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AALBORG UNIVERSITY

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Disclaimers:

In this keynote I present my mature body of research titled “SoundScapes”

It is important to state that this research is not claimed as a medical intervention.

This presentation is on an over three-decade body of award-winning iterative ongoing research involving specific applied digital media across societal contexts

Keynote title:

“(WORKING TOWARDS) PROBABLY THE BEST (RE)HABILITATION COMPLEX IN THE WORLD” (REFLECTING APPLIED AI + ICT, HEALTH 5.0 AND DIGITAL WELLNESS)”

Introduction

In the following short video if any discomfort or anticipation of reaction to animated images is felt then please look away on slide change for approximately 45 seconds – thank you.

Background –

Who?.....What?.....Why?.....How?....etc

SOUNDSCAPES: THE EVOLUTION OF A CONCEPT, APPARATUS AND METHOD WHERE LUDIC ENGAGEMENT IN VIRTUAL INTERACTIVE SPACE IS A SUPPLEMENTAL TOOL FOR THERAPEUTIC MOTIVATION

– targeted societal impact

Born with (across functional abilities) or **Acquired** (across functional abilities)

children/people of determination e.g. Stroke, through to locked-in syndrome

……including the elderly (across functional abilities) ……. and families (home-based)

+

……intervention/care/treatment program staff – including design teams / tech teams / evaluation teams….. etc

Identifying and exploring challenges they may be facing… towards improved situations…..

Questioning potentials and impact to pass onto the next generation of researchers, educators and therapists…etc

SoundScapes

Keywords of focus are:

(Re)habilitation – The holistic body of research covers those ***born-with*** a condition or with an ***acquired*** condition – it thus covers ***habilitation*** and ***rehabilitation***

Habilitation
Habilitation refers to a process aimed at helping individuals with disabilities attain, keep, or improve skills and functioning for daily living.

Rehabilitation
Rehabilitation refers to regaining skills, abilities, or knowledge that may have been lost or compromised as a result of illness, injury, or acquiring a disability.

SoundScapes'
Other keywords include:

Experience - (***both for participant and facilitator*** – be they professional staff, family or others)

Creativity – interactive environments are ***created and tailored to each participant*** according to profile, need, and desired outcome:

Play – In SoundScapes contemporary gameplaying is an option.

Enjoyment – Fun and motivation to participate are targeted as a result of user experiences.

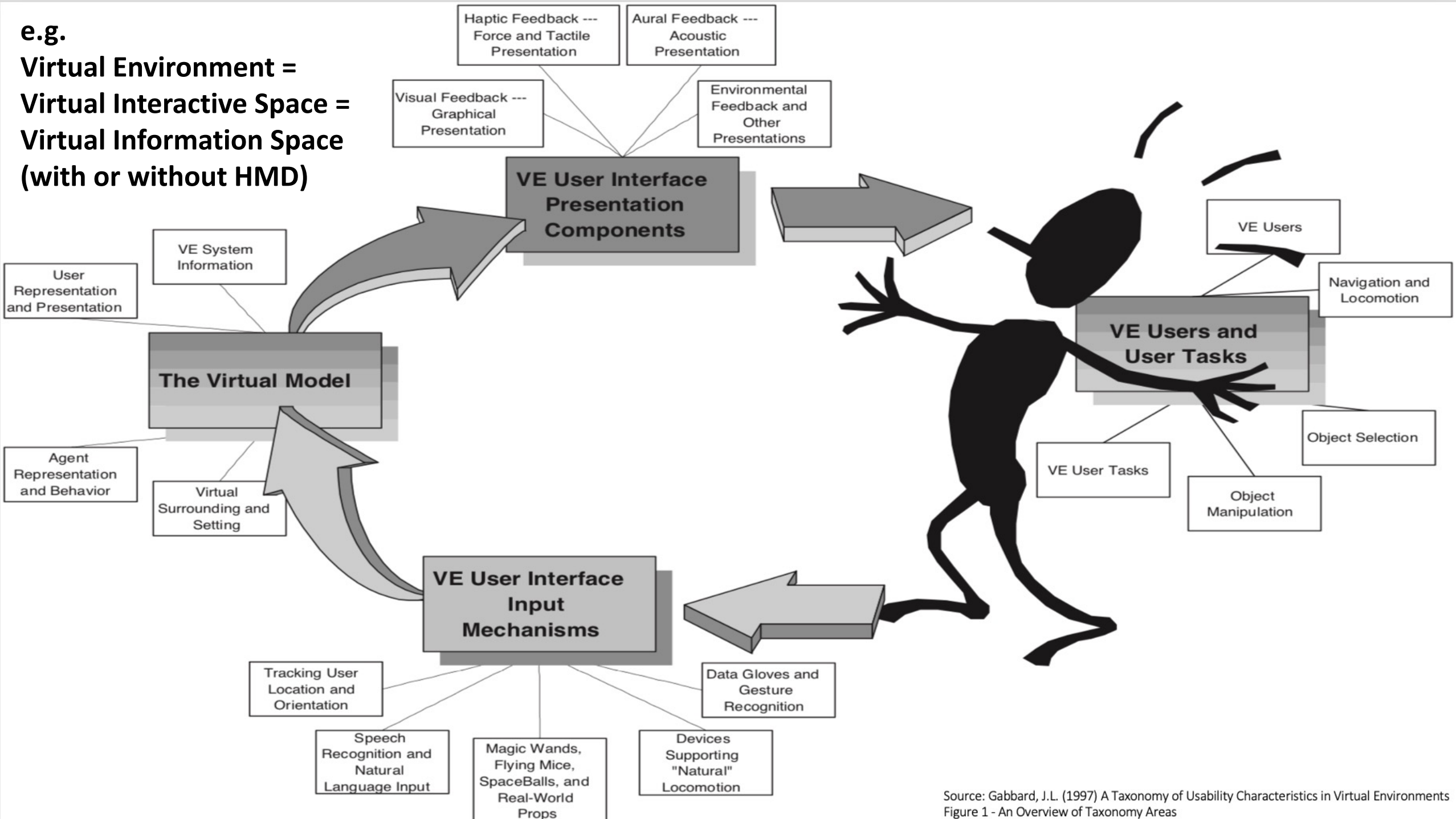
Successes and Achievements – Efficacy and positive experience align with self-agency

Empowerment – towards happy and engaged compliant participants

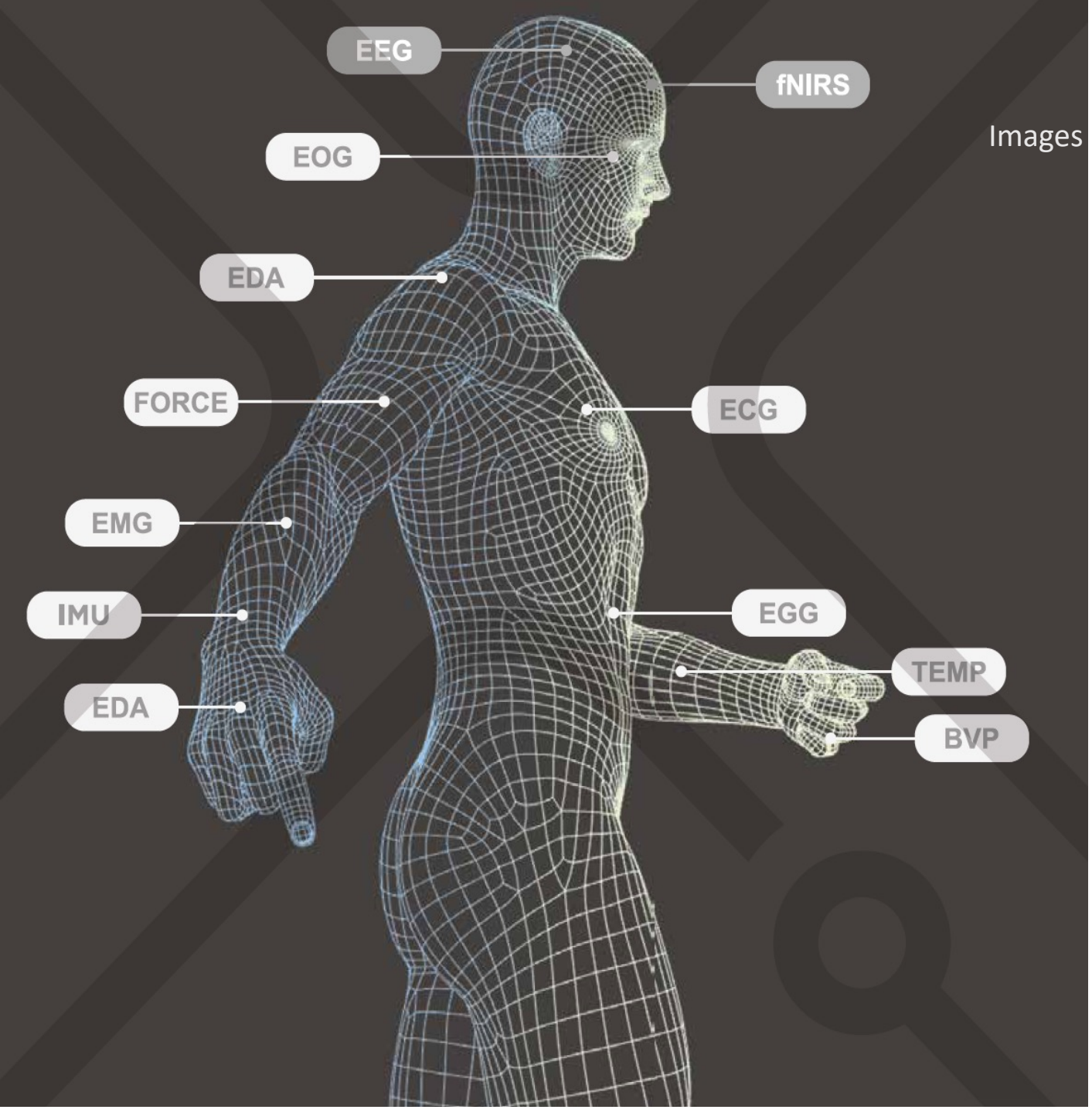
Virtual (figurative or abstract forms of 'Reality') – selectable tools/interfaces, hw/sw, and contents

Blackbox (Opening) – improved documentation and rapportage of expert interventions (>> sharing)

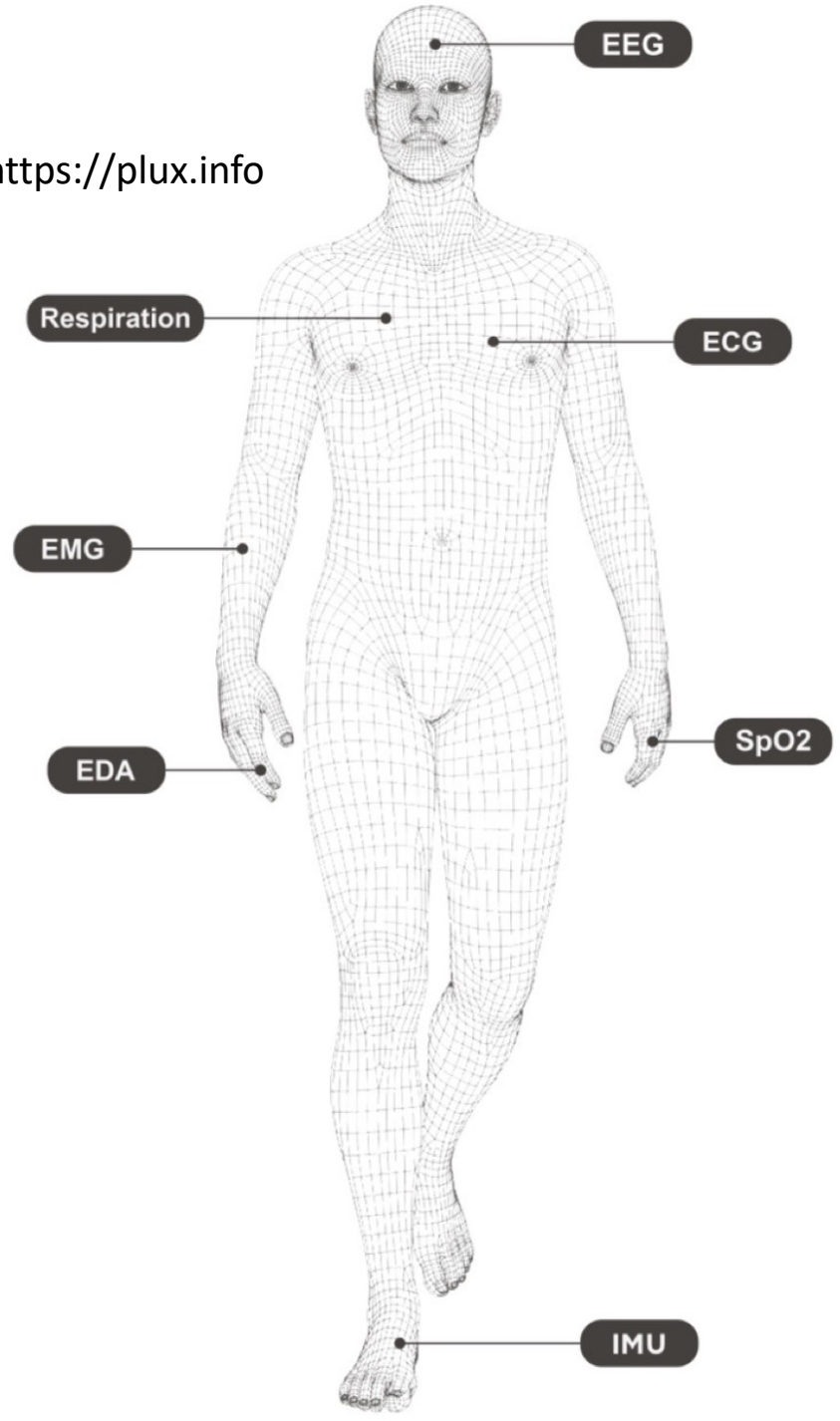
e.g.
Virtual Environment =
Virtual Interactive Space =
Virtual Information Space
(with or without HMD)



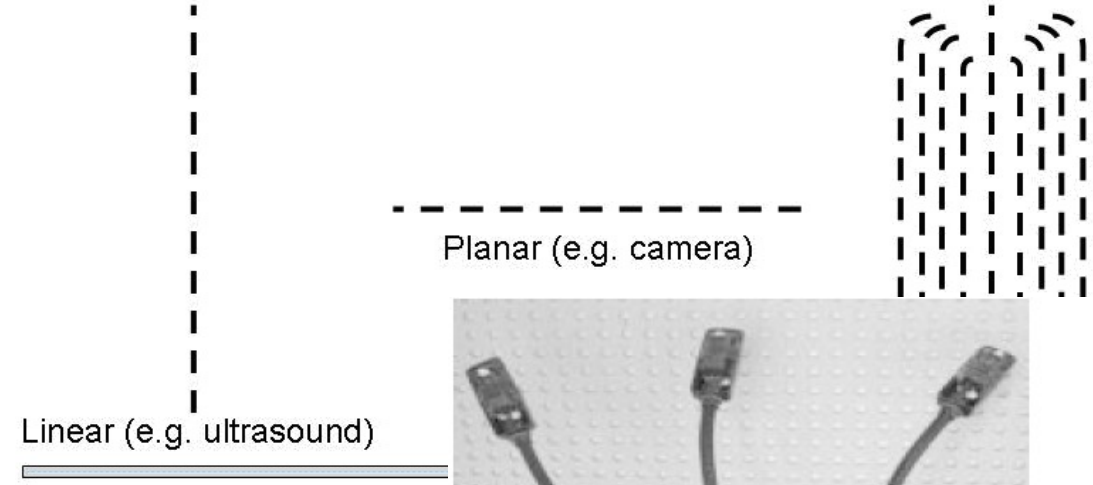
Source: Gabbard, J.L. (1997) A Taxonomy of Usability Characteristics in Virtual Environments
Figure 1 - An Overview of Taxonomy Areas

