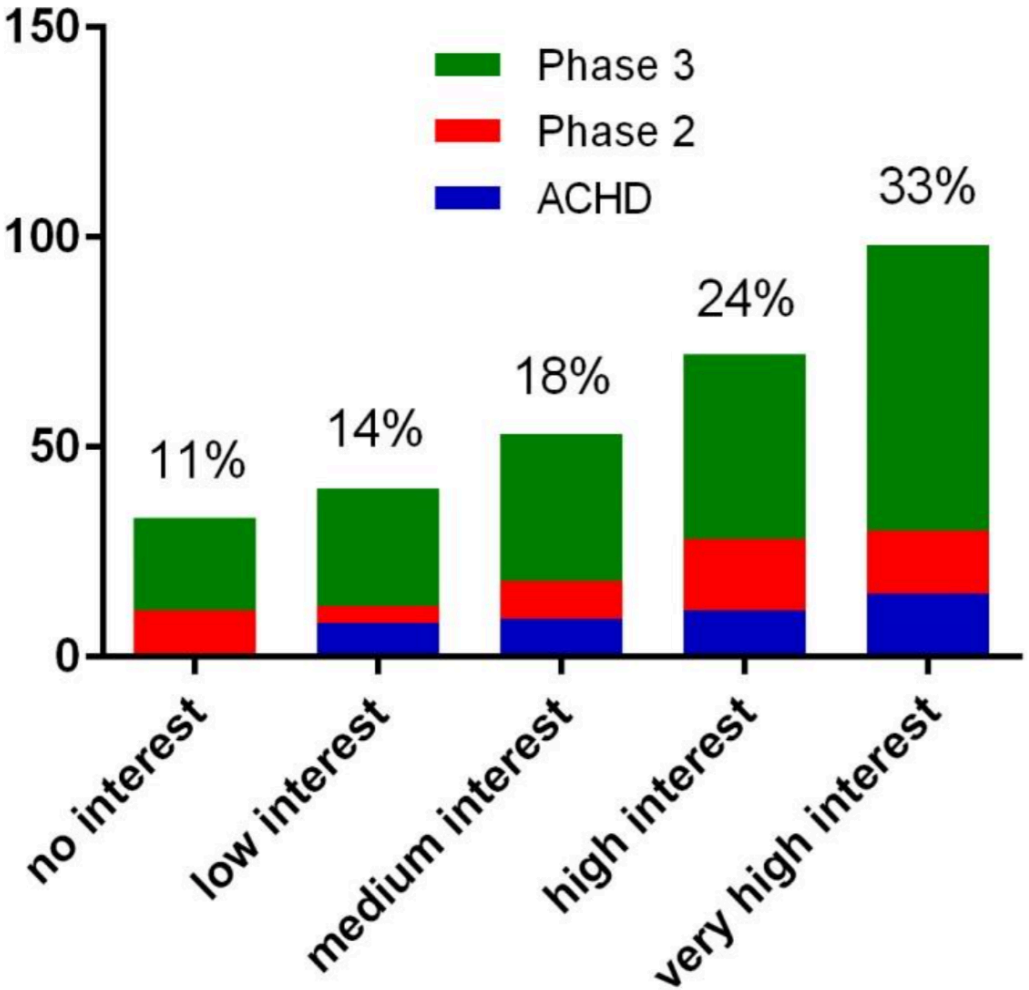
Would you think that a virtual rehabilitation class would be useful?



Overall interest in PATHway

(mobile, internet, computer game, virtual environment)





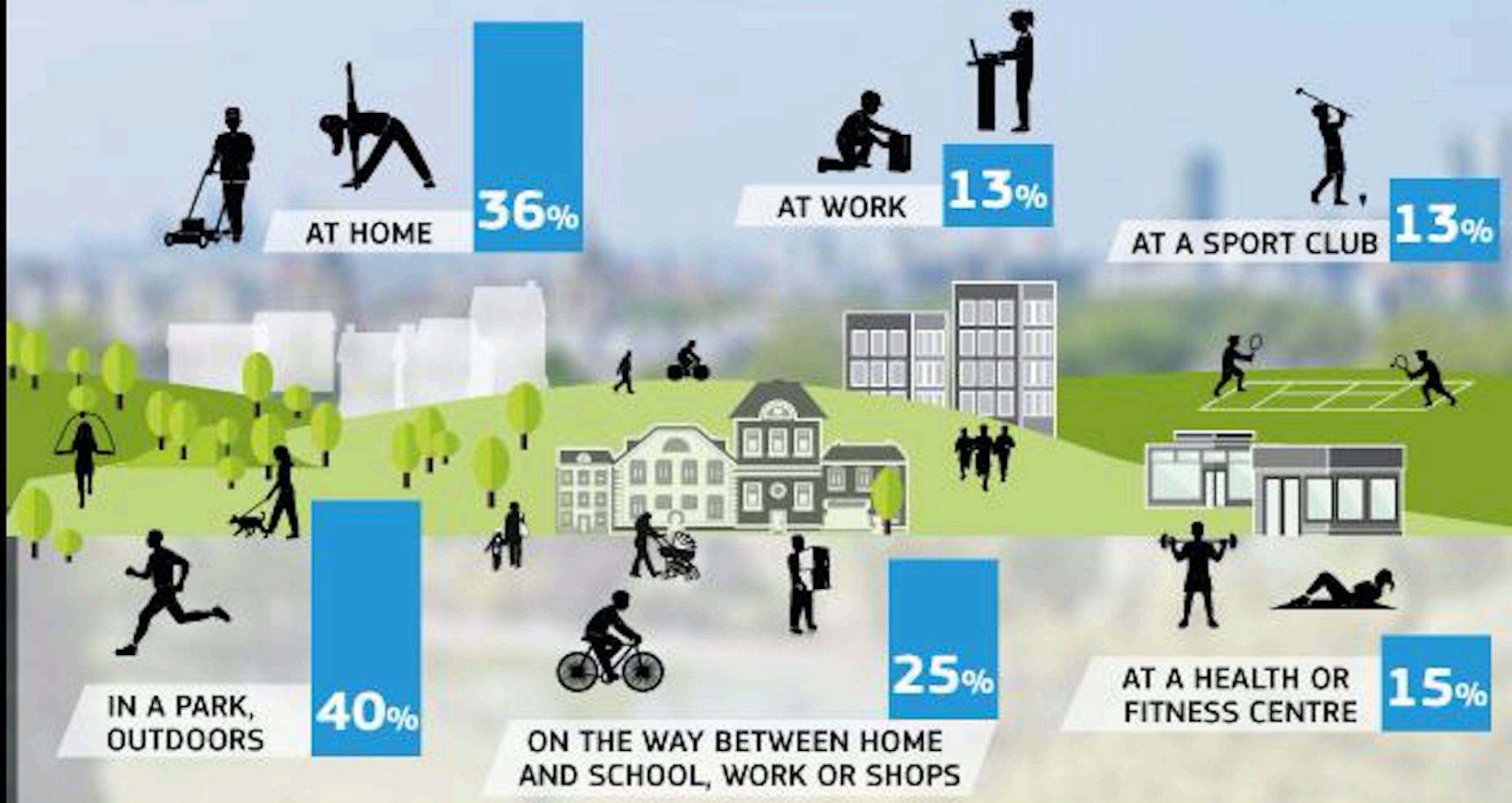
How useful would the following advice be?