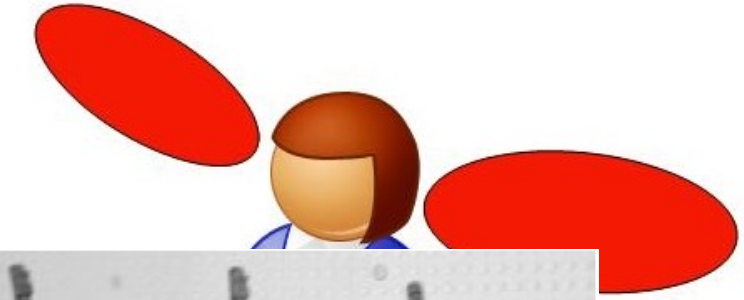


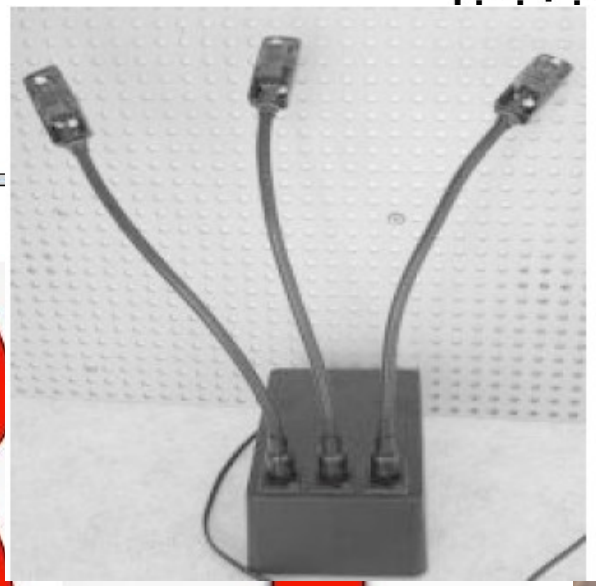
Images by Plux - https://plux.info

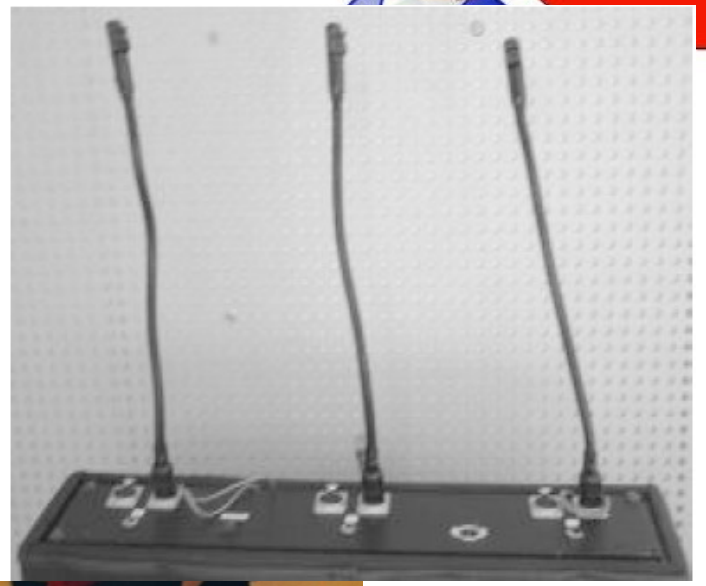


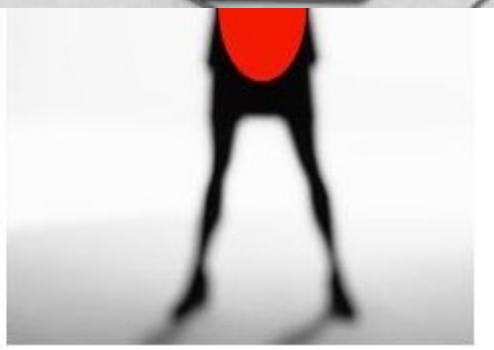
Sensor collection of data – on body or off-body

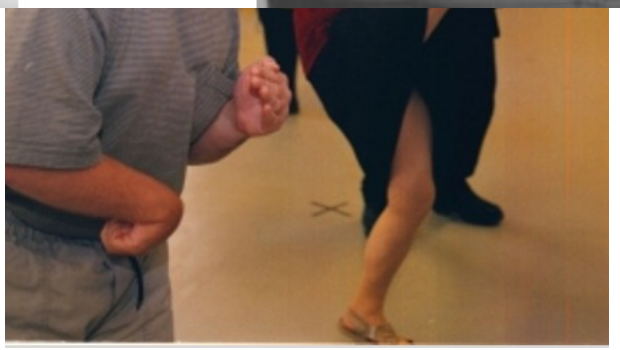


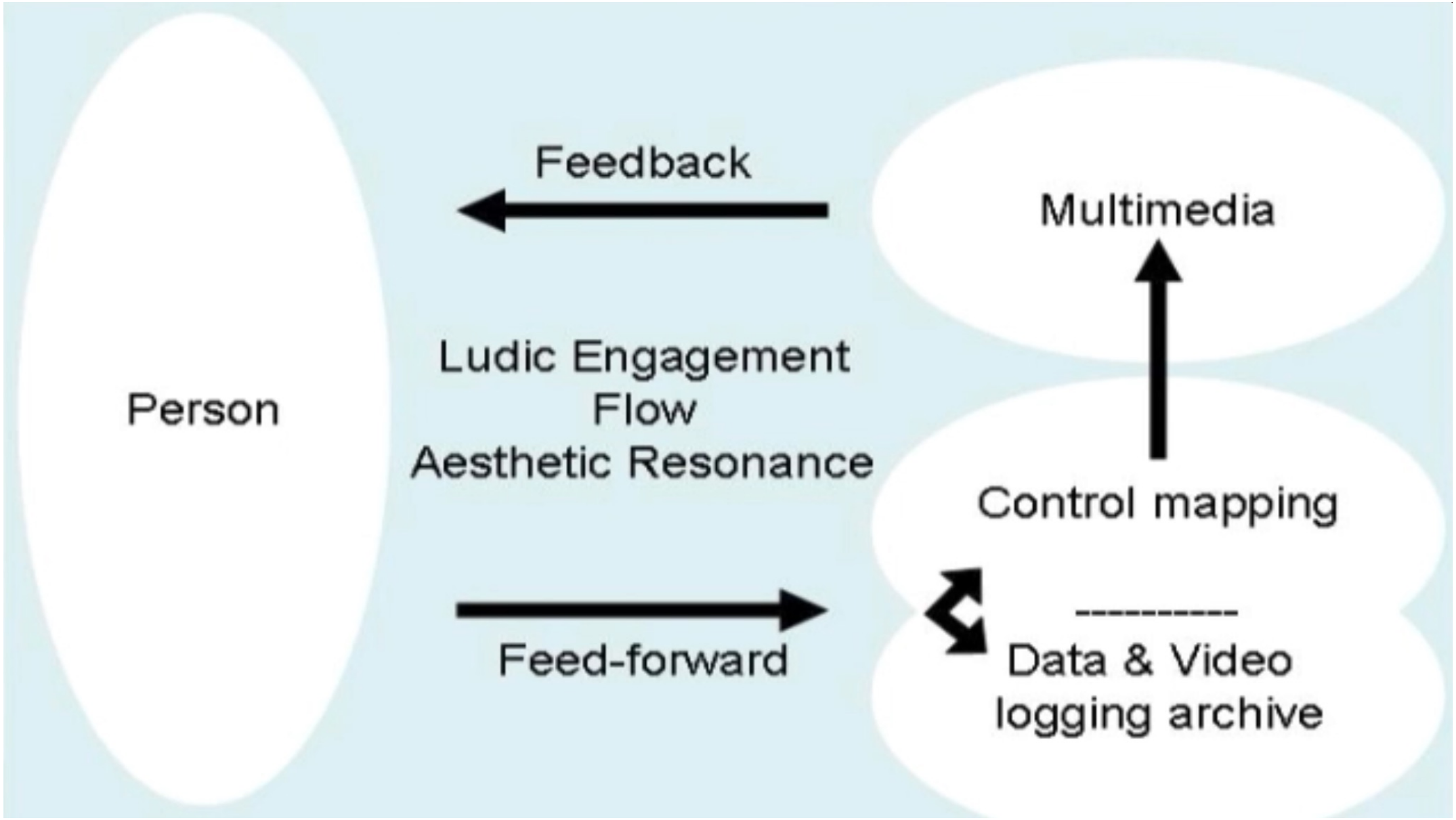




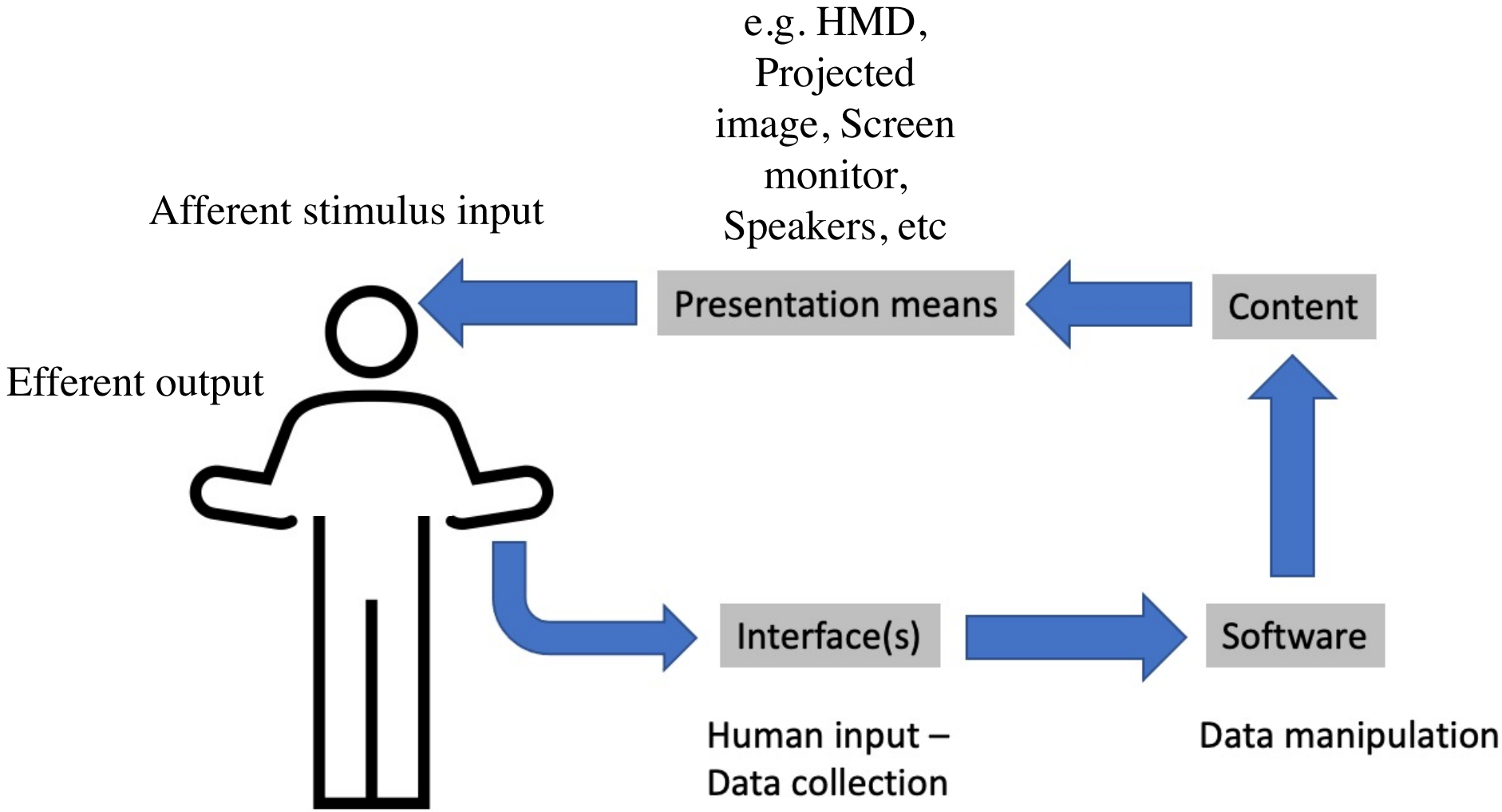


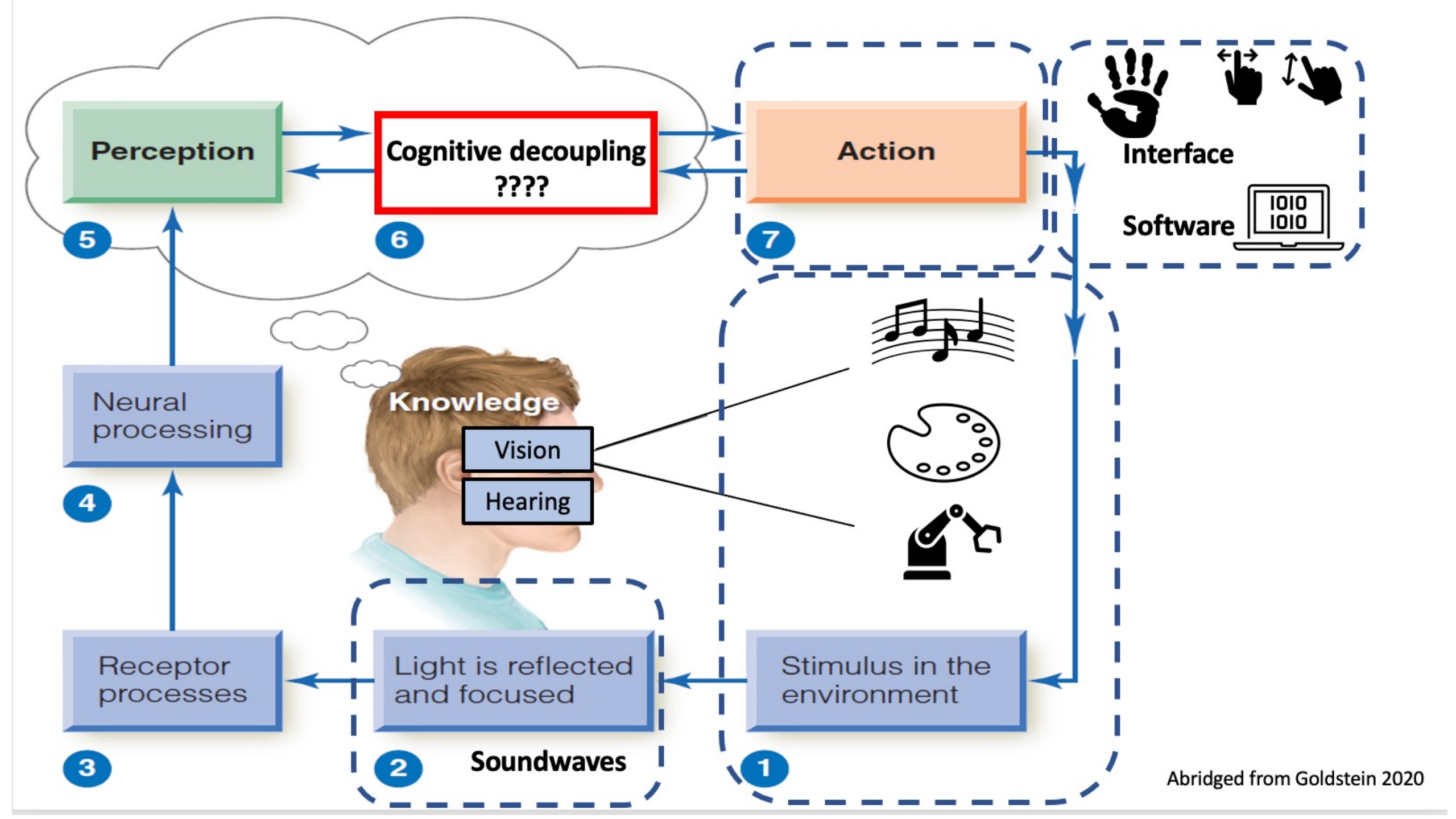





Feedback
Multimedia
Person
Ludic Engagement
Flow
Aesthetic Resonance
Control mapping
Feed-forward
Data & Video
logging archive

SoundScapes – Virtual Interactive Space (VIS) – (data)



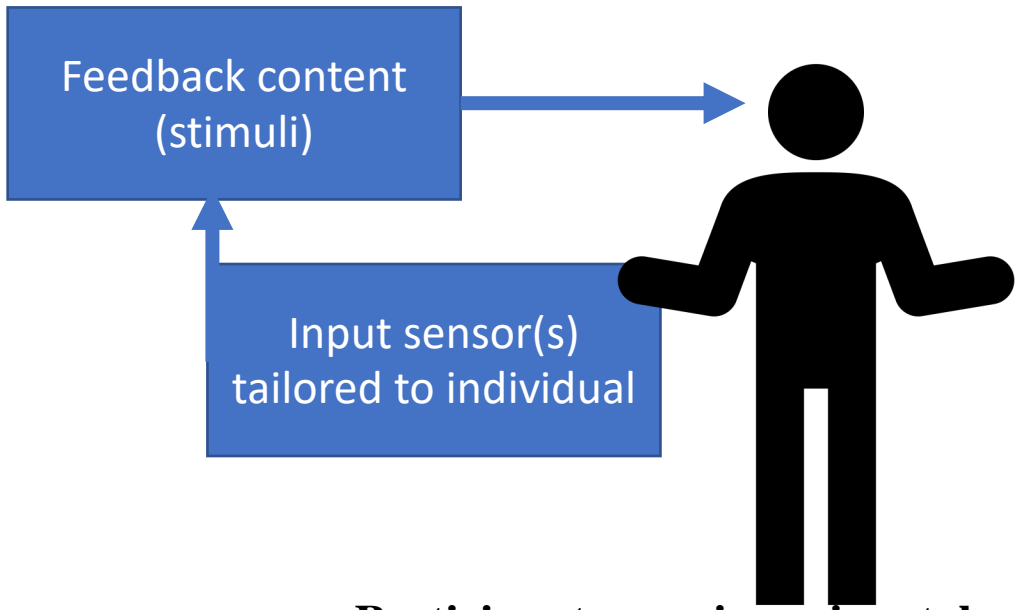


Abridged from Goldstein 2020

Participant experience = simple and participant-centered

= a fun interactive environment where he/she can creatively express, play/perform and enjoy

– a space and place to be happy

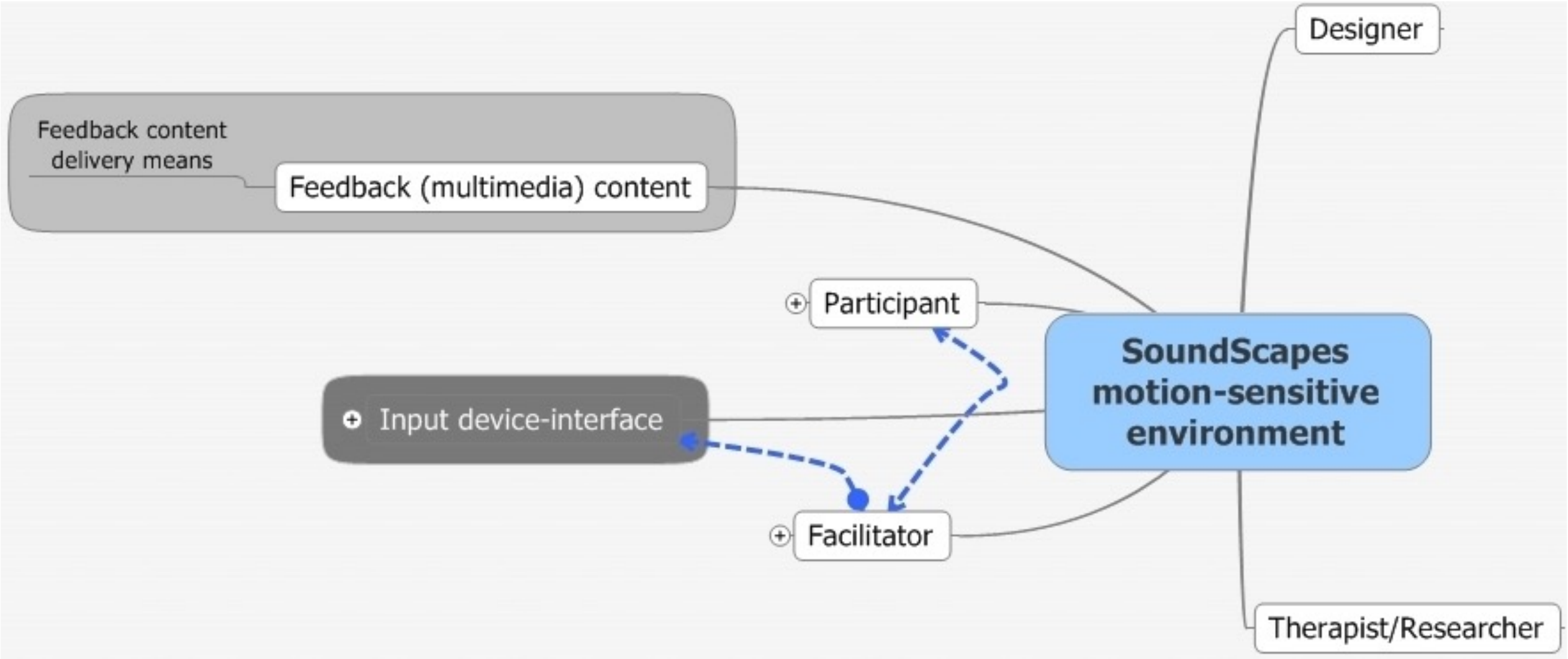


Participant experience is catalyst and focus =
human centered use of technology

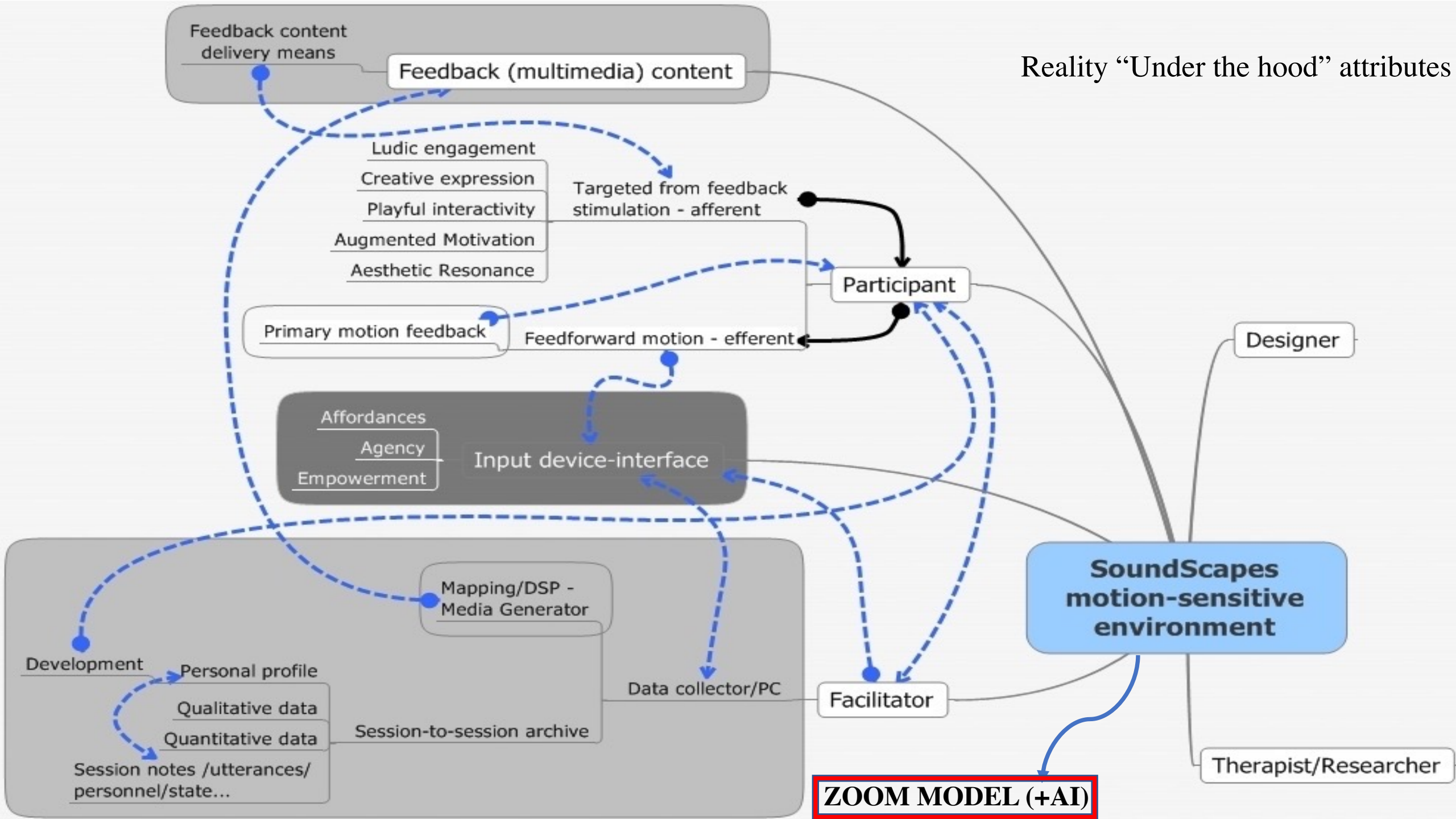
He or she enters, and the set-up just works

(following prior fine tuning via role playing)

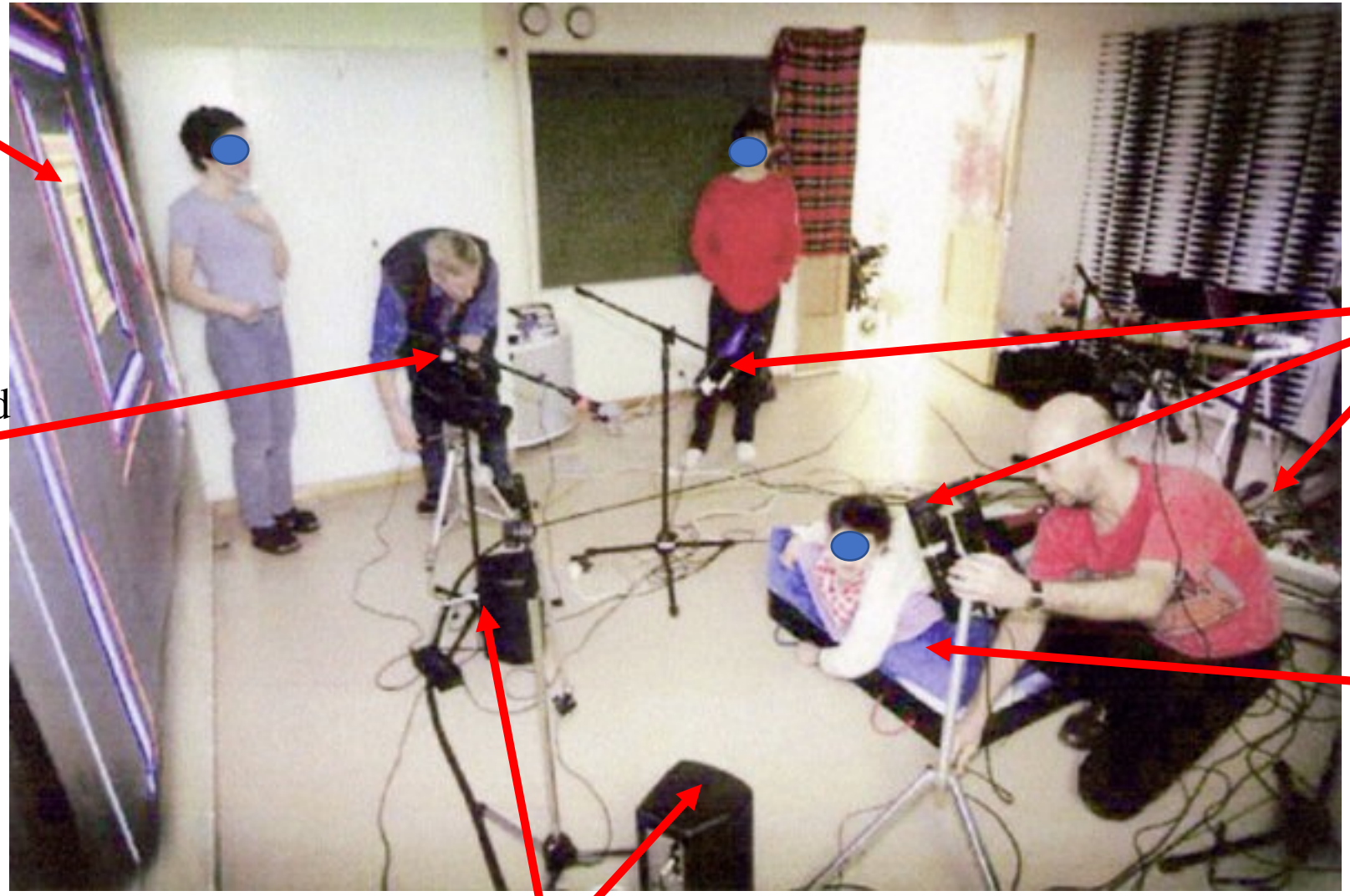
Targeted participant experience



Reality “Under the hood” attributes



Example of a SoundScapes Multisensory Multimedia Set-up: Variety of Interfaces + Stimuli



Projected visual feedback

Video camera as interface and data archiving

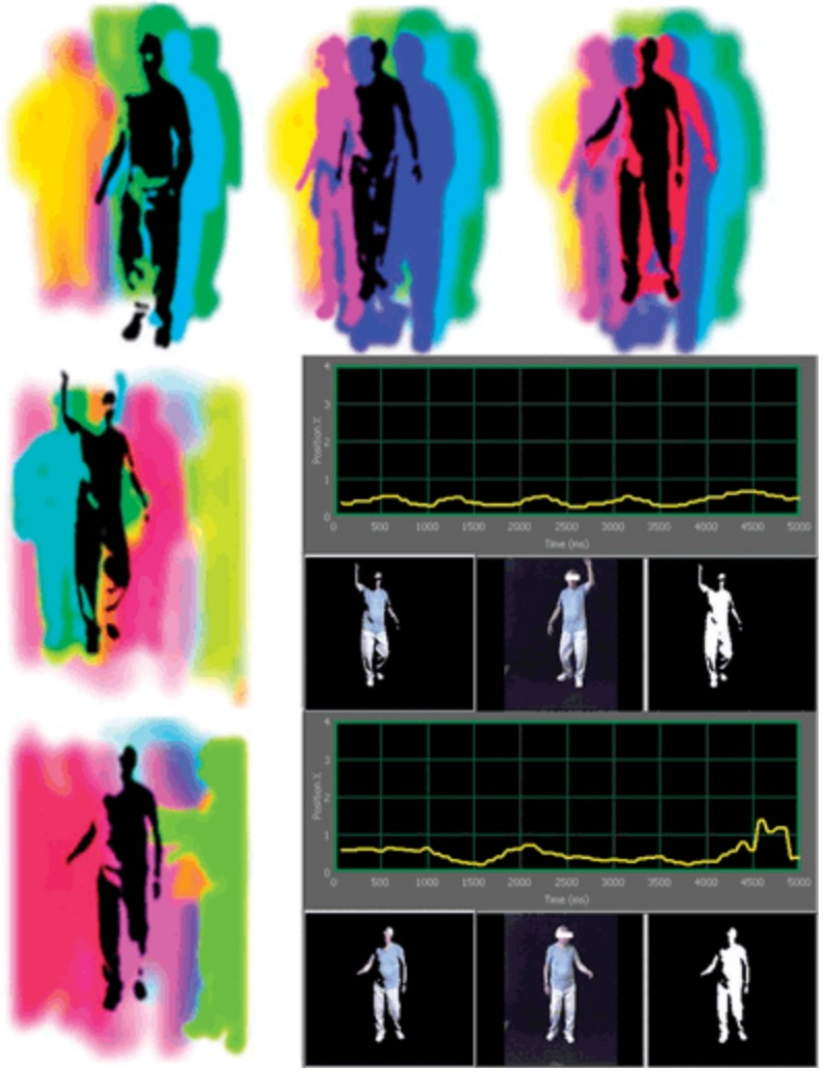
3 x Infrared 3D sensors for triggering sounds and images

Vibroacoustic platform

Speakers for audio feedback

https://vbn.aau.dk/ws/portalfiles/portal/41580679/Porto_Workshop_2008_paper.pdf

In SoundScapes VR music making and painting



Source: Camurri – EyesWeb - CAREHERE

BodyPaint videos

Tangible outcome – ownership, pride in sharing etc.

Lots of positive stories on this…..

Brooks (2008) https://vbn.aau.dk/ws/portalfiles/portal/41580679/Porto_Workshop_2008_paper.pdf

SoundScapes at The Center for Advanced Visualisation and Interactivity (CAVI) Aarhus University 1999

A child with profound disabilities controls a 3D model of an A-Wing Starfighter from the Star Wars movie via his head movements using two invisible 3D sensors achieving afferent efferent neural loop closure.

Copyright
Tony Brooks
March 2001

compiled from two source tapes
recorded in February 2001

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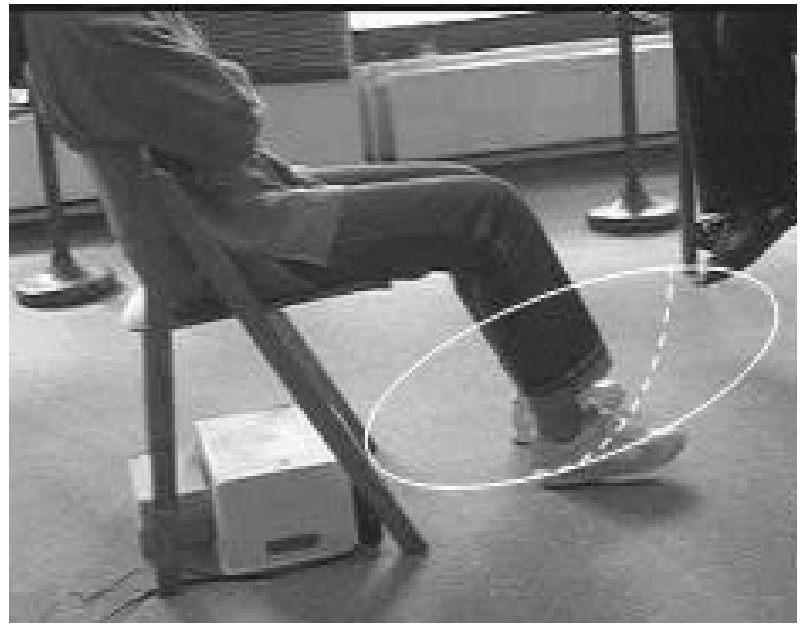
Stroke patient (CFH = Denmark's leading centre for rehabilitation of brain injury) [circa 1999]

CFH (Stroke + motor accident)



Utilising alternative channelling of stimuli sensing…. so for example incremental sounds or visuals can indicate proprioception (body/limb position) to support balance training or task feedback

Example of a single therapist's evaluation (S. Falkenberg) re: People of Determination (PMLD = profoundly and multiply disabled)

- Training with causality
- Training with gross motor skill (arm)
- Eye hand coordination
- Eye-eye contact
- Change between hard and easy tasks
- Possibilities for imitation tasks
- Working with hands
- Eye tracking
- Improved concentration
- Increased motivation
- Improved communication
- Safe, natural and personal contact
- Experience of control
- Trust
- Improved body language
- expression
- Reduced learning curve over existing tools
- Improved auditory association
- Reduced stress
- Reduced spasm attacks
- Increased relaxation
- A successful smile on conclusion of session

National Library of Medicine
National Center for Biotechnology Information

PubMed.gov

Randomized Controlled Trial > Eur J Phys Rehabil Med. 2010 Jun;46(2):159-68.

Epub 2010 Apr 13.