	1 Not at all useful	2	3 Somewhat useful	4	5 Very useful
Exercise ideas	11	5	19	**29**	**36**
Exercise prompts	15	9	**26**	24	**27**
Exercise programme taught by a virtual coach (via the internet)	21	10	**22**	**26**	21
Information on local exercise opportunities	10	9	24	**27**	**30**
Healthy meal ideas and recipes	9	9	20	**24**	**38**
Practical ideas to manage stress	13	9	**21**	**21**	**36**
Setting goals	16	9	**29**	**23**	22
Steps to achieve goals	17	8	**27**	21	**27**
How to remember to take your medications	**37**	9	17	13	**25**
Healthy eating tips for takeaways and dining out	**21**	9	**21**	20	**29**
How to link up with others who are living with heart disease	**22**	14	**31**	15	18

 — Source: Eurobarometer Physical Activity 2013

WHERE ARE EUROPEANS *ACTIVE*?

European Week of Sport



European Commission | Sport

#BEACTIVE

Behavourial change: Key Objectives

1. bring together patients, exercise specialists and clinicians to identify and collaboratively define the exercise, health and referral content for PATHway

2. manage ongoing engagement and consultation with stakeholders (health workforce) to ascertain their opinions on how best to effectively implement PATHway within the health care and community settings

CVD Patients

1. Help CVD patients to express their own experiences related to exercise, PA and SB.
2. Help CVD patients to express their needs and wants towards (PATHway) intervention to change specific health-enhancing exercise, PA and SB.
3. Identify CVD patients' needs and wants from a technology-based intervention.

Patient 1-1 Interviews

- **Ethical approval**
- **TUQ: high, moderate and low tech interest/use**
- **In-depth 60 minute interviews**

Our participants

- 42 patients recruited
- 42 patient interviews ☑
  - Phase 4 attendees
  - Phase 3 attendees
  - Phase 4 dropouts
  - Phase 3 non-completers

Preliminary Data Analysis

- Main barrier - Motivation
  - (goal setting/monitoring key to PATHway success)
- Needs to be easy to use, potentially have IT support
- Preference for Active Lifestyle among low tech users
- Want PATHway to augment existing networks, do not want PATHway to replace traditional Phase 4 classes (e.g., HeartSmart)

Preliminary data analysis

- Social connection with other CR patients is key to CR adherence and enjoyment
- Want demonstrations and training with PATHway
- Liked idea of wrist worn sensor
  - Phase 4 patients felt zensor 'too medical'
  - Phase 3 patients like the security of being 'monitored'
  - Raises issues regarding confidence, illness perceptions, will data be monitored
  - Some participants wanted wrist worn sensor to be waterproof

Stakeholder Interviews

Key Stakeholders

1. To explore opinions and preferences for the most appropriate content and most viable approach for delivery of the PATHway intervention
2. Explore strategies for recruitment and retention of study participants.
3. Explore strategies for treatment adherence
4. Explore strategies to overcome barriers to the acceptability of the intervention in the proposed study.

Recruit Key Stakeholders

Chief of the cardiology department (1), CR cardiologists (2), adult congenital heart disease cardiologist (1), hypertension specialist (1), vascular surgeon (1), specialized CR nurses (4), CR physiotherapists/ exercise physiologists involved in phase 3 and 4 (4), CR psychologist (1), GPs (3), social workers (2), local patient organisation (1), technologists with experience of healthcare devices in cardiac rehabilitation (1), the Irish Heart Foundation (1) and the Irish Association of Cardiac Rehabilitation (2)

Recruitment (20 participants)

Public Policy Level:

- Department of Health
- Health Service Executive

Organisational Level:

- Cardiac Rehab Nurses
- Cardiologist
- Health psychologist in CR
- Hypertension specialist
- Physiotherapist
- Cardiology technician

Community Level:

- Irish Heart Foundation
- General Practitioner
- Patient advocacy group

Preliminary data analysis

- Main target should be GPs but patient led.
- Needs easy to read printable summaries (graphs etc.)
- Emergency protocol needs to be in place in case of adverse events (e.g., emergency services numbers provided)
- Issues for implementation/ sustainability
  - Staffing
  - Space (motion capture sensors working accurately within a busy room)
  - Needs to have variety for patients within exerclass / exergame
  - Needs 'buy in' from senior staff and be promoted as the key to Phase 4 throughout team and hospital based CR
  - Buy in comes with evidence based outcomes and if patients enjoy using Pathway.

next steps for behavioural change…

- ✓Development of behaviour change content
- ✓ Formative testing of PATHway content
  1. Focus groups with CVD patients (N= 12 FGs)
     - How to incorporate PATHway in daily lifestyle?
     - What functions they find useful?
     - Strategies to maintain engagement with PATHway?
  2. Steering committee review (Stakeholder Expert Panel)
     - Review existing content
     - Review theoretical basis and logic behind PATHway prog.
     - Agreement on key PATHway components and functionality

RePLAY: Digitally Capturing Unique skills in European Traditional Sports and Games

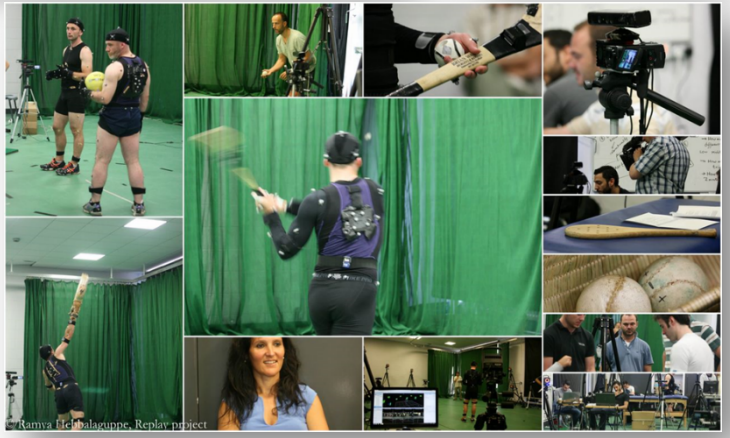
(FP7, ICT-2011.8.2 : €2m, 8 European partners)

Understand

Preserve

Promote

Protect



Why this project?

- "Traditional Sports and Games (TSG) are part of Intangible Heritage and a symbol of the cultural diversity of our societies" (UNESCO, 1989)

  - Only in Europe, there are over 3000 Traditional Sports and Games
  - Many Traditional Sports and Games are already lost or in danger of disappearing
    - Globalization by a few sports
    - Increased tendency towards individual physical exercise

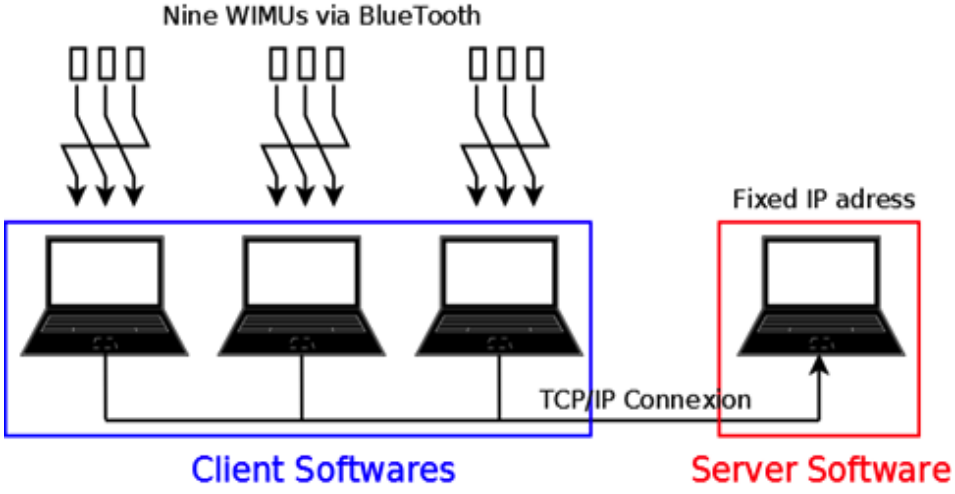
What is RePlay

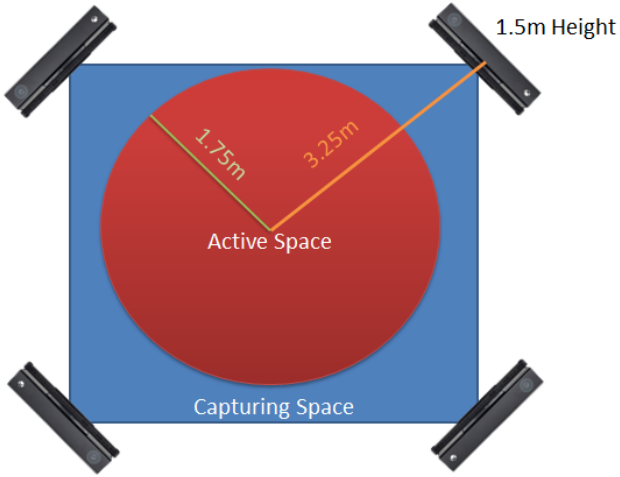
Understand, preserve and promote Traditional Sports and Games