Effects of traditional physical training and visual computer feedback training in frail elderly patients. A randomized intervention study

D K Hagedorn [1], E Holm

Results *= "…the computer feed-back training group showed a marked improvement that was up to 400% in the training specific performance"*

Conclusion *= "Elderly frail patients were able to increase muscle strength and physical endurance. A limited improvement was seen in the static balance tests. The computer feedback group showed a remarkable increase in training specific performance. Clinical Rehabilitation Impact.*

Tools for analysis of pupil dilation aligned to eye-tracking in VR experiences

Outside of a HMD

Inside a HMD

Images used with permission: Medialogy Msc Student credits = Alex – Flaviu – Hans Pauli – Henrik

Thanks to Margrethe Madsen Als, and Annemette Ugelvig, and involved staff at Bo- og rehabiliteringscenter Lunden, Varde, DK
http://lunden.vardekommune.dk

https://link.springer.com/chapter/10.1007/978-3-030-06134-0_44

SensoramaLab circa 2004

Bespoke camera-based gesture-tracking interface (instead of mouse)

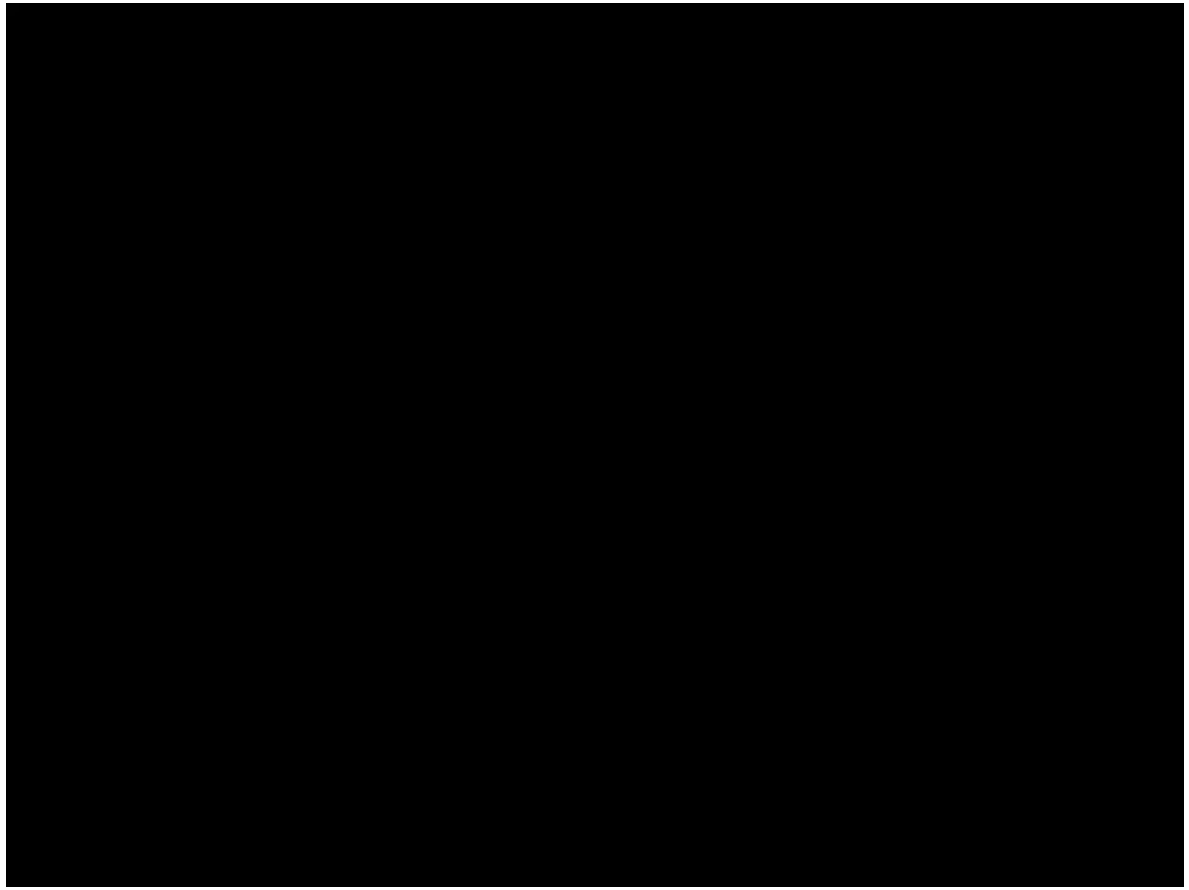
Passive stereo VR

Penguin Racer - Serious gaming for rehabilitation using the open-source game PPRacer

Passive stereo VR via foot control of a ‘physical/virtual magic (point cloud) flying carpet’ around a 3D VR Beijing model (with head tracking)

SensoramaLab Complex, Aalborg University c2004

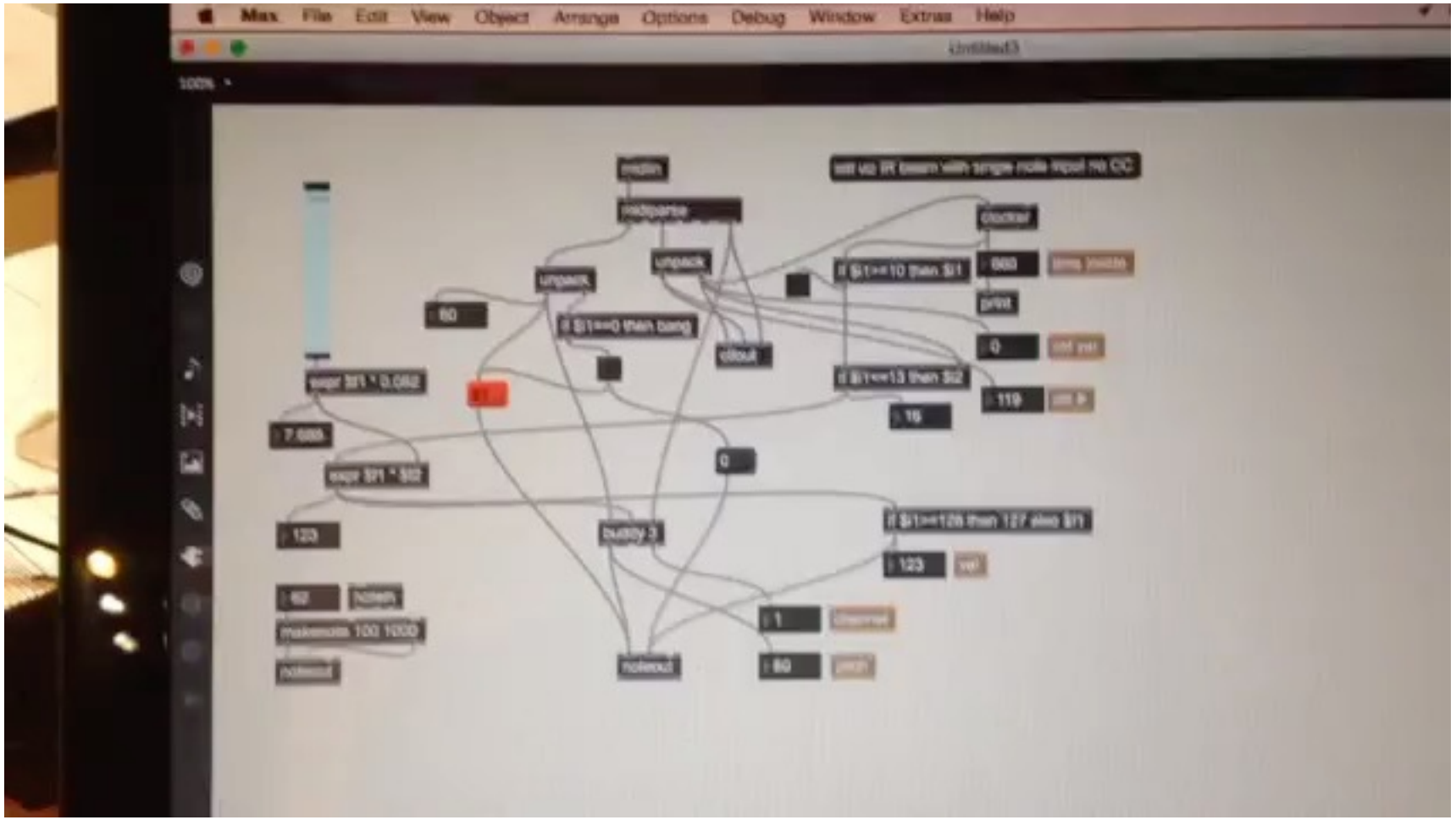
The Magic Carpet - An immersive simulation where you fly a magic carpet



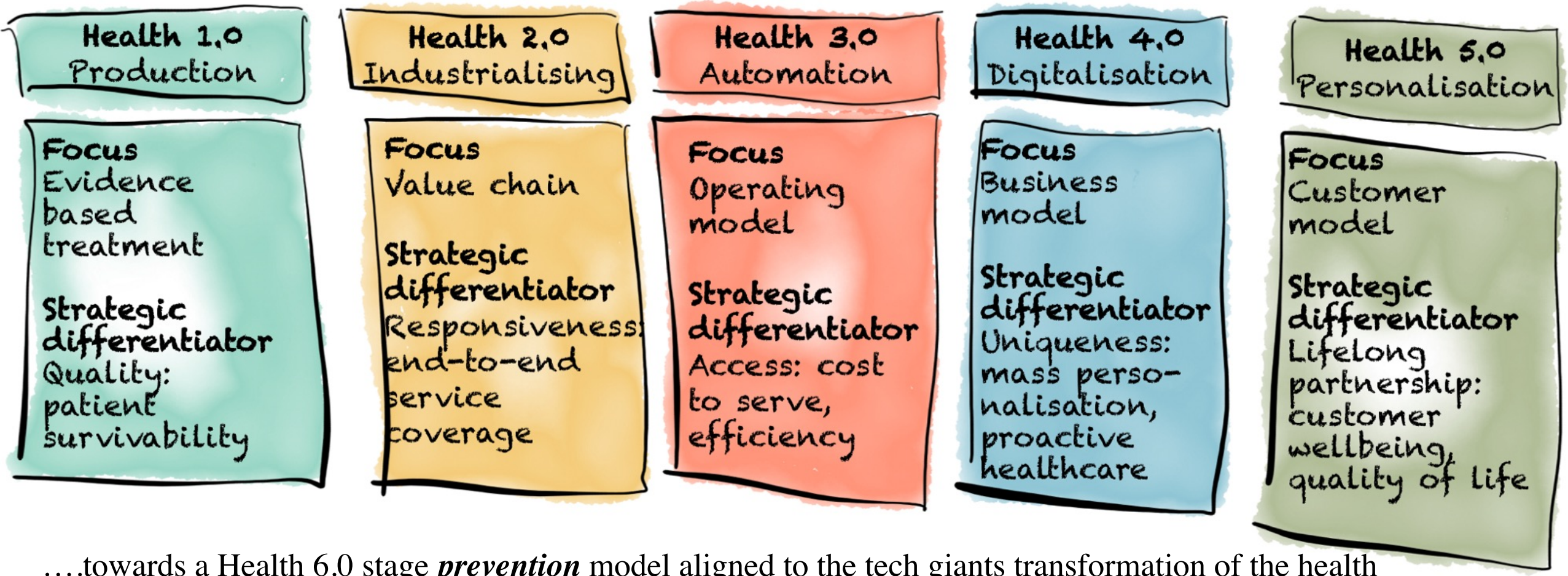
(video online)

https://www.youtube.com/watch?v=zdPXCkbNFMI

In SoundScapes invisible air sensing space can be dynamic like a drum skin



Healthcare – “an area that's ripe for change” (ZDNet)



….towards a Health 6.0 stage ***prevention*** model aligned to the tech giants transformation of the health sector via ‘***digital wellness***’ as aligned in my three books on ‘**Technologies of inclusive wellbeing**’

Five stages of evolution of the health sector. (Marek Kowalkiewicz 2017: Health 5.0: the emergence of digital wellness)

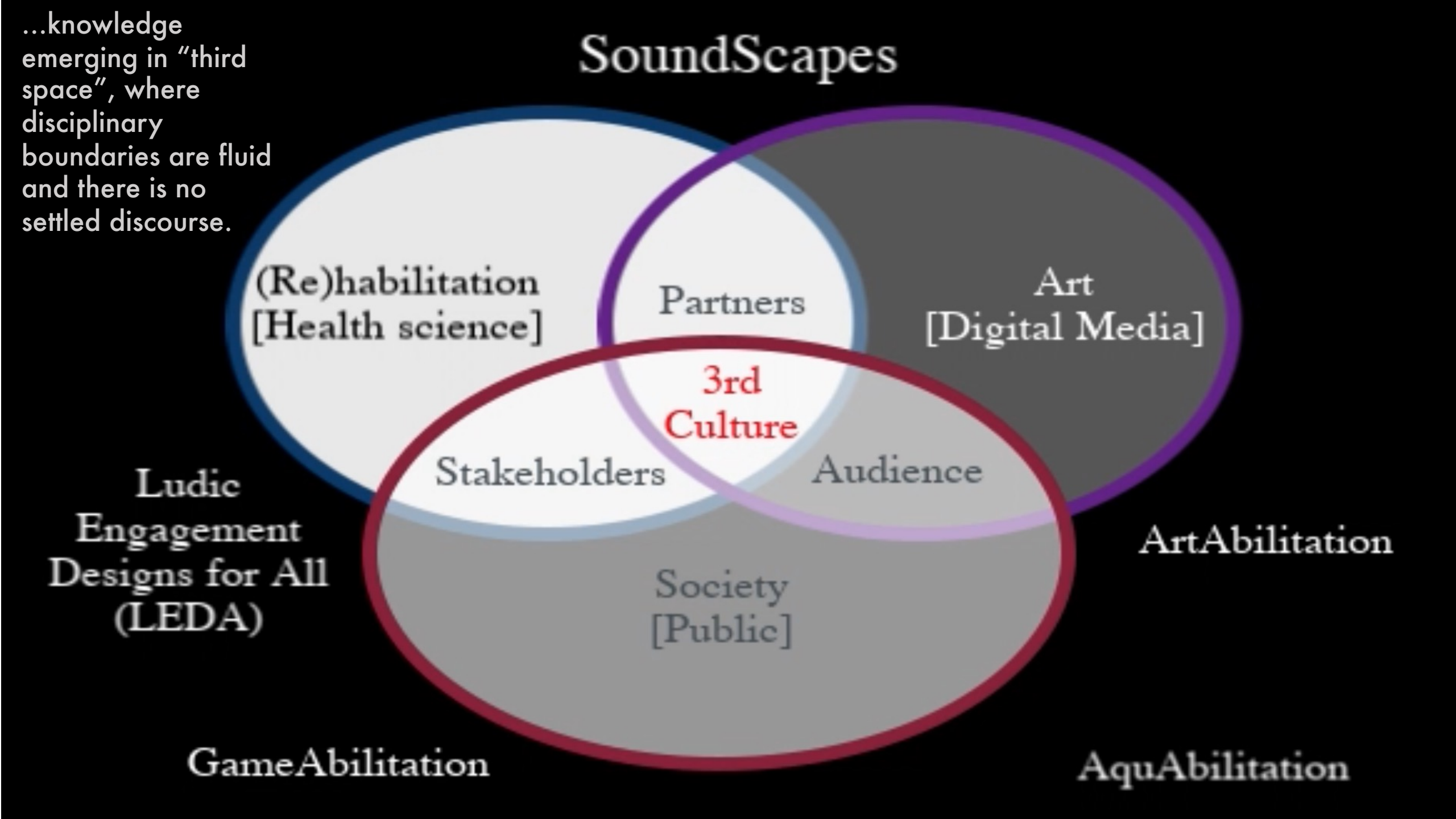
BIG TECH IN HEALTHCARE

	Alphabet	amazon	Apple	Microsoft
Strengths	• Google Cloud • Verily Life Sciences • AI data analytics	• Amazon Web Services • HIPAA-eligible voice assistant • Amazon Care • PillPack	• Apple Watch • Research functions • Apple Health Records • iPhone consumer base	• Azure • Microsoft Genomics • Health Bot
Weaknesses	• Initiatives fragmented across divisions	• Many projects still in nascence	• Mixed clinical effectiveness of Apple Watch • Limited to iOS	• Lack of consumer-facing services
Opportunities	• Remote patient monitoring or research via Fitbit • EHR market disruption • Precision medicine	• Health insurance disruption • Broad-scale telehealth service • Medical supplies delivery	• Remote patient monitoring • Health system partnerships • Healthcare payments	• Precision medicine • Population health • Clinical decision support • Chatbot market dominance
Threats	• Consumer trust • Data security • Competition in the wearables space • Cloud competition	• Consumer trust • Data security • Cloud competition • Healthcare voice tech market competition	• Consumer trust • Data security • Competition from low-cost wearables	• Consumer trust • Data security • Cloud competition

Source: Company filings

INSIDER INTELLIGENCE

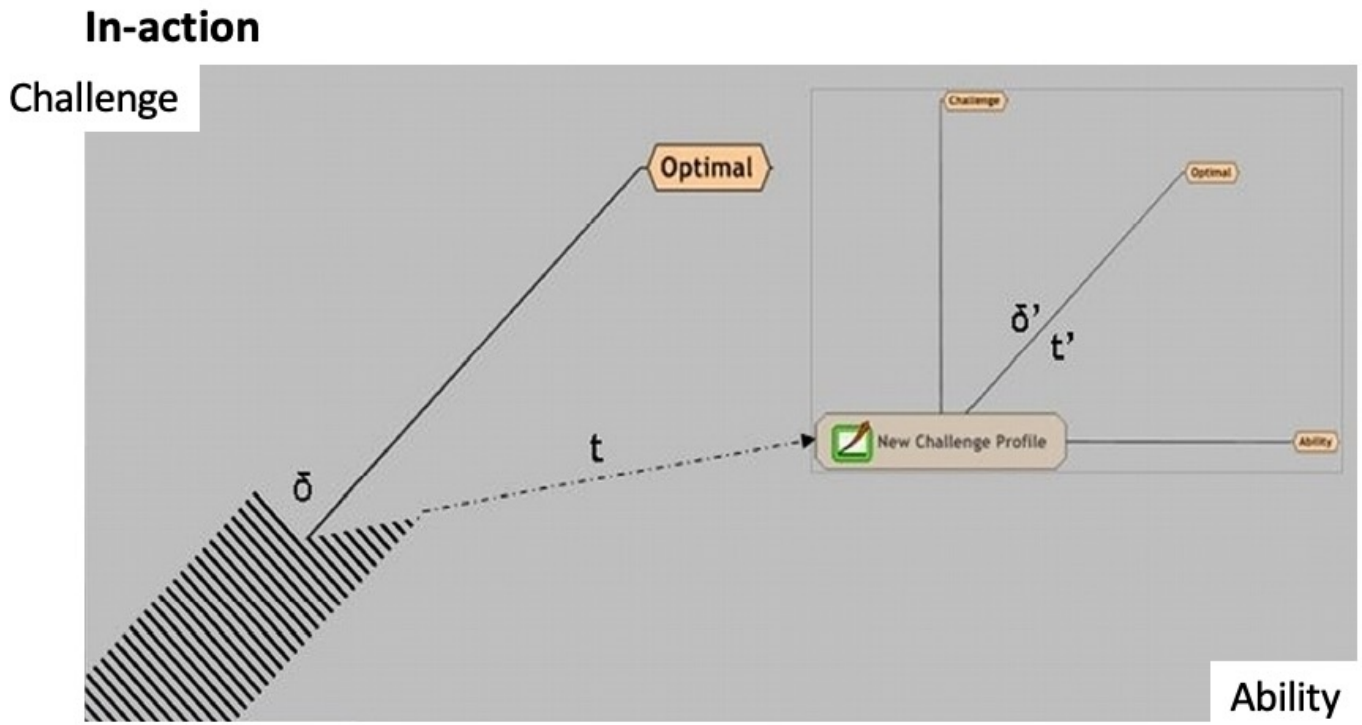
…knowledge emerging in "third space", where disciplinary boundaries are fluid and there is no settled discourse.