- RePlay is a €2million research project funded by the EU Framework Program 7 (FP7)
- RePlay will develop a low-cost technology platform to access and interpret digital content for Traditional Sports and Games
  - Selection of Sensors and low-cost capture technologies for 3D sports content
  - analysis and modeling of performance skills
  - 3D rendering and visualization of motion capture data
- RePlay will select several modalities from Basque Pelota and Gaelic Sports as representatives of Traditional Sports and Games
- The project started on the 1st of March 2013 and will last for 36 months (Until the end of February 2016)

RePlay Platform set-up

- COACH&TRAIN scenario
  - Hardware
    - Four Microsoft Kinects
    - Nine Shimmer3 WIMUs

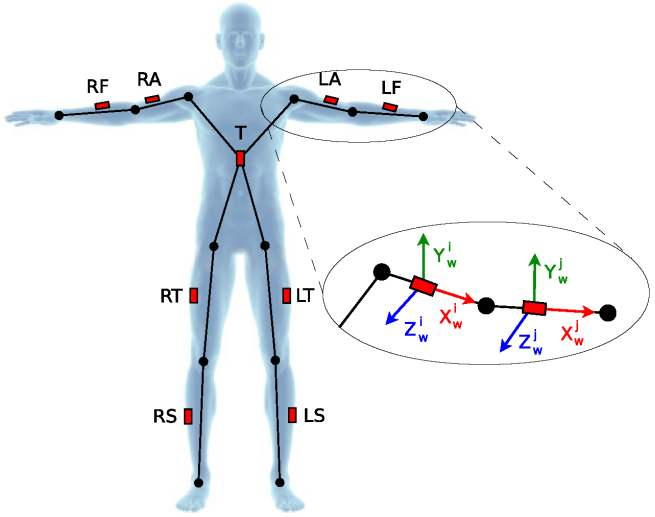




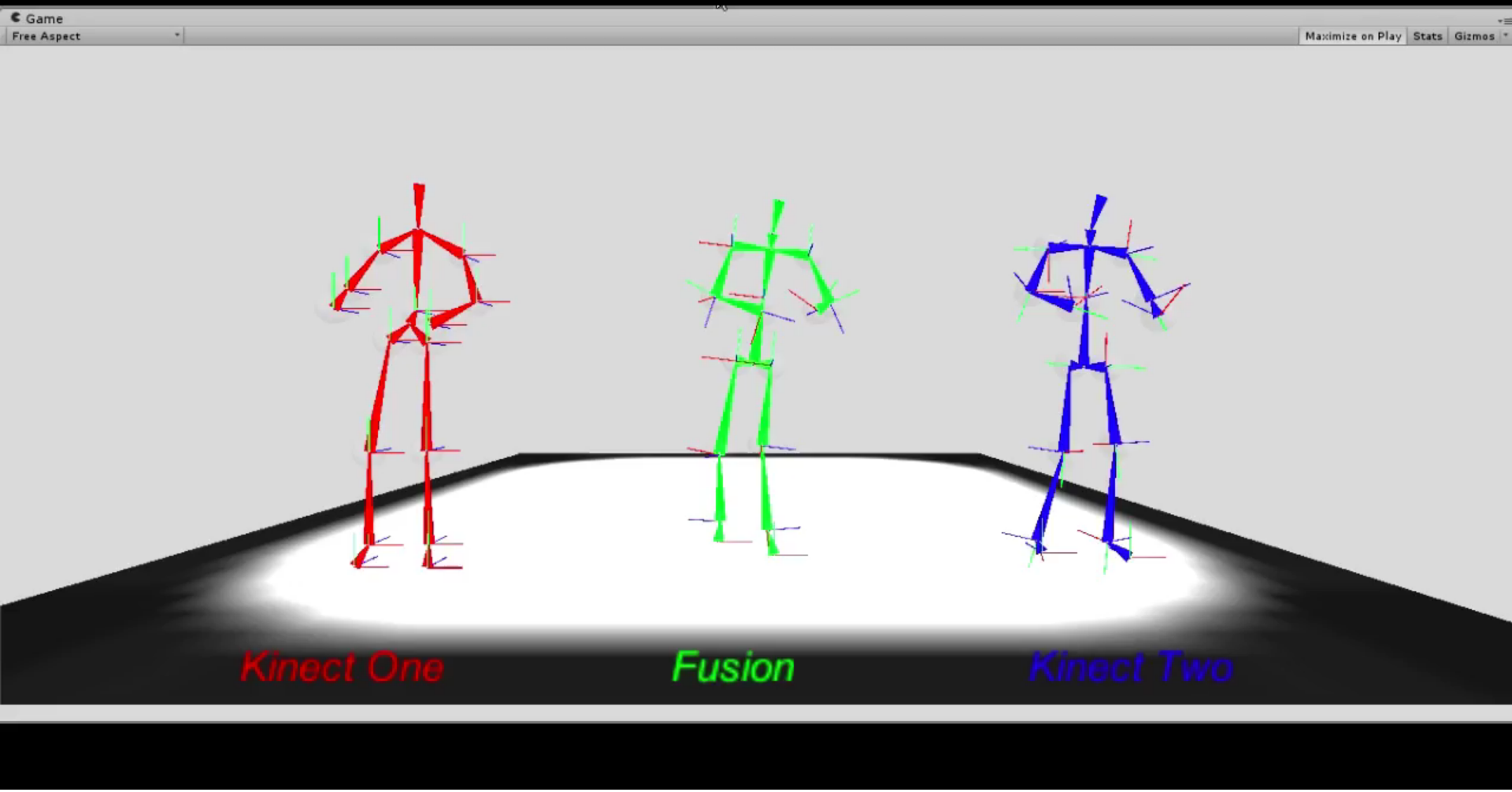
Fused skeleton

- The RePlay platform relies on fused skeleton combining the Microsoft Kinect and WIMUs
  - The platform extracts one skeleton of reference from the Microsoft Kinect device
  - Local orientations over time are extracted from the WIMUs

- The fused skeleton is the combination of the reference skeleton and the rotations

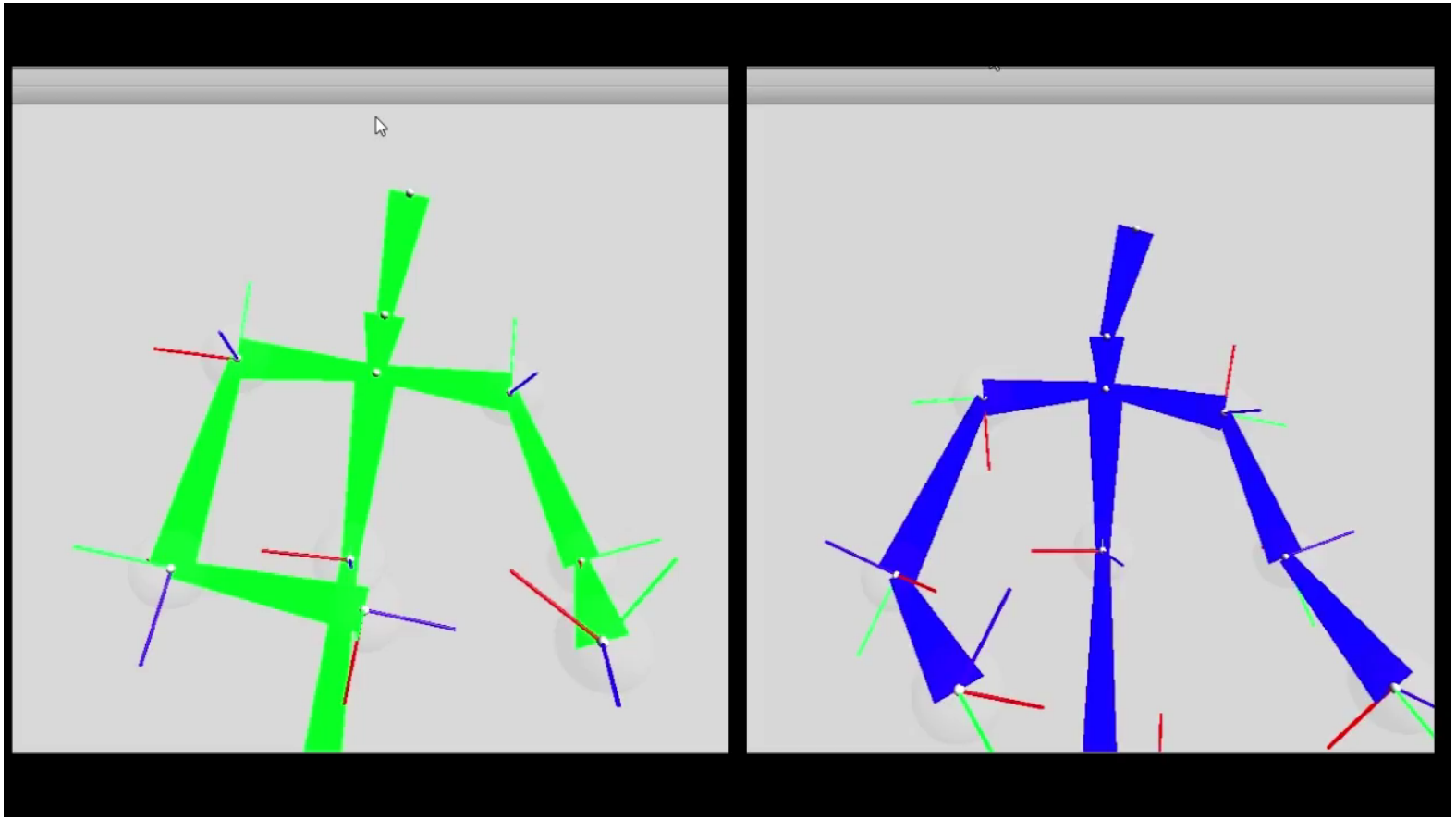


Fused skeleton

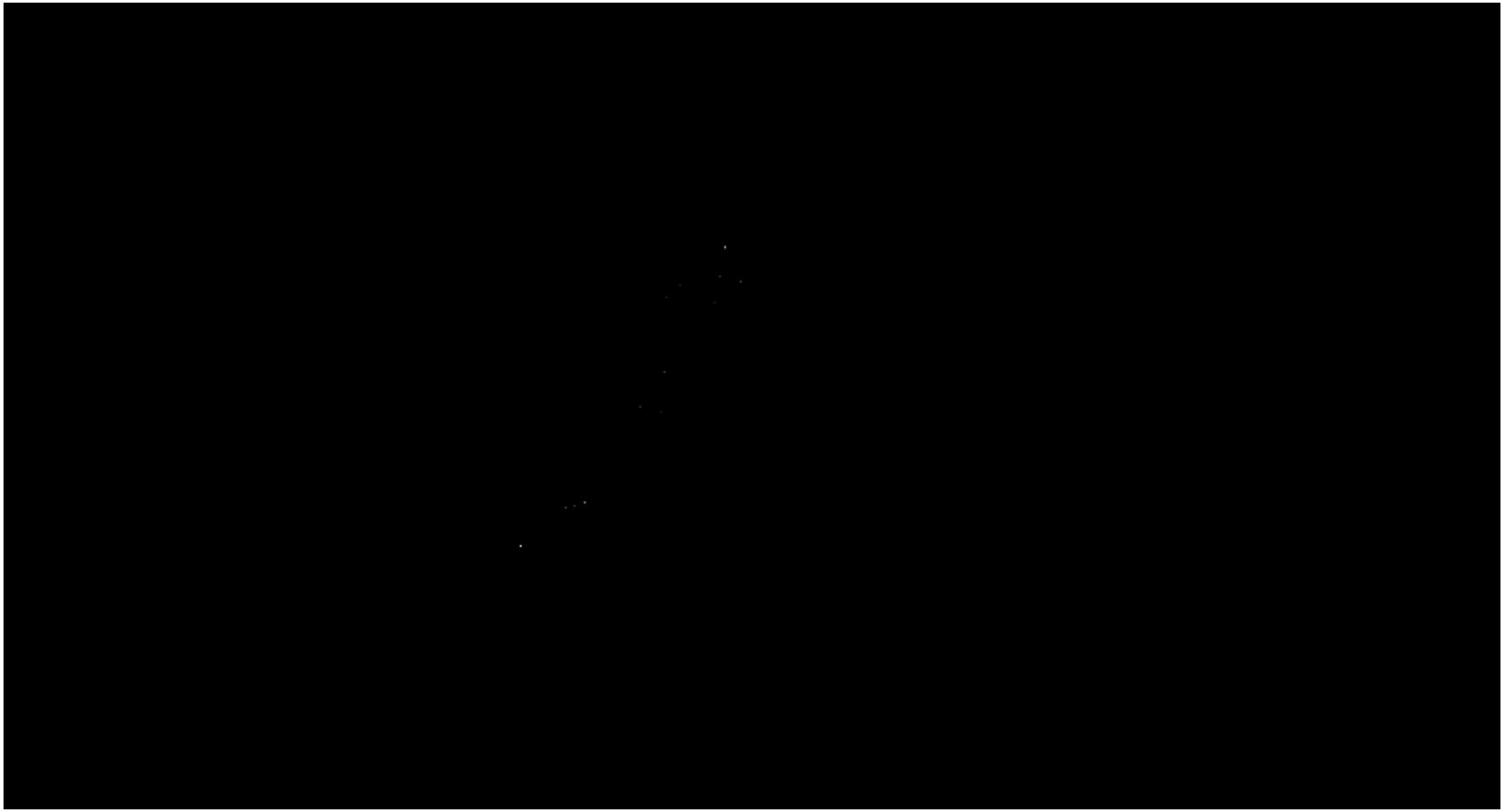


Fused skeleton

- Animation of the fused skeleton from a reference



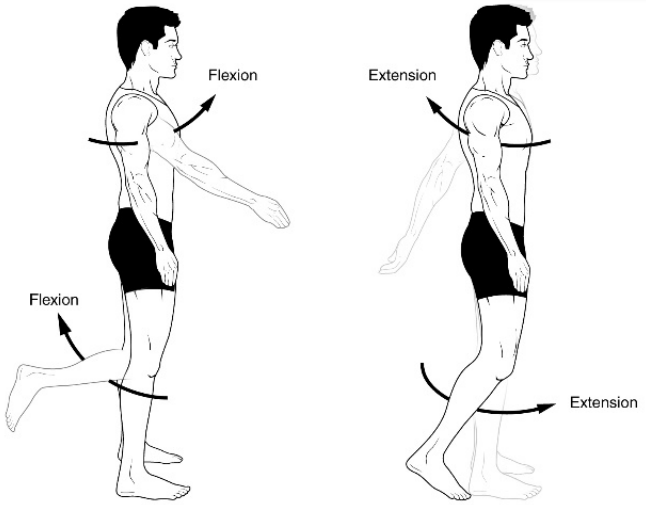
Full Body 3D Reconstruction



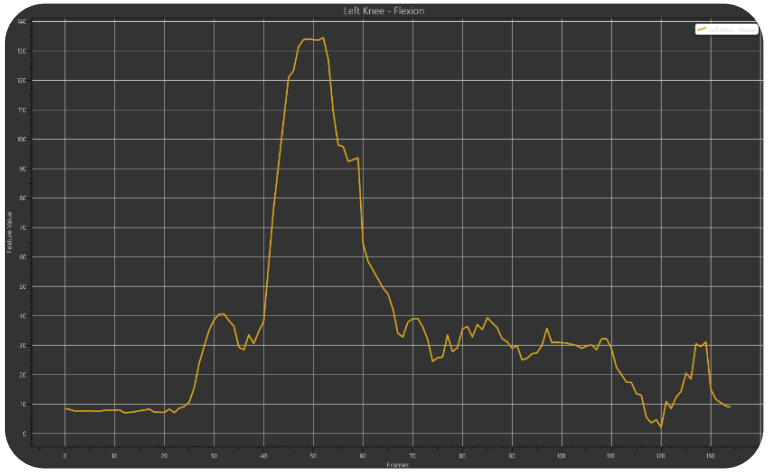
Feature extraction

- Feature extraction
  - Accurate motion features are essential, as they will be used for the scoring system and the semantic feedback
    - Joint's relative positions (to the root joint)
    - Joint's hierarchical rotations (with respect to their parent joint rotation)
    - Joint's linear velocity
    - Joint's angular velocity

    - Flexion
    - Extension
    - Adduction
    - Abduction
    - Linear kinetic energy of each joint