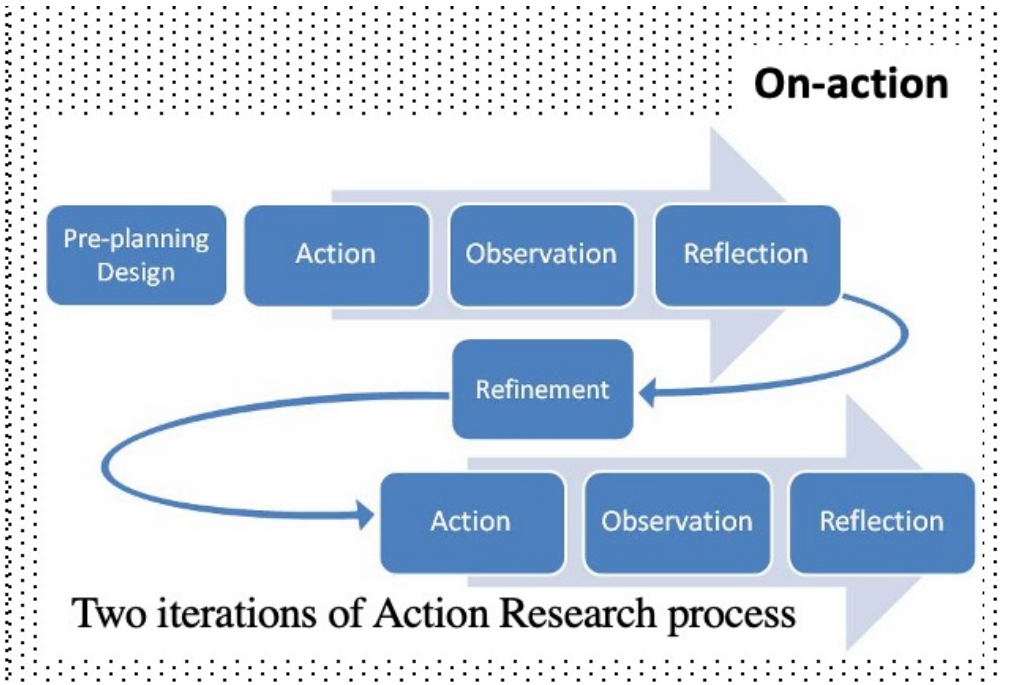


SoundScapes emergent model = ZOOM (Zone of Optimized Motivation)

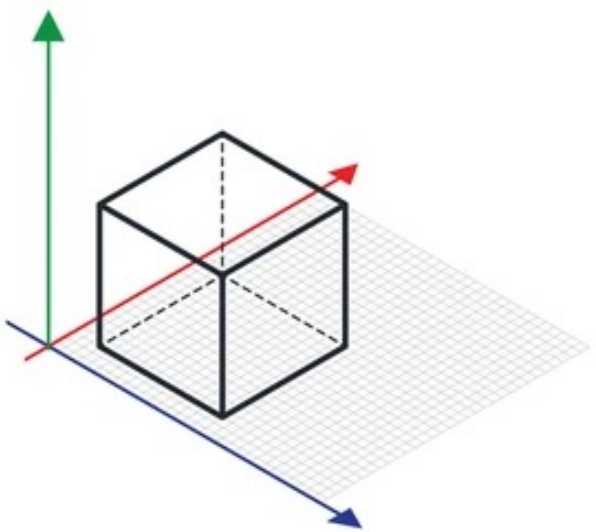
First published in 2005 at IEEE HealthCom Busan Korea (7th International Workshop on Enterprise Networking and Computing in Healthcare Industry).

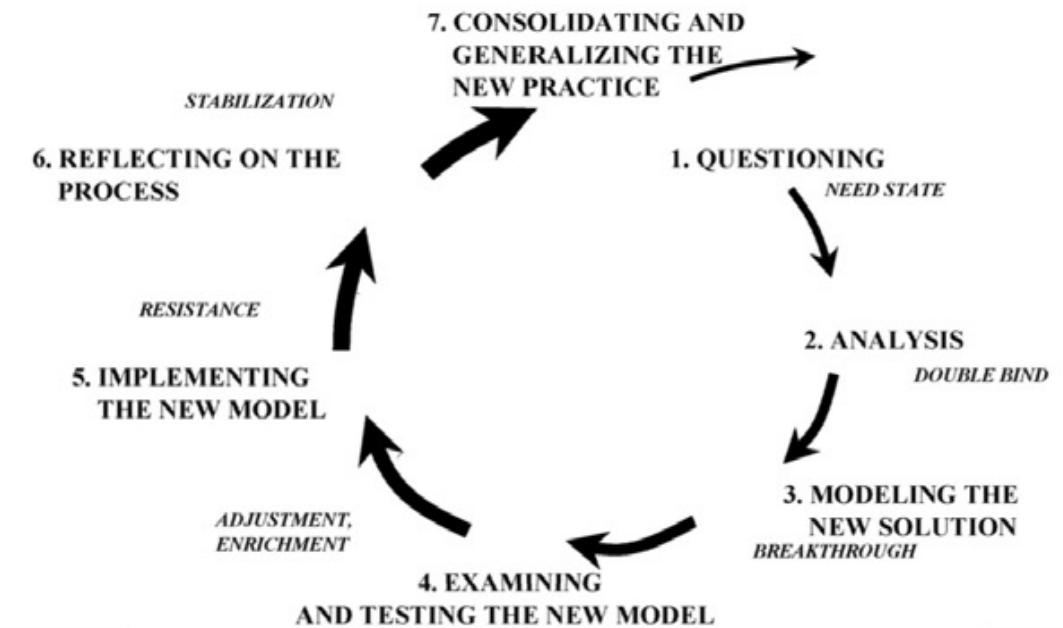
ZOOM is posited as a framework towards an AI-driven (re)habilitation system at the core of future international healthcare facilities considered as "**Probably the best (re)habilitation complex in the world**" …(*sized for multiple or solo**) >> leading to improved RT taxonomy/Specification System (including black-box rehabilitation), thus improved sharing + reliability



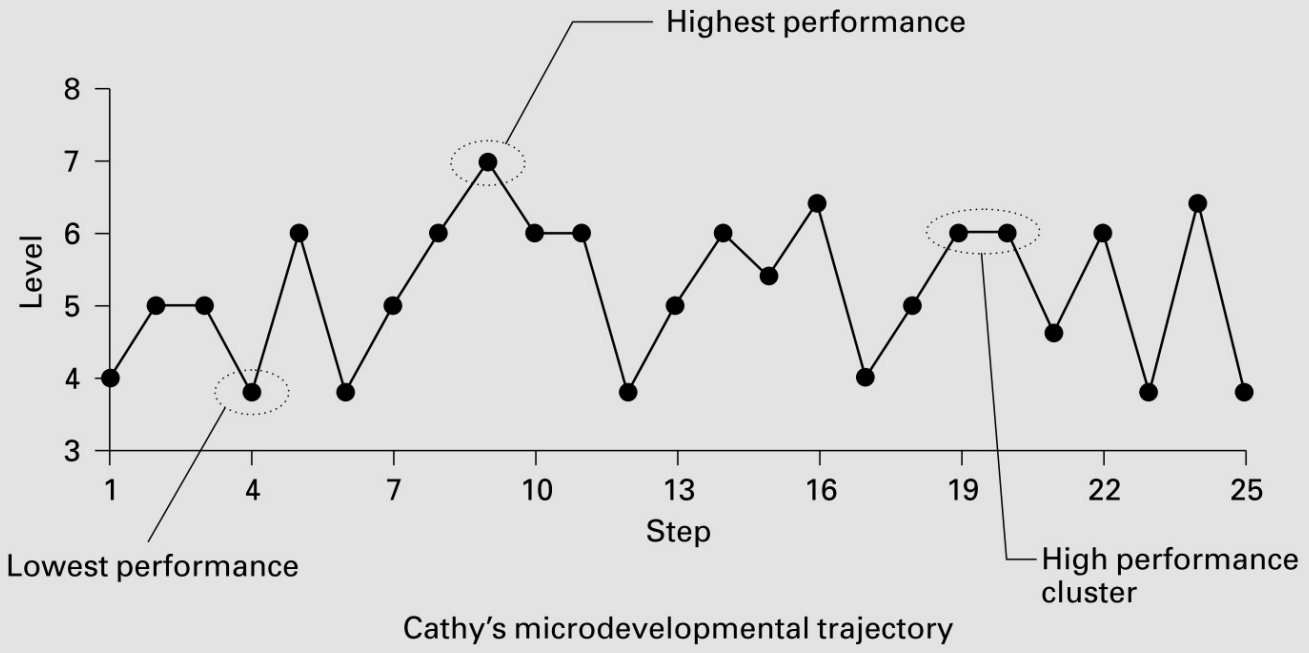


e.g. Fischer's dynamic learning and microdevelopment
+ Csíkszentmihályi's Flow theory on happiness / creativity
+ Schön's concept of 'reflection in action' and 'reflection on action'
+ Vygotsky's ZPD etc

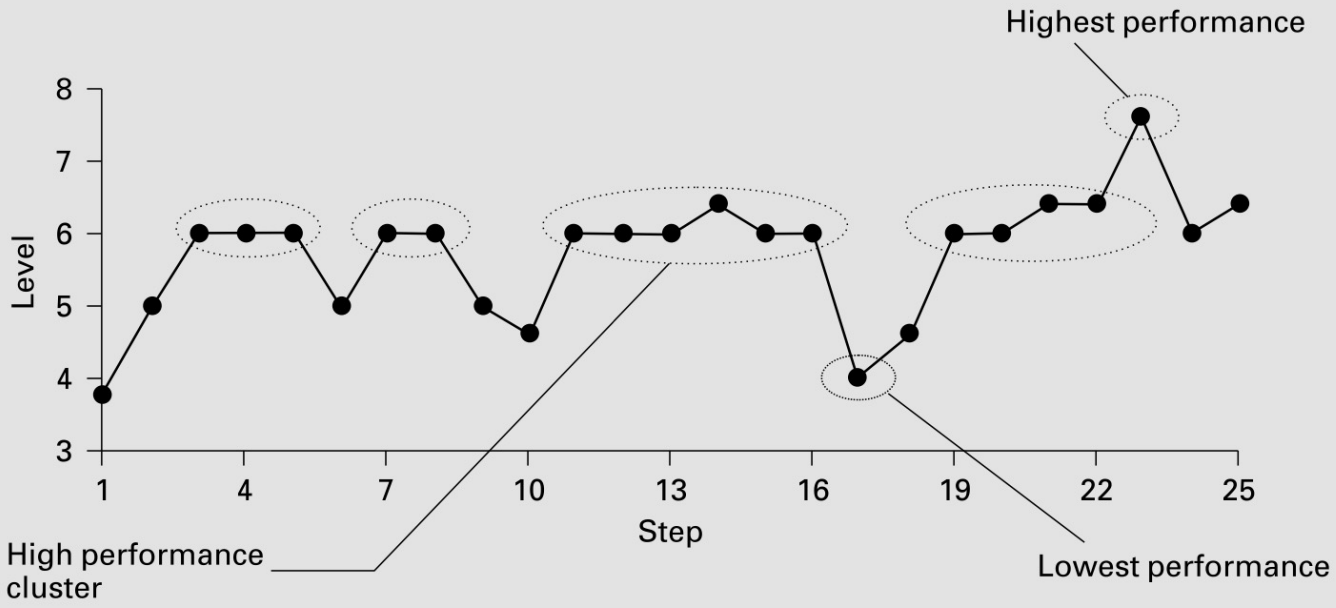




The ideal-typical cycle of expansive learning (Engeström, 2015)



Cathy's microdevelopmental trajectory



Jack's microdevelopmental trajectory

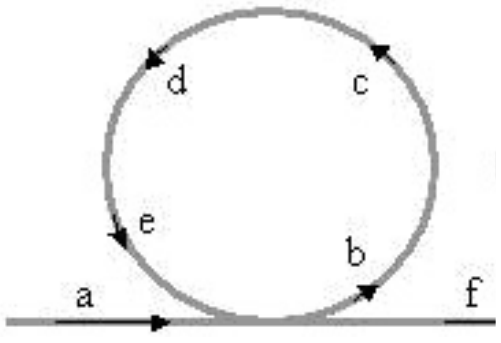
SoundScapes / ZOOM 'learning' analogy

- 'Steps' = changes of challenge
- 'Level' = learning achieved / ability

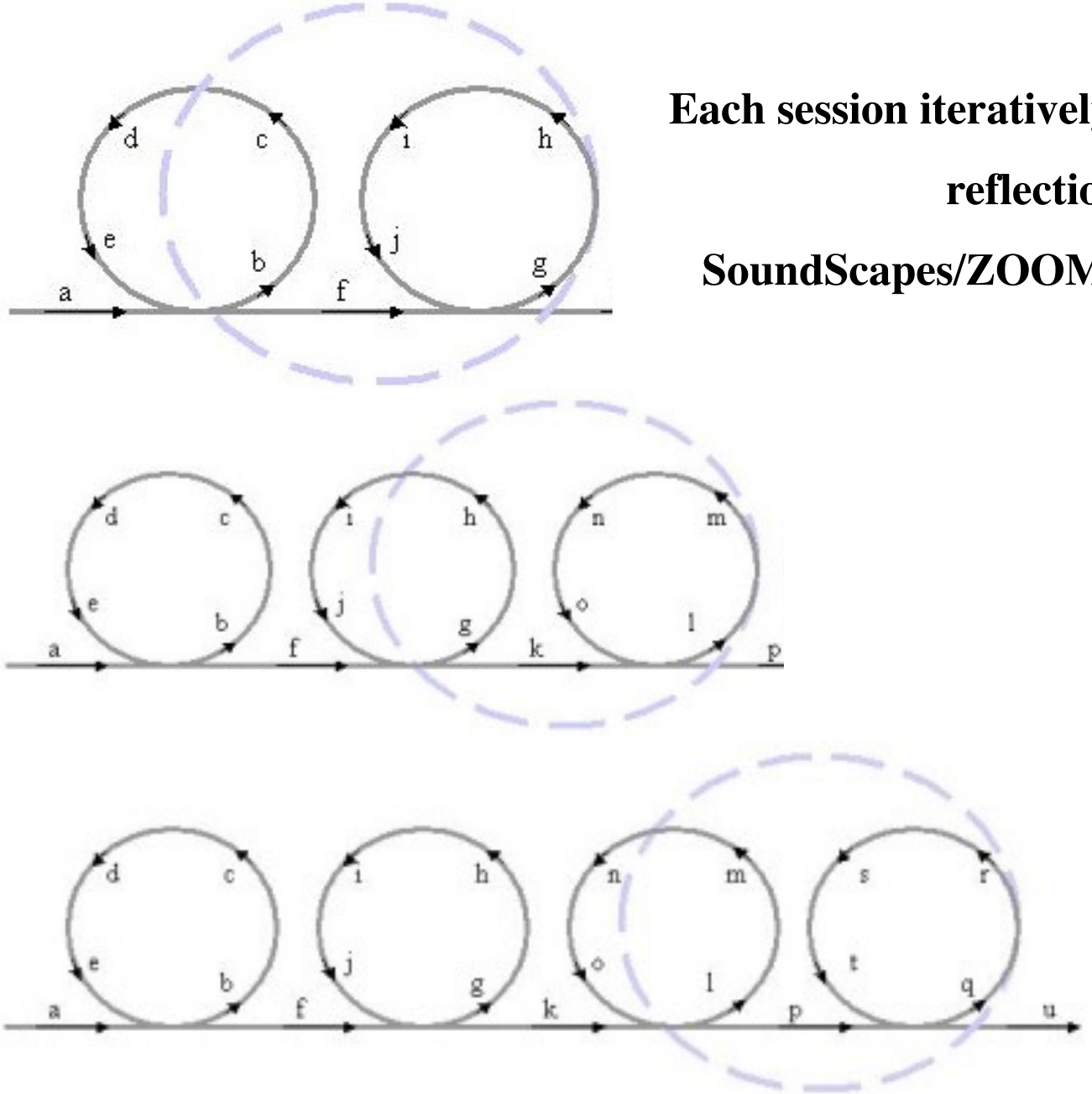
Additional in ZOOM intervention phase (in-action) is a 'return to previous' option to 're-engage' to prevent participant disengagement.

microdevelopmental pathways of two participants (source Fischer)
https://www.gse.harvard.edu/~ddl/articlesCopy/AlwaysUnderConstructnHumDev.0402.pdf

So let’s exemplify via sessions from a treatment programme

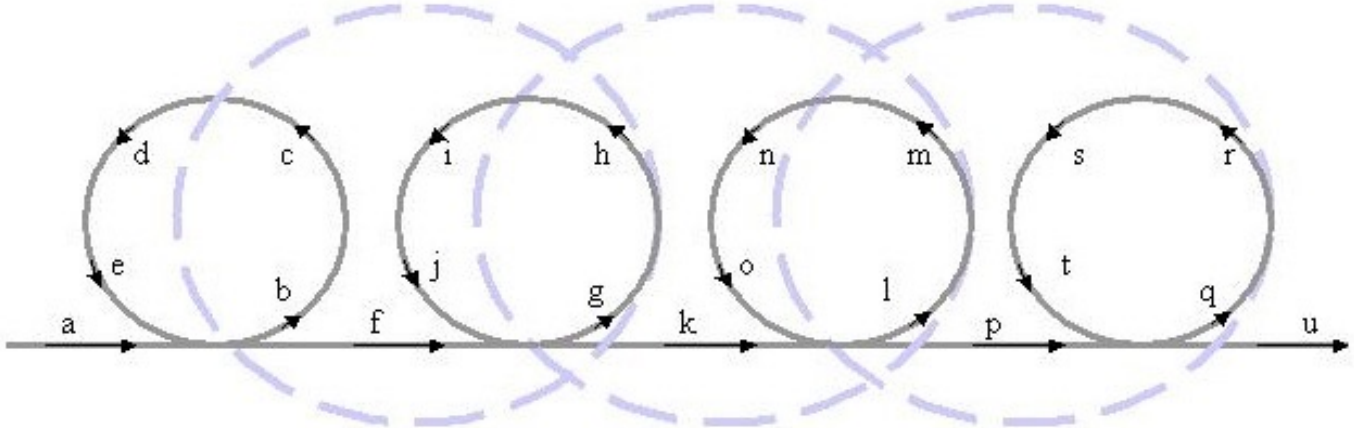


(1) planning a change via action [segment a];
(2) action – the actual session with participant [segment a-to b];
(3) post-session observation of the action [b-c];
(4) reflection on the action [c-d];
(5) refining – e.g. of the created system set-up or strategies [d-e], and
(6) the planning for the next action [e-f]…

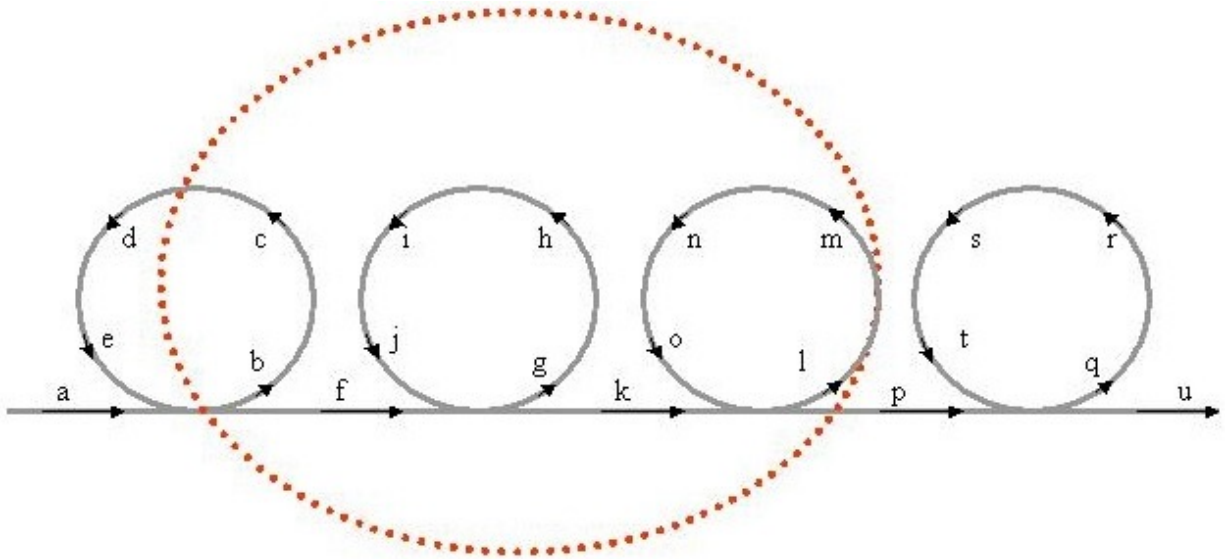


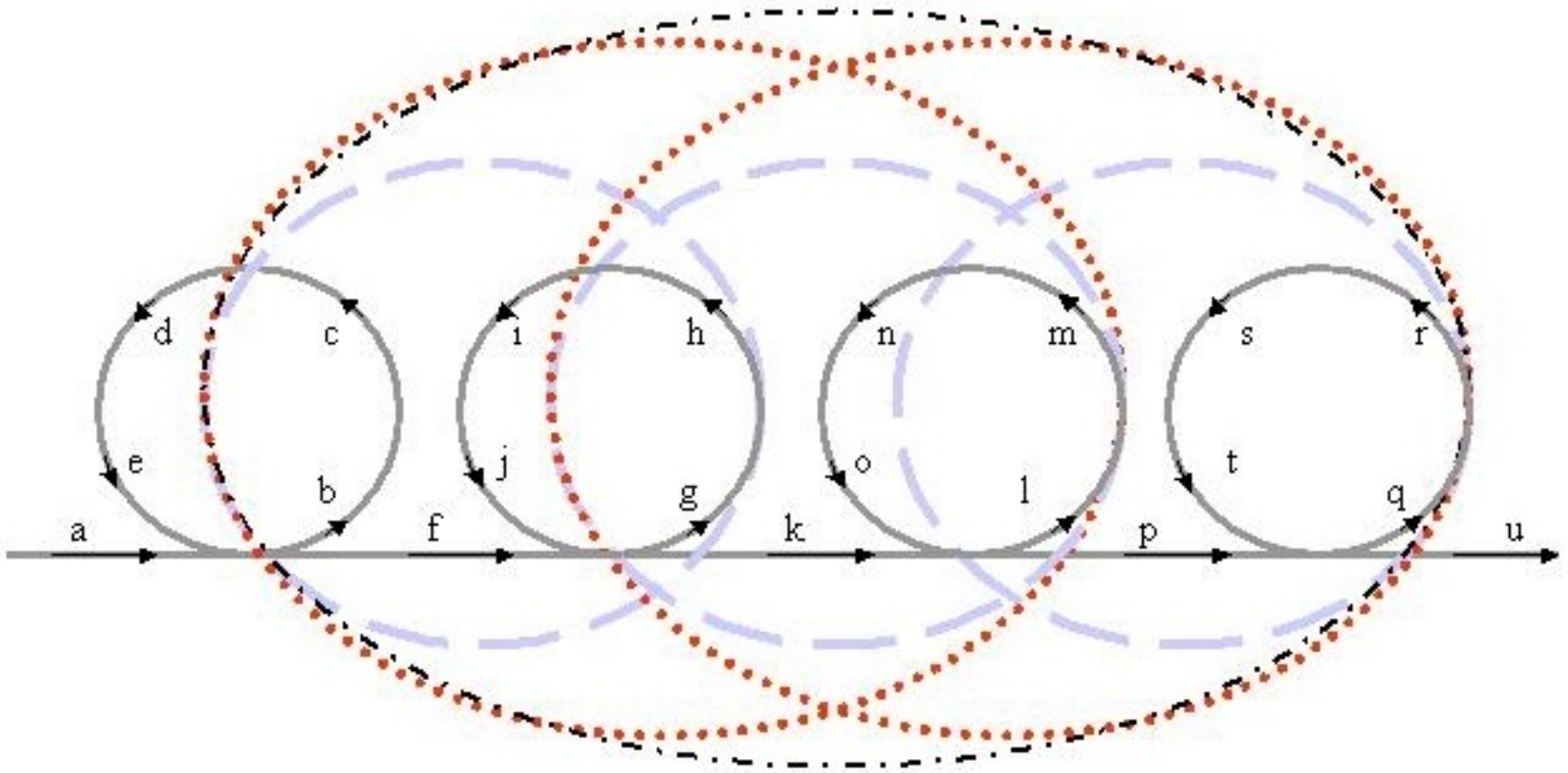
Each session iteratively informs the next and enables reflection on previous =