(a) and (b) Angular movements: flexion and extension at the shoulder and knees

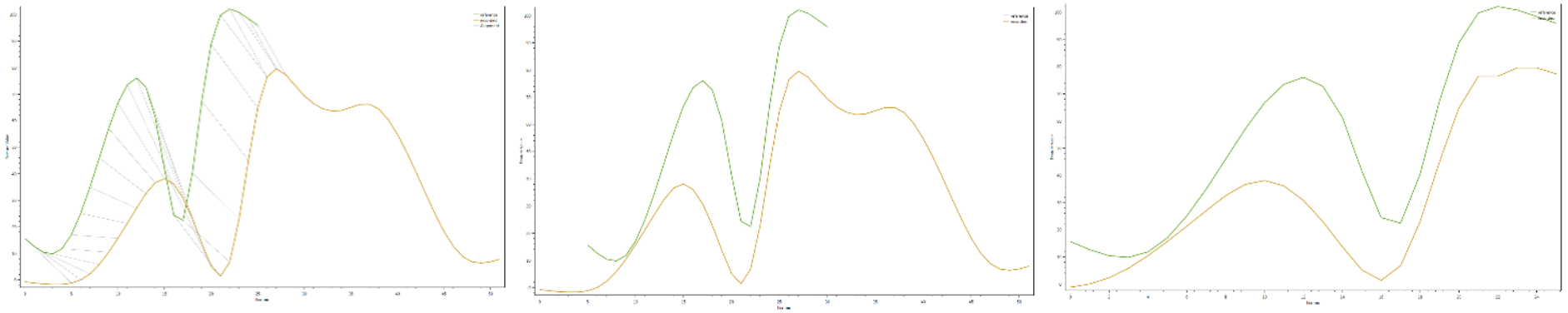


Left knee flexion

Skill synchronization

- The DTW technique is applied without constrains to align the trials globally and offer the temporal warping
- Joints information are combined using the weights of importance defined by experts

"Right-Handed Underarm Shot" (Handball Sport)



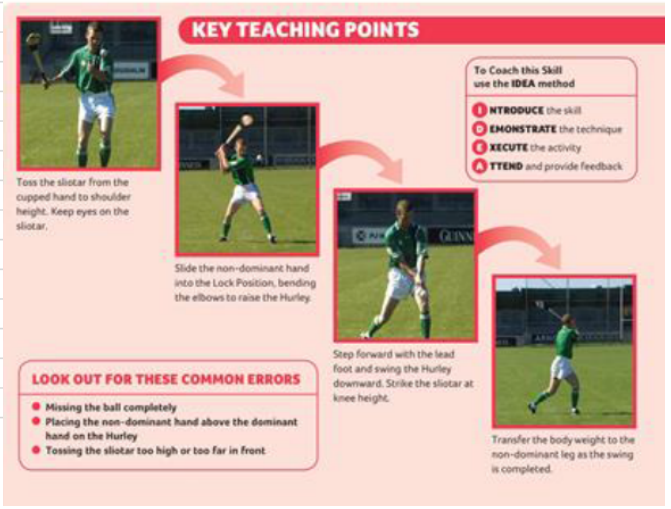
Y component of the wrist position. The green is the reference activity, the orange one is the user's recording activity.

Skill comparison

- Skill evaluation
  - It follows a weighted scheme
  - Pre-defined weights for every sport action have been assigned on the basis of specific teaching points