SoundScapes/ZOOM Recursive Reflection model

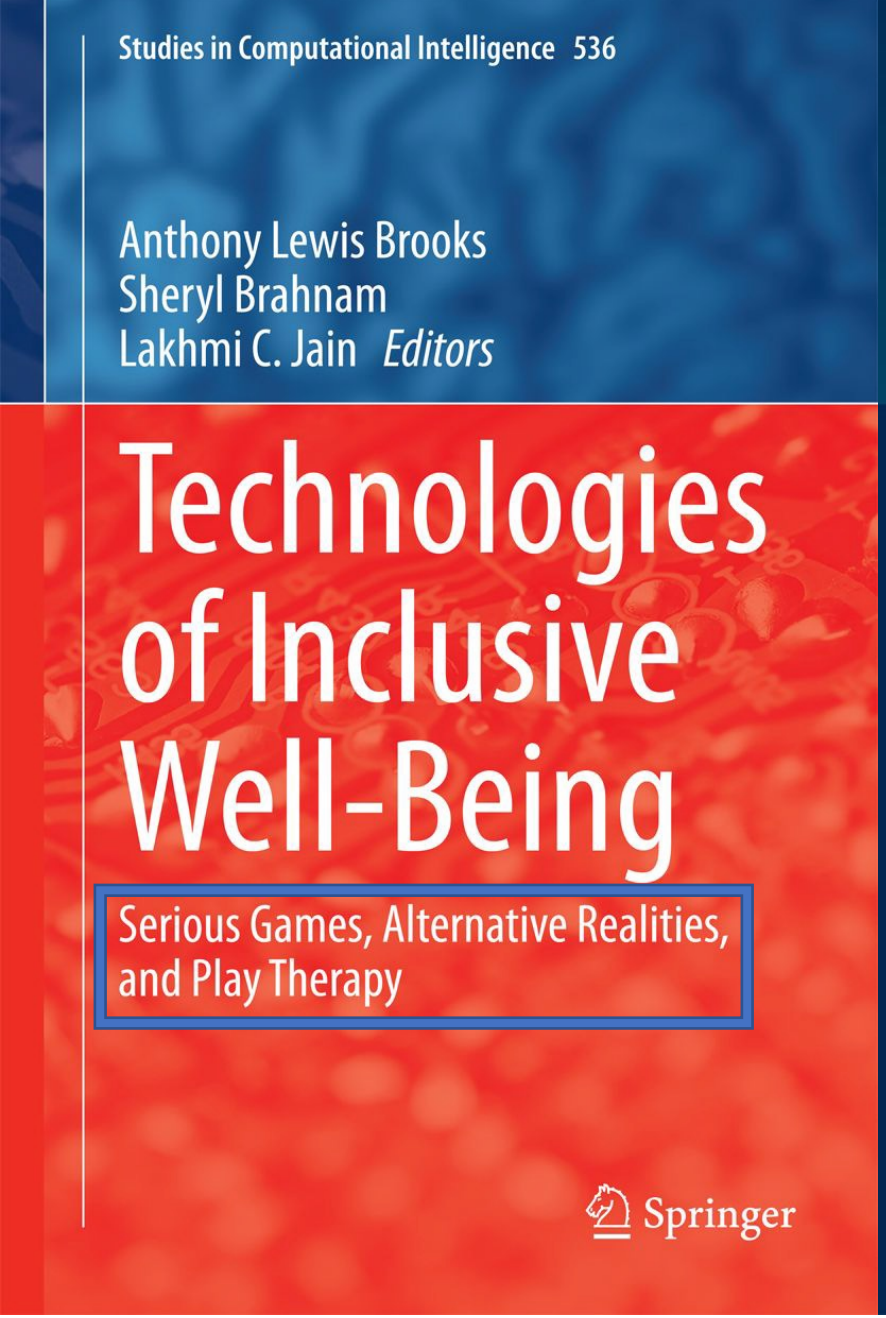


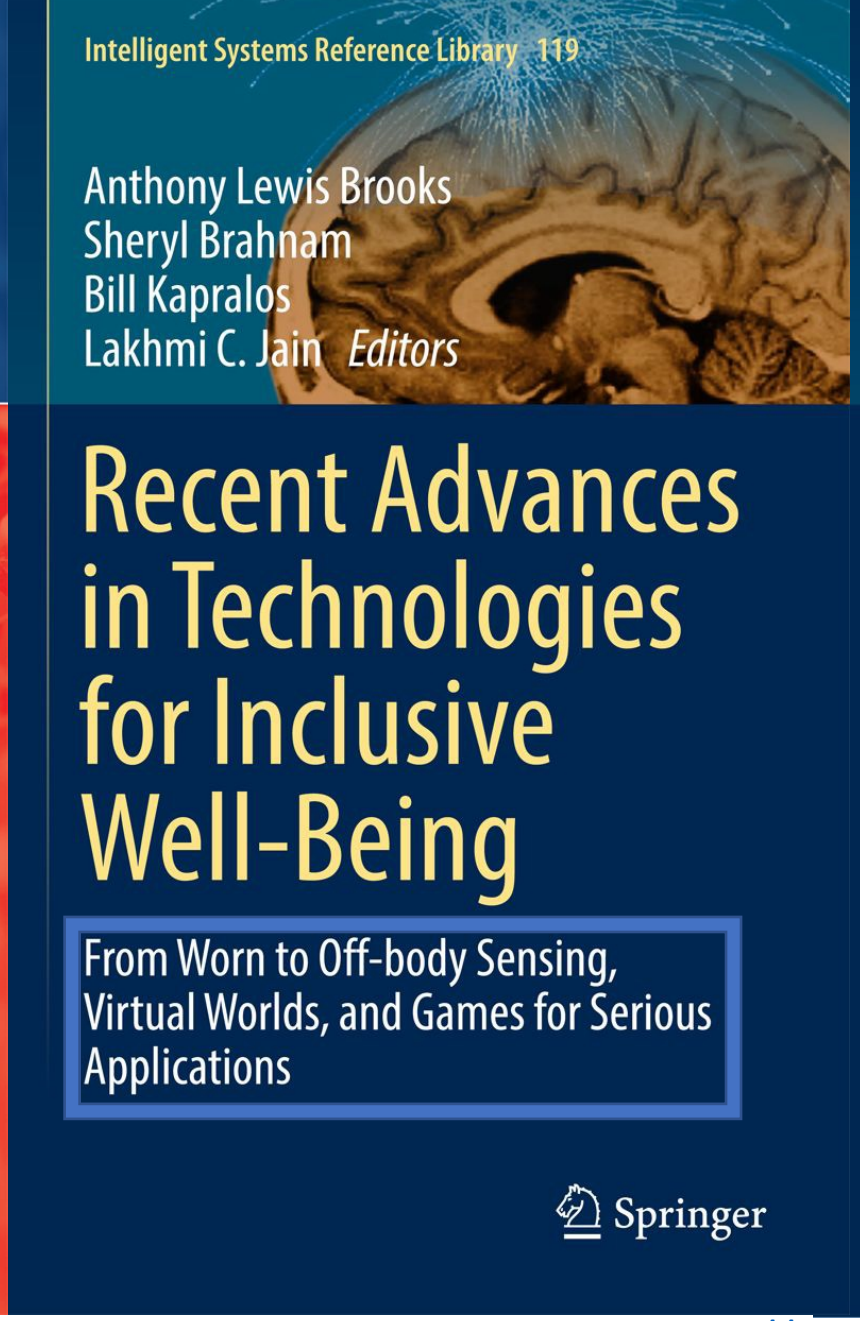
Thus, sequential and non-sequential

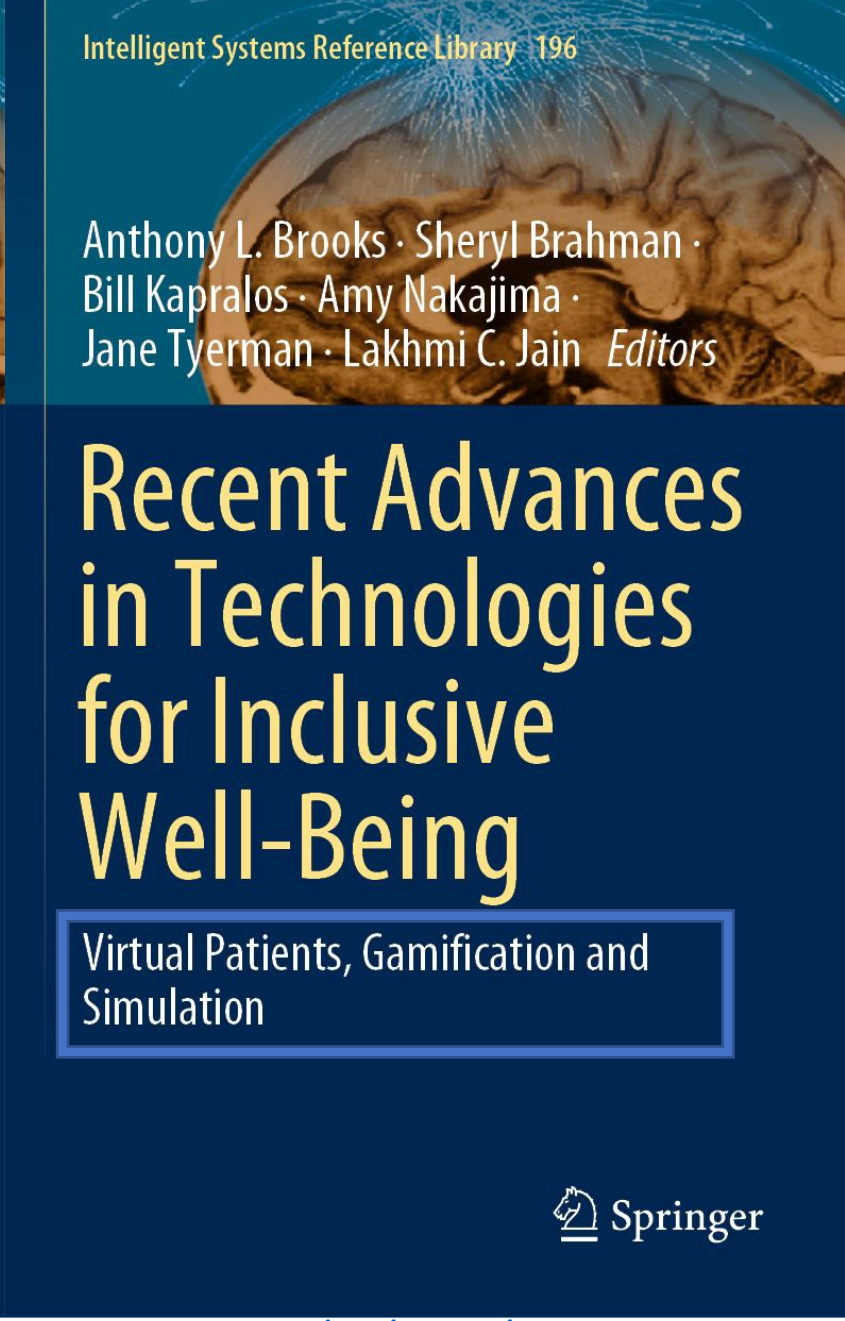




Under the SoundScapes/ZOOM hybrid ‘Hermeneutics – Action Research’ methodology, each whole is considered relative to its constituent parts…. then each part is considered as a whole that is considered relative to its constituent parts… and so on… this towards an improved rapportage and sharing of intervention (and system use) details as opposed to current = an educational and professional tool in healthcare



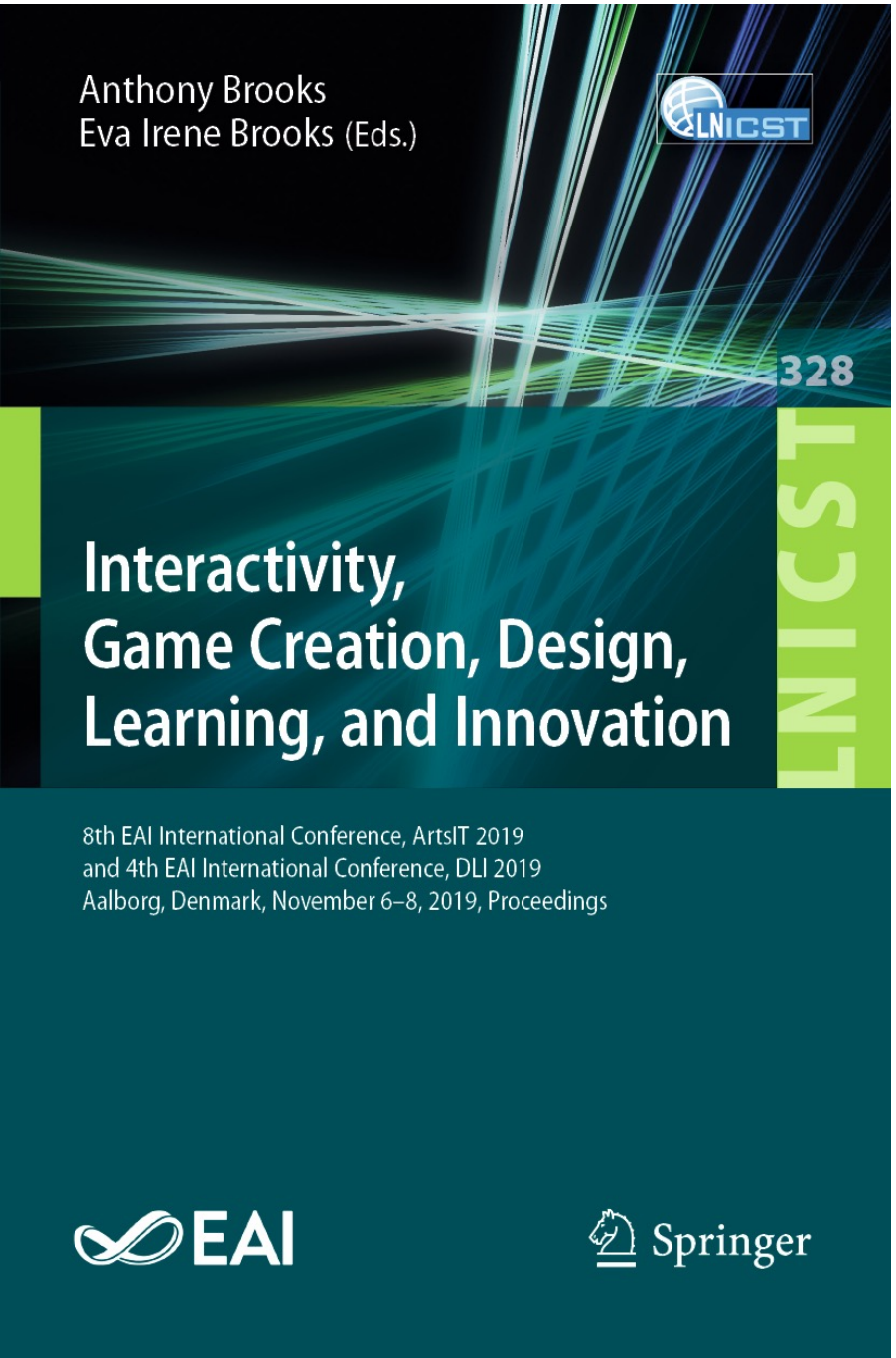




2014: https://www.springer.com/gp/book/9783642454318

2017: https://www.springer.com/gp/book/9783319498775

2021: https://www.springer.com/gp/book/9783030596071



Other Published Books:

- Interactivity and Game Creation (2021) – https://www.springer.com/gp/book/9783030734251
- Design, Learning, and Innovation (2021) – https://www.springer.com/gp/book/9783030784478
- Interactivity, Game Creation, Design, Learning, and Innovation (2020) – https://www.springer.com/gp/book/9783030532932
- Interactivity, Game Creation, Design, Learning, and Innovation (2019) – https://www.springer.com/978-3-030-06133-3
- Interactivity, Game Creation, Design, Learning, and Innovation (2018) - https://www.springer.com/978-3-319-76907-3
- Interactivity, Game Creation, Design, Learning, and Innovation (2017) - https://www.springer.com/978-3-319-55833-2
- Arts and Technology (2012) – https://www.springer.com/978-3-642-33328-6

End – Thank you for your attention –

I am open for Questions

EXTRA Slides in case needed

Sponsors include…

Studio Artist One-Click AI Generated Art and Animation

Intelligent Music Accompaniment Software

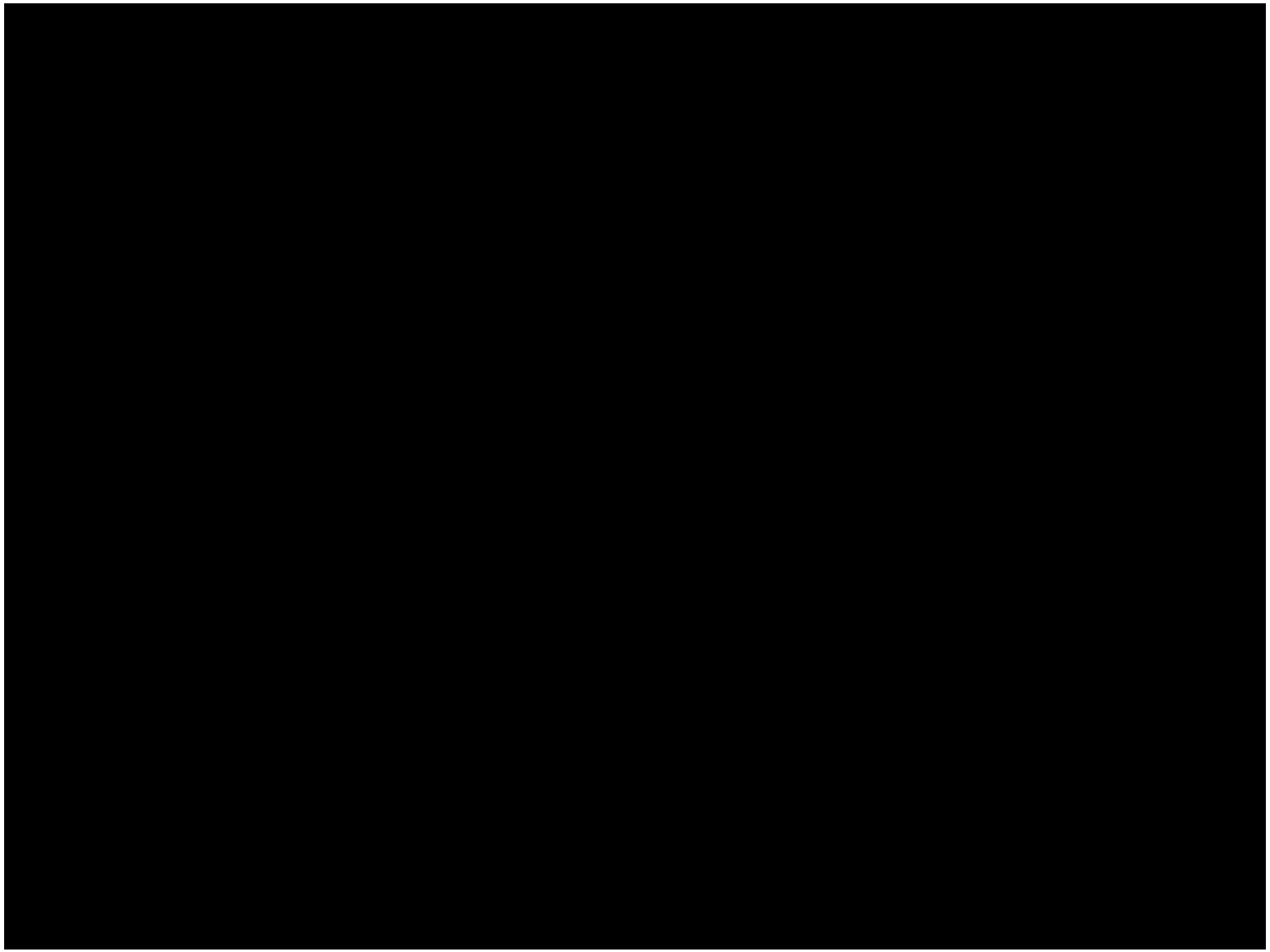
and others……

Thanks to all participants
+ healthcare professionals
+ art tech crews

IBM
Sony (SCEE)
Egmont/Nordic Film
Expressive E

Intelligent Lighting

In SoundScapes VR music making and painting aligned to AR e.g. Choir Conductor



“Artistic research is an integral part of an artistic process, leading to a publicly accessible result and accompanied by consideration of both the process and the presentation of the result.”

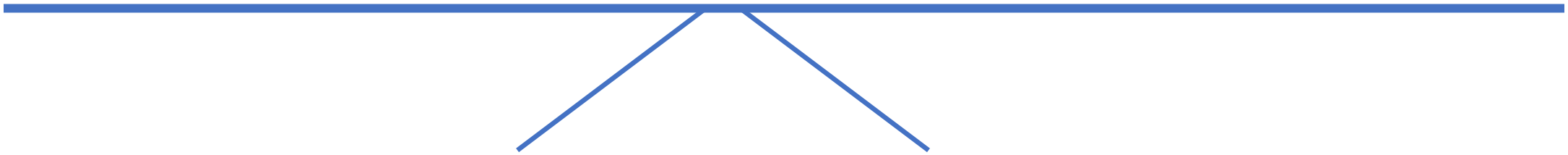
The Ministry of Culture - Report on the knowledge base of artistic education (2010/2011)

a continuum of different ways of generating knowledge and recognition (why art makes sense)

fully documented and reproducible academic results

various forms of practice-based research and artistic research

concrete, time- and place-related event



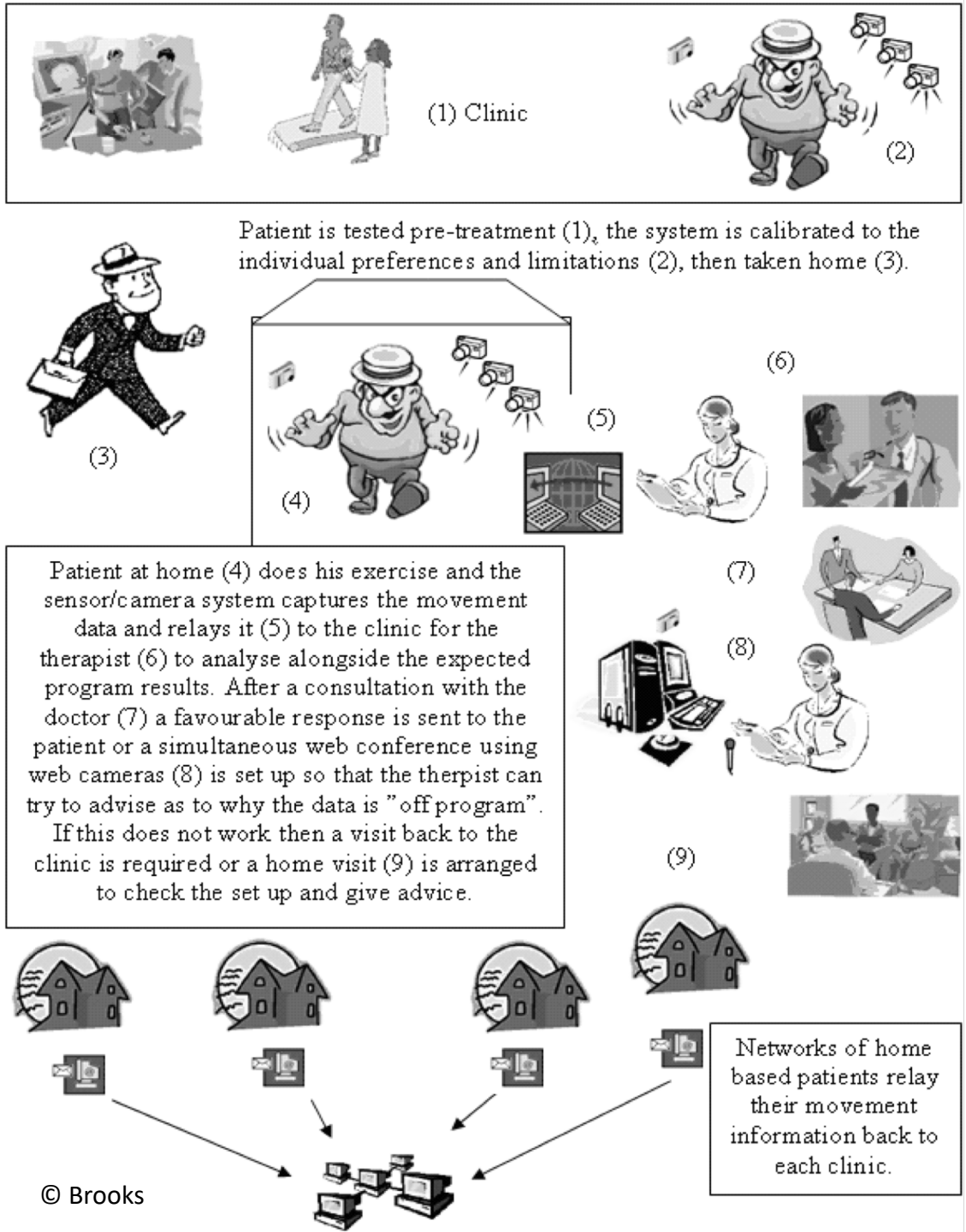
Practice-based research - academic research involving actions and events, which are not systematic or exactly reproducible, but which nevertheless can help to produce academically recognised results.

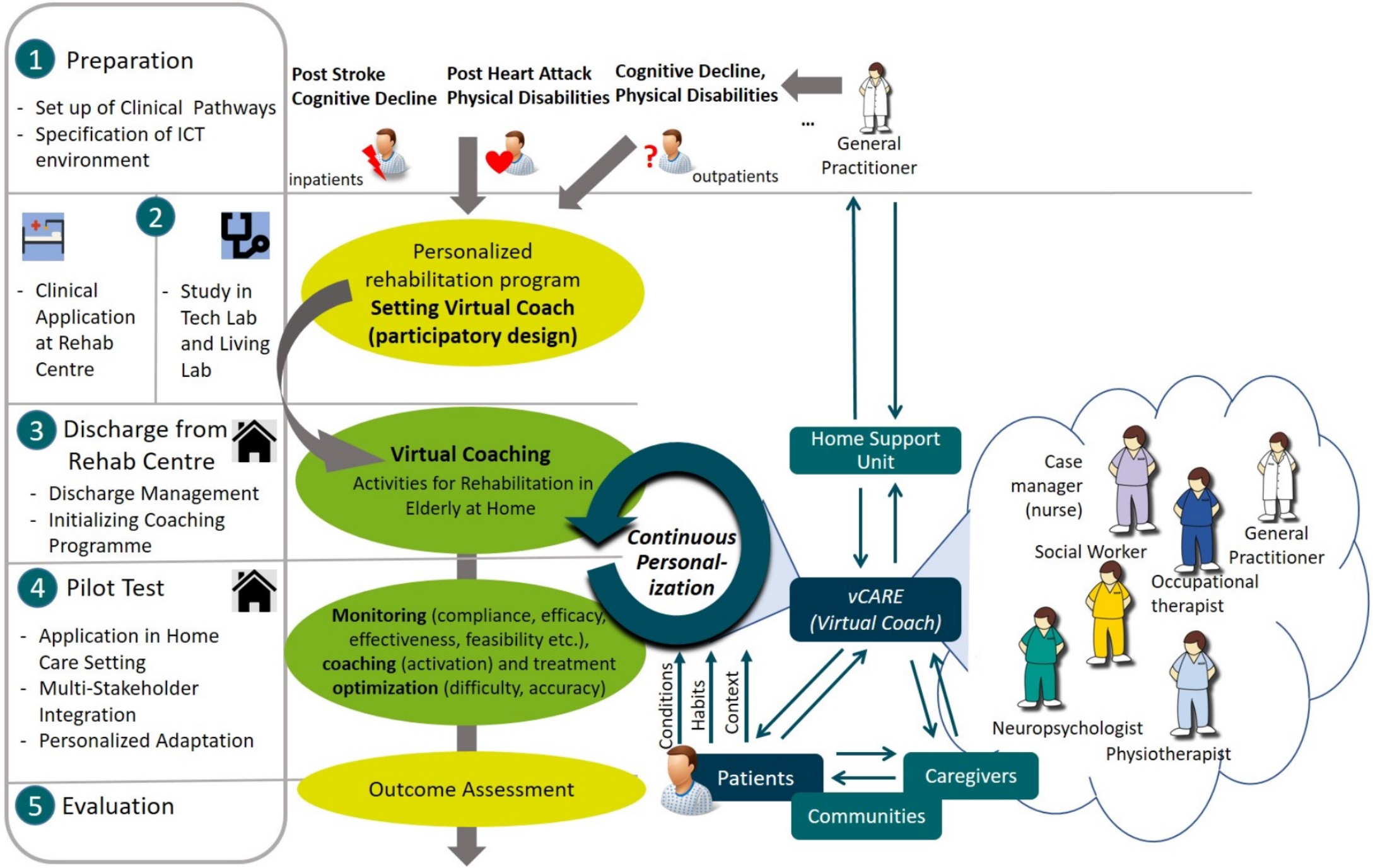
Artistic research - in tune with artistic practice, but combined with a set of definition-determined criteria for explicit reflection, documentation and dissemination, which can help to maintain, develop and disseminate knowledge related to artistic processes, events and results.

Humanics telehealth system © Brooks

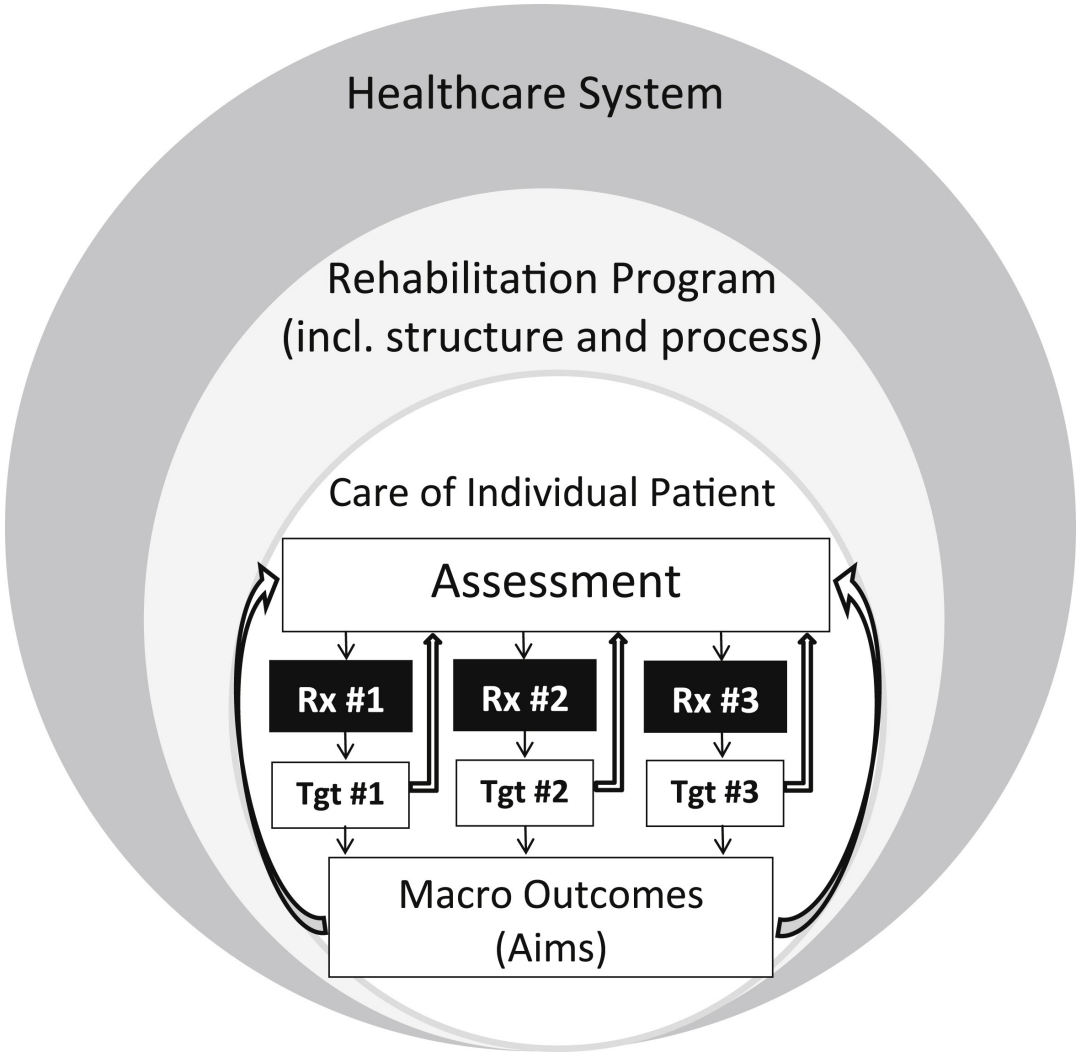
International Journal of Disability and Human Development:

Volume 4, issue 4: pages 279-284





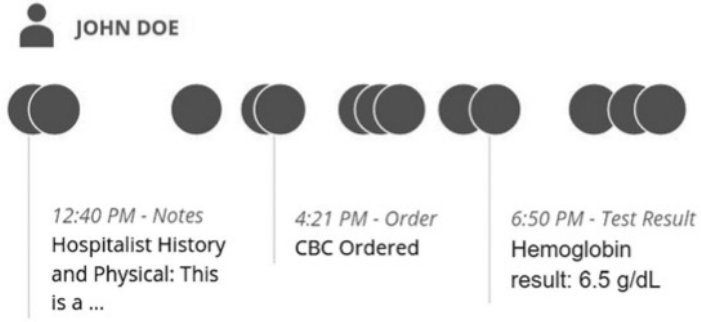
Source: https://vcare-project.eu/welcome/mission-statement/



Source: American Congress of Rehabilitation Medicine (RTT/RTSS literature)

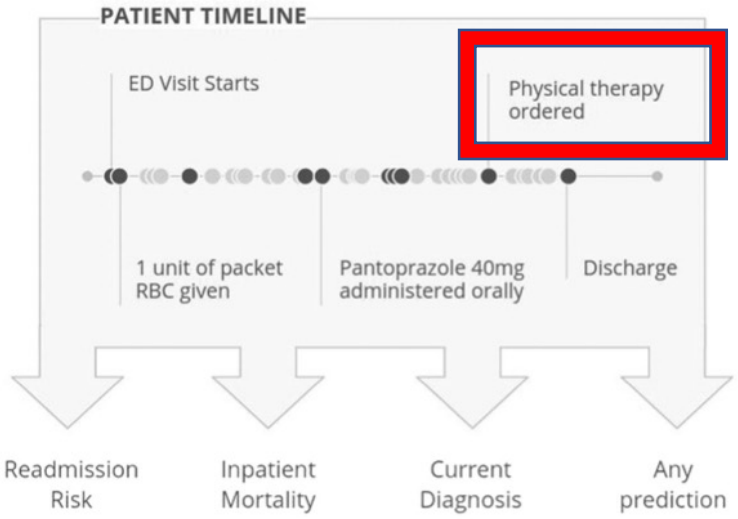
1

Health systems collect and store electronic health records in various formats in databases.



2

All available data for each patient is converted to events recorded in containers based on the Fast Healthcare Interoperability Resource (FHIR) specification.

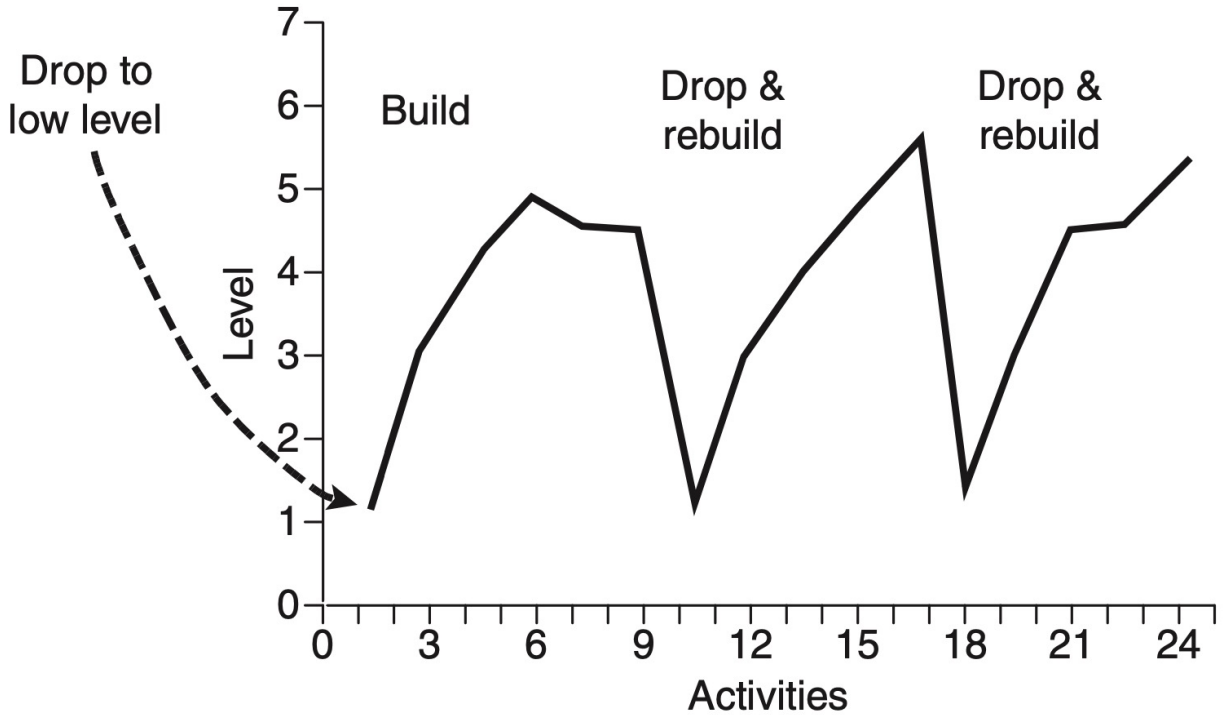


3

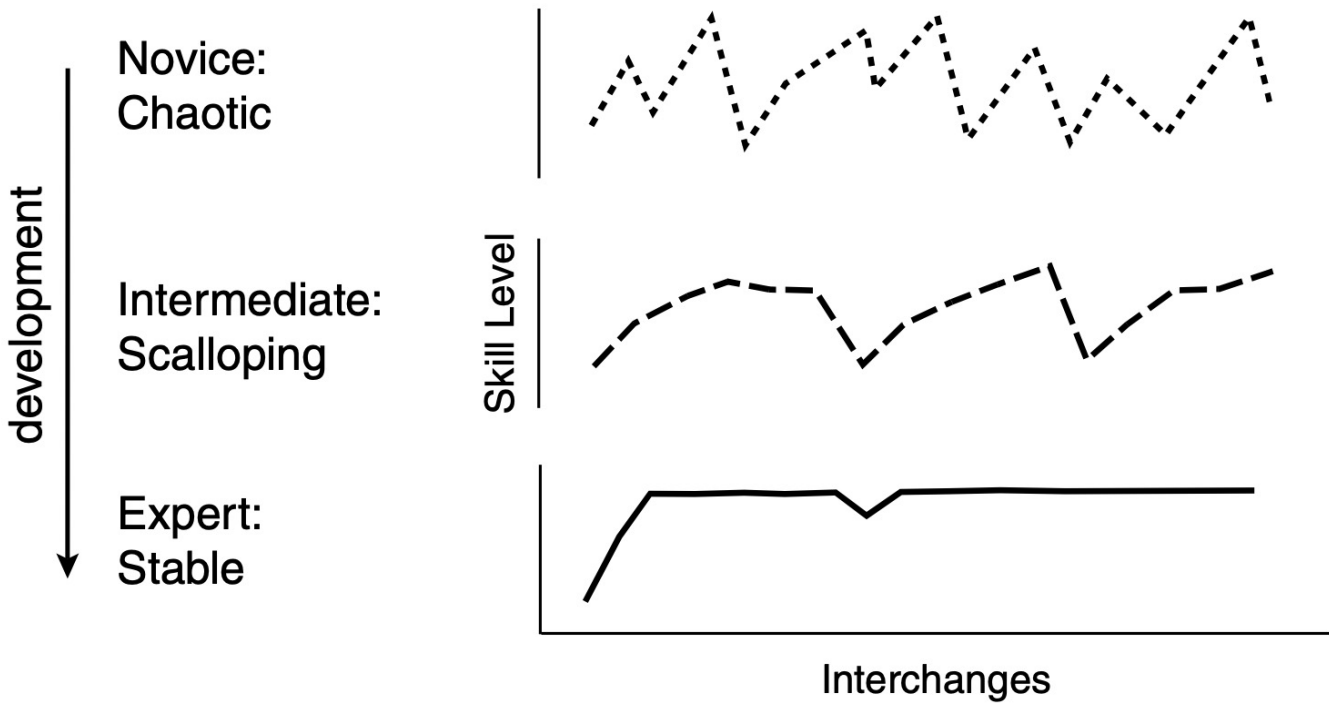
The FHIR resources are placed in temporal order, depicting all events recorded in the EHR (i.e. timeline). The deep learning model uses this full history to make each prediction.

Source:Scalable and accurate deep learning with electronic health A Rajkomar et al. (fig 4)

cf Fischer - Developmental cycles of brain and cognition



Building a new skill through repeated reconstruction, or scalloping. (Levels 1 to 3 involve actions, 4 to 6 involve representations, and 7 and above involve abstractions.)



Growth curves for learning a task: novice, intermediate performers, and experts.

According to Brooks 1999

Four technologies are crucial for VR:

- the visual (and aural and haptic) displays that immerse the user in the virtual world and that block out contradictory sensory impressions from the real world;
- the graphics rendering system that generates, at 20 to 30 frames per second, the ever-changing images;
- the tracking system that continually reports the position and orientation of the user's head and limbs; and –
- the database construction and maintenance system for building and maintaining detailed and realistic models of the virtual world.

Brooks 1999 - *What's Real About Virtual Reality?* https://www.researchgate.net/publication/220518370_What%27s_Real_About_Virtual_Reality

1999: (IBM sponsored) presentation at International Congress of the World Confederation for Physical Therapy (WCPT), Yokohama, Japan.

“Virtual Interactive Space (V.I.S.) as a Movement Capture Interface Tool Giving Multimedia Feedback for Treatment and Analysis.”

JST Japan Science and Technology Agency

First line of the abstract =

The VIS system was developed to research whether multimedia feedback through movement in virtual interactive spaces is capable of enhancing current methods of rehabilitation therapy.

https://www.researchgate.net/publication/257536704