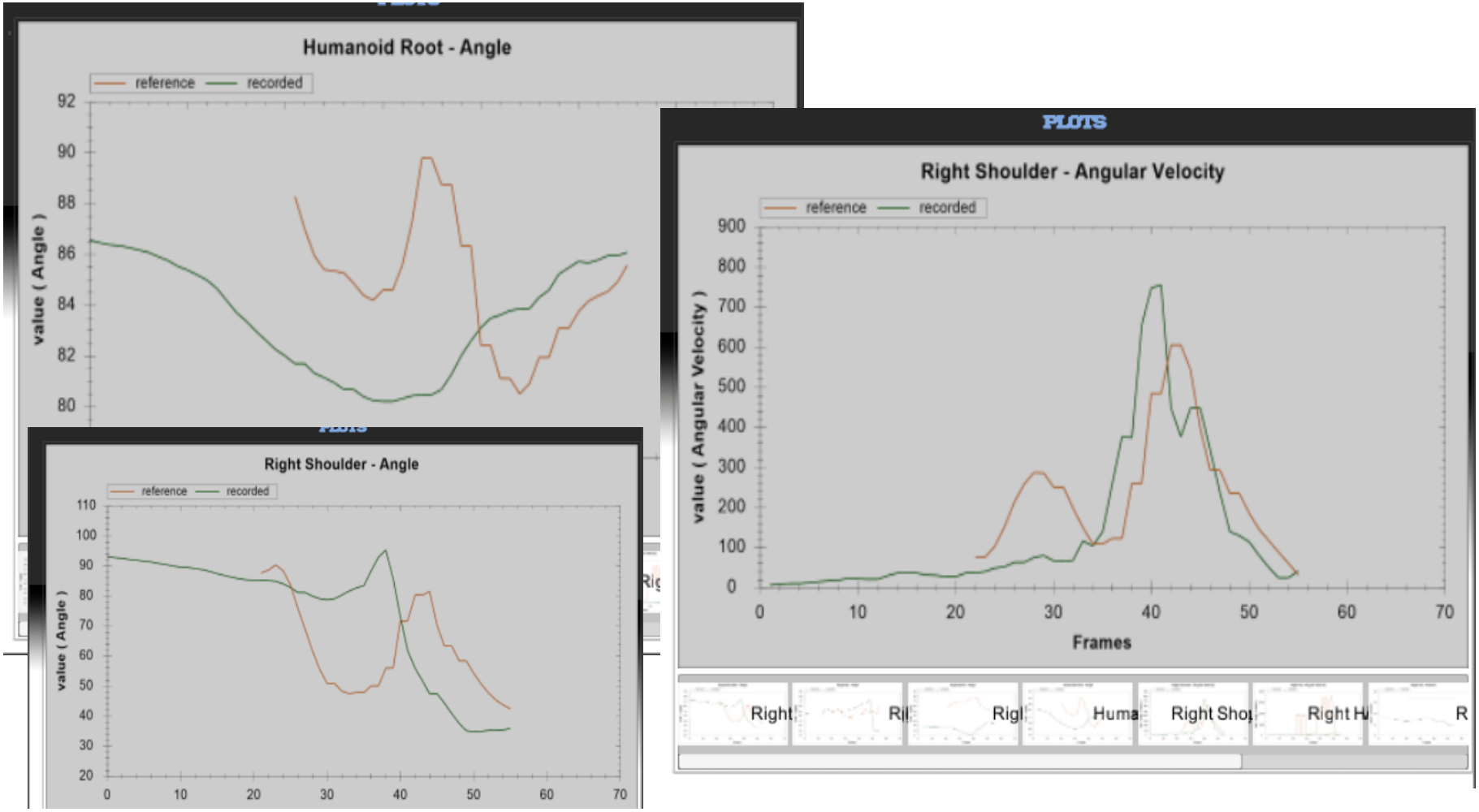
Hurling – Strike from the Hand

	position	angle	linear vel	angular vel		
Head		1			0.1	
Trunk		1		0.33	0.6	Measured relative to the global ccordinate system (intended direction of strike)
R_Hip						
R_knee						Flexion - extension
R_ankle						
R_Shoulder		1		0.8	1	
R_Elbow		1		0.8	1	Flexion - extension
R_wrist		1			0.3	
L_Hip	0.33	1	0.22	0.56	0.9	
L_knee		1			0.1	Flexion - extension
L_ankle						
L_Shoulder		1			1	
L_Elbow		1			1	Flexion - extension
L_wrist		1			0.3	



Feedback return

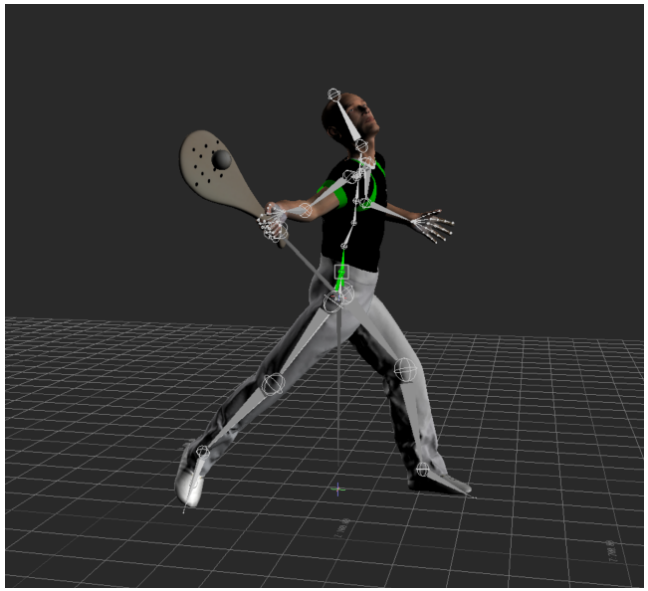
- COACH&TRAIN scenario

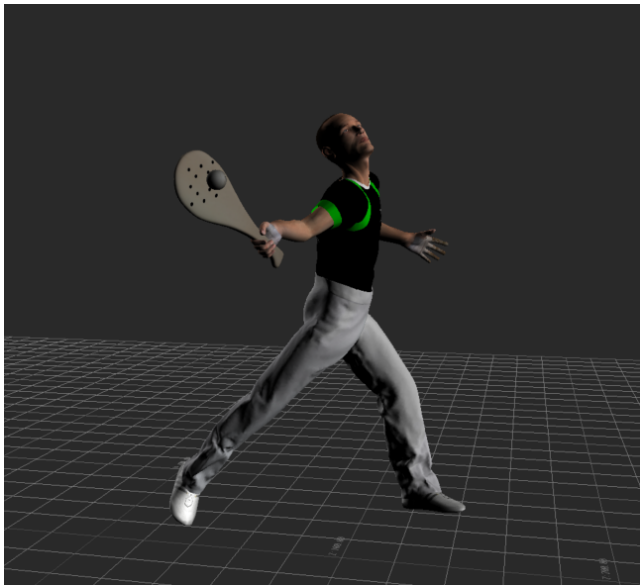


Feedback return

Rendering and Visualization

- 3D reconstruction of the appearance of the National/Local Heroes component
  - Template avatar
    - A template avatar has been designed
    - A customized avatar has been created for each disciplines
      - Clothes
      - Accessories





Rendering and Visualization

- 3D reconstruction of the appearance of the National/Local Heroes component
  - Image based 3D scanner
    - A low cost 3D scanner has been built in order to create an accurate 3D avatar of the National Heroes
    - 81 compact cameras are synchronized
    - Photogrammetry technique is used for 3D reconstruction

What has been achieved?

- Dynamic animation viewer to visualize the activation of the targeted muscle during the animation

RePlay Platform

deirdre walsh
amin ahmadi
dave monaghan

….. thanks for listening